Role of ligno-cellulosic enzymes in the biodegradation of maize residue in soil: influence of plant residue quality

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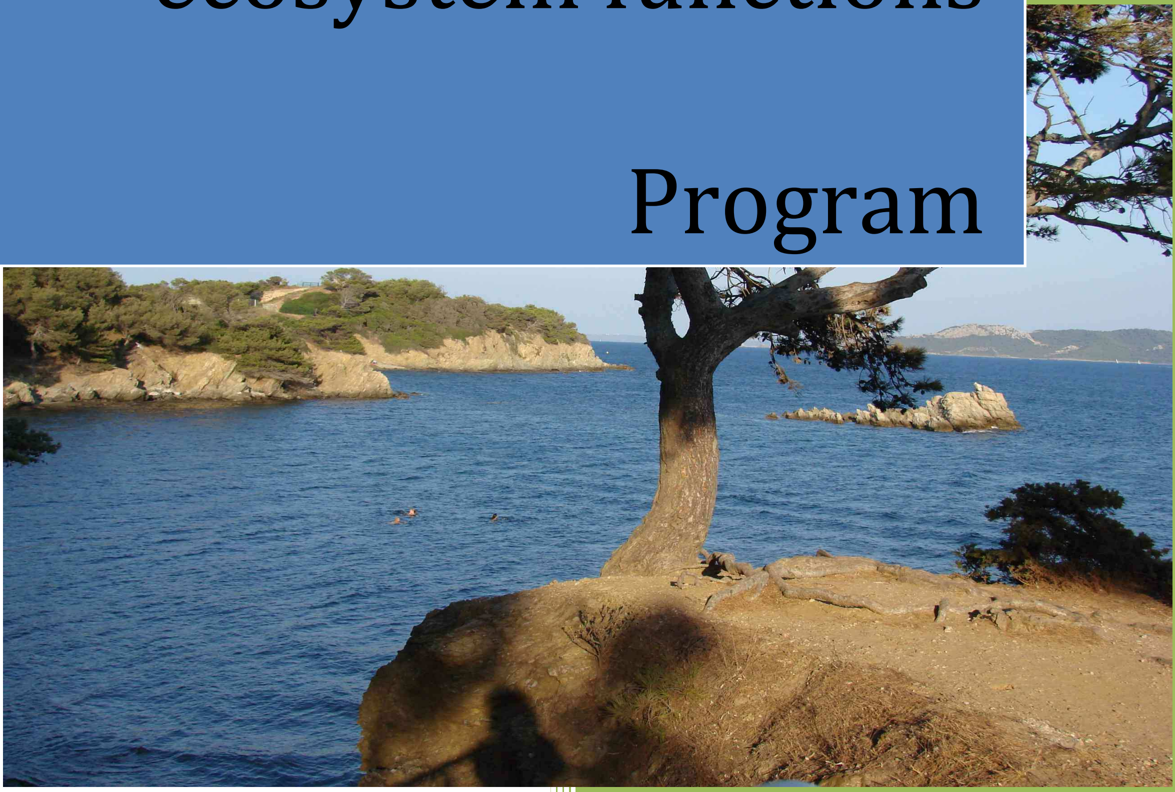
Organic matter stabilization and ecosystem functions

Program



19th-23rd September 2010

Presqu'île de Giens (Côte d'Azur), France

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The European Science Foundation (ESF) is an independent, non-governmental organisation, the members of which are 79 national funding agencies, research performing agencies, academies and learned societies from 30 countries.

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molTER

MOLTER is an ESF-funded Research Networking Programme for the 2008-2013 period. MOLTER aims at stimulating European research on isotopic and organic chemistry exploration of carbon stabilization and biogeochemistry in terrestrial ecosystems and soils in particular.
Our understanding of the formation, stabilisation and decomposition of complex organic compounds in the environment (e.g., organic matter in plants, litter, soils and water) is currently being revolutionized by advanced techniques in identification, quantification, and origin tracing of functional groups and individual molecules. MOLTER promotes exchanges of ideas on emerging concepts and paradigms in this important field of research. In particular, MOLTER recognizes the need to further promote research on

the continued development of new analytical techniques,
the inter-comparison of results from different techniques,
the creation of molecular databases on studied ecosystems.
the development of molecular modelling from soil to ecosystem levels.

The MOLTER network organizes and supports several activities addressing these research themes:

Conferences. For the 5-year period two international science conferences are planned.
Summer schools, providing training to PhD students in relevant fields of research.
Scientific workshops, focusing on specific MOLTER research topics.
Exchange grants (long- and short-term), to visit institutions in other participating countries in order to foster the exchange of knowledge on the European level.

ADEME

Agence de l'Environnement
et de la Maîtrise de l'Energie

ADEME:

The French Environment and Energy Management Agency.

The French Agency for Environment and Energy Management (ADEME) is a public agency under the joint supervision of the French Ministry for Ecology, Energy, Sustainable Development and Sea (MEEDDM), and the Ministry for Higher Education and Research. The Agency is active in the implementation of public policy in the areas of the environment, energy and sustainable development. ADEME provides expertise and advisory services to companies, local authorities, government bodies and the public at large, helping these actors finance projects, in particular research. Hence, one main activity of the agency is to support research and development activities.

The soil is a non-renewable resource with potentially rapid rates of degradation, while the formation and regeneration processes are extremely slow. The soil is subject to an increasingly large number of threats related to human activities, eight of which are considered the most serious by the European Commission: erosion, contamination, surface sealing, compaction, reduction of biodiversity, salinisation, floods and landslides and decline in organic matter content.

Concerning soil issues, ADEME is responsible for taking actions to protect the soil, clean-up the soil and determine the interactions between soil, climate and land-use changes. About 20% of ADEME's programme credits are devoted to these actions. ADEME is thus able to finance private and public research on the development of new tools to monitor and protect the environment. The Agency is also largely involved in the dissemination of scientific results to end-users, decision-makers and general public (e.g. ADEME is coordinator of the Program GESSOL).

ADEME currently supports research and development projects conducted on the following topics:

- The definition of indicators and methods for characterising soil quality. For example, ADEME funds and coordinates the French Programme on the development of "soil bio-indicators" since 2004.
- The standardisation of protocols for soil samples characterisation at French, European and international levels.
- The monitoring of soil quality. Since 2000, ADEME supports the French soil monitoring network, called RMQS ("Réseau de Mesure de la Qualité des Sols »). Thanks to this network, it is already possible to map soil quality in 2 180 sites evenly spread out across France.
- The determination of the impact of agricultural practices, soil management and sludges / composts amendments on the soil quality and the environment.

As soon as 2011, ADEME will support projects studying the links between soil, climate change and land-use changes.

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RÉPUBLIQUE FRANÇAISE
Ministère de l'Écologie, de l'Énergie, du Développement durable et de la Mer

PROGRAMME
GESSOL
Fonctions environnementales & gestion du patrimoine sol

ADEME
Agence de l'Environnement et de la Maîtrise de l'Energie

The Program GESSOL:
A French Research Program on the environmental roles of soil

Soil was hitherto regarded as simply as a support for agricultural production. Now, it becomes clearer that soils as a natural resource perform a number of key environmental, social and economic functions. The Program GESSOL is based on the recognition of these roles. Its main aim is to provide scientific basis and the appropriate tools to decision makers and environmental managers to improve the consideration of the multifunctionality of soils and to reduce risks of degradation, particularly with respect to the draft of the European directive on soils.

GESSOL is an applied Research Program supported by the French Ministry for Ecology, Energy, Sustainable Development and Sea (MEEDDM). Since 1998, after three successive calls for proposals, the program financed 31 research projects. They addressed the most pressing requirements of decision makers and environmental managers concerning the environmental roles of soils, their sensitivity to degradation and the need for their protection. They also contributed to the installation of observation systems of soils and to the discussions about the European Strategy for Soil Protection.

The Research Program is administered by a Steering Committee which brings together various end-users, decision makers and managers concerned with soils. They define the research priorities in accordance with their perceived needs and concerns. A scientific advisory board is composed of specialists in various disciplines associated with soil. It elaborates calls for proposals based on the priorities established by the Steering Committee and guarantees the scientific excellence of the projects selected for funding and the results produced at the end of each project.

The last calls for proposals, published in 2008 and 2009, aimed to emphasize the many services rendered by soils because of the diversity of their functions, by associating researchers in social and human sciences. The Ministry pays particular attention to the dissemination of the research results to decision makers and managers. Conferences are regularly organized to encourage interaction and dialogue between researchers and end-users and a review of the research results, entitled "Gestion durable des sols"[1] (i.e, "Sustainable soils management"), was published in 2008 by Quae Editions.

The Program GESSOL and Soil Organic Matter

SOM is essential for productive and environmental functions of soils. SOM is the principal source of nutrients for plants and soil organisms. SOM increases water holding capacity. SOM reduces risks of erosion. SOM stabilizes pollutants. SOM is a stock of carbon.

Aware of all these roles, the Program GESSOL has already financed several projects aiming at (i) developing management practices that increase SOM stocks and reduce emissions of greenhouse gases, (ii) quantifying and predicting the long-term impacts of these practices on the amount and the quality of SOM and (iii) assessing their effects on the physical, chemical and biological functioning of soils. Among other things, these projects have shown that SOM originating from roots is preferentially stabilized compared to SOM originating from crop residues and that SOM content may be reliably used as an indicator for risks of soil erosion. Besides, predictive models of the effect of soil management on GHG emissions, including N_2O emissions, have been developed.

[1] Citeau L., Bispo A., Bardy M., King D. coord. 2008. Gestion durable des sols. Editions Quae, Paris. 336 p

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PROGRAM

Sunday 19 September

18:30 Icebreaker party

Monday 20 September

8:15-8:30 Introduction of the conference

Session 1—Relative contributions of root and shoot C to C storage in soils

(Chair persons: Ute Hamer and Yakov Kuzyakov)

8:30 -09:10	**Keynote: Daniel P. Rasse (Ås, Norway)** ***Preferential storage of root-derived C in soils***
9:10 -09:30	**Jens Leifeld** , S. Bassin, J. Fuhrer (Zurich, Switzerland) *Soil and root carbon turnover along a pH gradient in subalpine grassland*
9:30 -09:50	**Catherine Roumet**, M. Birouste, A. Blanchard, E. Kazakou (Montpellier, France) *Linkages between fine root traits, root decomposability and soil C accumulation*
9:50 -10:10	**Sandra Spielvogel**, J. Prietzel, I. Kögel-Knabner (Freising-Weihenstephan, Germany) *Spatial distribution and contribution of above- and belowground carbon input to SOC stocks in Norway spruce and European beech stands*

10:10 -10:40 Coffee break

10:40 -11:00	**Bilal Amin**, B. Chabbert, J. Beaugrand, I. Bertrand (Reims, France) *Role of ligno-cellulosic enzymes in the biodegradation of maize residue in soil: Influence of plant residue quality*
11:00 -11:20	**Martina Gocke**, Y. Kuzyakov, G.L.B. Wiesenberg (Bayreuth, Germany) *Root-derived incorporation of C in deep subsoils ? assessment using rhizoliths*
11:20 -11:40	**Jens Altmann,** M. Palviainen, E. de Loon, B. Jansen, K. Kalbitz (Amsterdam, The Netherlands) *Root derived biomarker are slower degraded than leaf derived compounds*

11:40 -12:40 Lunch

12:40 -16:00 Poster Sessions 1, 2, 3

Session 2—Natural molecular structures as drivers and tracers of ecosystem functions

(Chair persons: Ingrid Koegel-Knabner and Sylvie Derenne)

16:00 -16:40	**Keynote: Myrna Simpson (Toronto, Canada)** ***Molecular-level studies of soil organic matter composition in a changing world***
16:40 -17:00	**Ruth H. Ellerbrock,** M. Leue, H.H. Gerke (Müncheberg, Germany) *DRIFT mapping of SOM composition at intact surfaces of preferential flow path*
17:00 -17:20	**Anja Miltner**, R. Kindler, P. Bombach, C. Schurig, M. Kästner (Leipzig, Germany) *Stabilization of microbial biomass carbon in soil - a significant contribution to the formation of refractory soil organic matter*
17:20 -17:40	**Elder A. Paul**, N. Mellor, M. Haddix, R. Conant, K. Magrini, F. Calderon, S. Morris (Ft. Collins, USA) *Relating soil organic matter dynamics to its molecular structure*

17:40 -18:10 Coffee break

18:10 -18:30	**Nadezda A. Vasilyeva,** E.Y. Milanovskiy, S. Abiven, M. Hilf, M.W.I. Schmidt (Zurich, Switzerland) *Black carbon quantity and quality unchanged after 55 years of organic matter depletion in a Chernozem*
18:30 -18:50	**Roman Teisserenc**, M. Lucotte, S. Houel, J. Carreau (Montreal, Canada) *Integrated transfers of terrigenous organic matter to lakes at their watershed level: a combined biomarker and GIS analysis*
18:50 -19:10	**Lauric Cecillon** (Paris-Grignon, France), D.P. Rasse, K. Knoth de Zarruk, A. Budai, R. Sørheim, R. Jeannotte, G. Ragan, E. Ancelet, F. Bray, J.-J. Brun, S. De Danieli, C.E. Thompson, A.F. Plante, G. Hudson *Towards a database and on-line analysis tool for soil molecular research*

20:00 Dinner

Tuesday 21 September

Session 3—Microbial communities as drivers of organic matter dynamics

(Chair persons: Julie Jastrow and Anke Herrmann)

8:30 -09:10	**Keynote: Jim Prosser (Aberdeen, UK)** ***Relationships between microbial diversity and organic matter transformations: more species than we need***
9:10 -09:30	**Lamiae El Moujahid,** T. Pommier, X. Le Roux, F. Bellvert, S. Michalet, F. Poly (Lyon, France) *Relationship between plant diversity, carbon compound diversity and functioning and diversity of denitrifiers in grassland soils*
9:30 -09:50	**Fernando Moyano,** S. Lukas, W. Kutsch (Witzenhausen, Germany) *Soil microbial respiratory up or down-regulation after exposer to short term temperature differences: acclimation, adjustment or what?*
9:50 -10:10	**Ellen Kandeler,** H. Pagel, M. Devers, F. Martin-Laurent, J. Ingwersen, T. Streck, C. Poll (Stuttgart, Germany) *Microbial regulation of carbon cycling at the soil-litter interface*

10:10 -10:40 Coffee break

10:40 -11:00	**Kate Orwin,** M.U.F. Kirschbaum, M. St John, I. Dickie (New Zealand) *Impact of mycorrhizal organic nutrient uptake on ecosystem carbon storage*
11:00 -11:20	**Karen Baumann,** P. Marschner (Adelaide, Australia) *Wheat addition affects microbial resistance and resilience to drying and rewetting in saline soils*
11:20 -11:40	**Joshua Schimel**, C. Boot, S. Schaeffer (Santa Barbara, USA) *The microbial biogeochemistry of drought*

11:40 -12:40 Lunch

13:00 -18:00 Excursion to Porquerolles

19:00 Dinner

20:00 -21:30 "Café des sciences": Phil Sollins and Ingrid Kögel-Knabner *Modeling SOM Dynamics: Pools or Particles?*

Wednesday 22 September

Session 4—Trophic networks and organic matter dynamics

(Chair person: Georg Cadisch)

8:30 -09:10	**Keynote: Richard Bardgett (Lancaster, UK)** ***Trophic interactions and soil organic matter dynamics***
9:10 -09:30	**Laetitia Bernard,** L. Chapuis-Lardy, T. Razafimbelo, A.-L. Pablo, E. Legname, T. Brüls, A. Brauman, J.-L. Chotte, E. Blanchart (Montpellier, France) *Endogeic earthworms modify bacterial functional communities and affect the balance between priming effect and crop residues mineralization in a tropical*
9:30 -09:50	**Evgenia Blagodatskaya**, N. Khomyakov, O. Myachina, S. Blagodatsky, B. Byzov, Y. Kuzyakov (Bayreuth, Germany) *Accelerated organic matter decomposition as a result of earthworms effect on soil microbial community*

9:50 -10:20 Coffee break

Session 5—Impact of changing environmental controls on SOM dynamics

(Chair persons: Isabelle Basile-Doelsch and Deborah Dick)

10:20 -11:00	**Keynote: Margaret S. Torn (Berkeley, USA)**, M.W.I. Schmidt, S. Abiven, T. Dittmar, G. Guggenberger, I. Janssen, M. Kleber, I. Kögel-Knabner, J. Lehmann, D.A.C. Manning, P. Nannipieri, D.P. Rasse, S.E. Trumbore, S. Weiner *Soil organic carbon turnover in a changing world*
11:00 -11:20	**Rota Wagai,** A. Kishimoto, S. Yonemura, Y. Shirato, S. Hiradate (Ibaraki, Japan) *Soil C dynamics and its temperature sensitivity along management-induced SOM gradient: Nature of Q10-substrate quality relationship*
11:20 -11:40	**Kirsten S. Hofmockel**, D.R. Zak, K.K. Moran, J.D. Jastrow (Iowa State University, USA) *Changes in forest soil organic matter pools after a decade of elevated CO_2 and O_3 fumigation*

11:40 -12:40 Lunch

12:40 -16:00 Poster Sessions 4, 5, 6

Session 5—Impact of changing environmental controls on SOM dynamics (continued)

(Chair persons: Isabelle Basile-Doelsch and Deborah Dick)

16:00 -16:20 **Luis Lopez-Sangil**, P. Casals , P. Rovira (Barcelona, Spain) *Soil organic and inorganic C dynamics under two contrasting rewetting frequencies: an annual experiment in* ^{14}*C-labelled mesocosms*

16:20 -16:40 **Kate Lajtha,** S. Frey, K. Nadelhoffer, R. Bowden, E. Brzostek, A. Burton , B. Caldwell, S. Crow, M. Day, A. Finzi, C. Goodale, S. Grandy, K. Lajtha, M. Kramer , J. LeMoine, R. Maclean , M. Martin, B. McDowell, A. Melvin, S. Ollinger, A. Plante , P. Templer, M. Weiss (Corvallis, USA) *Soil organic matter responses to Chronic nitrogen additions in a temperate forest*

16:40 -17:00 **Oihane Fernández-Ugalde,** I. Virto, M.J. Imaz, P. Bescansa, A. Enrique (Pamplona, Spain) *Interaction of carbonates and fresh organic matter in macroaggregate dynamics and organic matter stabilization in carbonate-rich Mediterranean soils*

17:00 -17:30 Coffee break

17:30 -17:50 Zhou Ping, **Pan Gen-xing,** Z. Xu-hui, S. Xiang-xun, L. Lian-qing (Nanjing, China) *Depressing decompostion of organic amendments in soil facilitated by oxyhydrate coating*

17:50 -18:10 **Pierre Bonnard,** I. Basile-Doelsch, J. Balesdent, A. Masion, D. Borschneck, D. Arrouays (Aix-en-Provence, France) *Characterizing organomineral complexes in surface and subsurface horizons of an acid loamy soil using sequential density fractionation*

18:10 -18:30 **Marc G. Kramer**, K. Lajtha, K. McFarlane, A. Aufdenkampe, C. Swanston (Santa Cruz, USA) *Scaling from density fractions up to the pedon: Organic matter chemistry across sequential density fractions from two contrasting Oxisol soil depth profiles*

18:30 -20:00 “Apero” Posters

20:00 Conference dinner

22:30 Dance party at the beach

Thursday 23 September

Session 6—Heterogenetity and scaling processes of OM decomposition and stabilization: molecular to regional scales (Chair persons: Göran Ågren and Alain Plante)

8:30 -09:10 **Keynote: John Crawford (Sydney, Australia)** ***Heterogeneity and scaling processes of OM decomposition and stabilization: molecular to regional scales***

9:10 -09:30 **Liesbeth Bouckaert,** D. Van Loo, B. Hantson, L. Van Hoorebeke, S. De Neve, S. Sleutel (Ghent, Belgium) *Localization of organic carbon pools in the soil matrix*

9:30 -09:50 **Pierre-Joseph Hatton**, L. Remusat, B. Zeller, M. Kleber, D. Derrien (Paris, France) *A sub micrometric-scale mapping of nitrogen at the surface of soil particles: a combined* ^{15}*N labelling and NanoSIMS approach*

9:50 -10:10 **Bernd Marschner,** E. Jueschke, J. Krannich (Bochum, Germany) *Small scale heterogeneity of enzyme activities in the top- and subsoil of a forested Cambisol*

10:10 -10:40 Coffee break

10:40 -11:00 **Carlos A. Sierra,** S. Trumbore, M. Harmon, S. Perakis (Irvine, USA) *Substrate heterogeneity and quality convergence in decomposing litters*

11:00 -11:20 **Sebastian Doetterl,** K. Van Oost, A. Stevens, B. Van Wesemael, T. Quine (Louvain-la-Neuve, Belgium) *Soil organic matter dynamics and spatial heterogeneity in relation to landscape scale processes*

11:20 -11:40 **Mike Whitfield,** N. Ostle, R. Bardgett, R. Artz, D. Beilman (Lancaster, UK) *Upscaling peatland biodiversity and carbon dynamics to the ecosystem level*

11:40 -12:40 Lunch and departure

ABSTRACTS

Session 1 – RELATIVE CONTRIBUTIONS OF ROOT AND SHOOT C TO C STORAGE IN SOILS

Oral presentations - Session 1

Posters - Session 1

Session 2 – NATURAL MOLECULAR STRUCTURES AS DRIVERS AND TRACERS OF ECOSYSTEM FUNCTIONS

Oral presentations – Session 2

Posters – Session 2

Session 3 – MICROBIAL COMMUNITIES AS DRIVERS OF ORGANIC MATTER DYNAMICS

Oral presentations – Session 3

Posters – Session 3

Session 4 – TROPHIC NETWORKS AND ORGANIC MATTER DYNAMICS

Oral presentations – Session 4

Posters – Session 4

Session 5 – IMPACT OF CHANGING ENVIRONMENTAL CONTROLS ON SOM DYNAMICS

Oral presentations – Session 5

Posters – Session 5

Session 6 – HETEROGENEITY AND SCALING PROCESSES OF OM DECOMPOSITION AND STABILIZATION: MOLECULAR TO REGIONAL SCALES

Oral presentations – Session 6

Posters – Session 6

Session 1 – RELATIVE CONTRIBUTIONS OF ROOT AND SHOOT C TO C STORAGE IN SOILS

Oral presentations - Session 1

Keynote lecture

Preferential storage of root-derived C in soils

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On a global basis, the fixation of CO_2 through plant net primary productivity exceeds anthropogenic emissions by nearly an order of magnitude. Therefore, efficient transformation of plant necromass into stable forms of soil organic C is pivotal to successfully mitigating global climate change. Recent research suggests that this efficiency is strongly dependent on whether this C originates from roots or from shoots. Root-derived C appears to be preferentially stored in soils as compared to shoot-derived C. Studies suggest that the mean residence time in soils of root C is twice as long as that of shoot C. Recent biomarkers studies probing the fate of root- vs. shoot-specific compounds also appear to confirm these results, although interpretation of biomarker data remains complex.

The stabilization in soils of shoot-derived C appears to be a particularly inefficient process. Only about 12% of maize-shoot C remains stabilized in soils a few initial years after incorporation. This low efficiency has strong implications for C storage in agricultural lands. For example, in the EU27 the cereal crop production generates each year an estimated 110 million tons of above-ground plant residue C. Excluding alternative usages, this figure implies that about 355 million tons CO_2 per year (96 million tons residue C) are released to the atmosphere from quickly mineralizing crop residues in European arable lands. In this context, some have suggested that burning crop residues as biofuel would be several times more efficient in terms GHG budget than returning these residues to the soil. Instead of complete burning, a more promising method is the transformation through pyrolysis of labile plant residues into biochar structures, which are stable in soils. Cereal-straw biochar appears to have many of the same soil-quality enhancement properties as fresh residues, e.g. increased retention of soil water and nutrient in soils. Crop-residue biochar decreases N_2O emission from soils but might not enhance soil structure as much as fresh shoot-residue application does. So, the question is not so much whether we can slow down the fast turnover rate of above-ground residue C in soil, because the answer appears to be yes with technologies such as biochar. Rather, the question is whether this fast turnover rate serves soil-quality functions of sufficient significance to offset its high cost in terms of GHG emissions.

The comparatively high sequestration of root-derived C in soils suggests that cropping systems could be optimized for storing C, in particular through increases in the relevant root activities. However, this supposes an understanding of the mechanisms governing the preferential storage of root C in soils. At this point, we do not know whether the job of sequestering C throughout the soil profile would be best done with plants having: 1) deeper root systems, 2) larger root biomass, 3) higher production of root exudates, 3) finer roots, 4) higher rates of root turnover, 5) roots with higher content of lignin and aliphatic compounds, 6) or possibly other properties? In other words, we do not yet have the emerging technology for exploiting the ability of root systems to preferentially store C in soils. Research needs in this direction as well as for reducing GHG emissions associated with shoot-residue application will be discussed.

Keywords: root C, shoot C, cutin, suberin, biochar, deep rooting crops

Soil and root carbon turnover along a pH gradient in subalpine grassland

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Owing to combined effects of litter quality and pH, soils in cold environments tend to accumulate relatively high amounts of labile carbon. We used a pH gradient (3.8 to 5.7) in subalpine grassland to identify the role of pH vs. root quality as two important factors controlling SOC turnover. Root quality was derived from C/N measurements and a 3-weeks decomposition of dead roots in the lab. Radiocarbon dating of soil fractions (particulate and mineral-associated C) and roots together with C inventories was used to compute turnover times and C fluxes through the individual compartments. Acidic sites accumulated more particulate organic matter though the total carbon stock was not different from sites with higher pH. Radiocarbon-based turnover calculations indicated that SOC mean residence times were longer at low pH for both, particulate (overall range 60 to 100 years) and mineral-associated (overall range 90 to 250 years) carbon. Longer turnover times compensated for smaller carbon inputs at low pH (input c. 50 % of that at high pH). Laboratory decomposition experiments of dead roots revealed similar degradability across the pH gradient, in agreement with radiocarbon-based root turnover calculations (mean root ages of between 6 and 17 years). It was, however, not possible to separate effects of pH on SOC turnover from those induced by the quality of roots as root pH significantly correlated with soil pH. Because root turnover time did not depend on pH, it seems that higher inputs as calculated for sites with higher pH must be due to higher aboveground litter input, in correspondence with measured higher aboveground yields. Thus, the relative accumulation of particulate C at low pH seems to be caused by a higher contribution of root litter vs. aboveground litter.

Keywords: SOC, root, radiocarbon, turnover, pH

Linkages between fine root traits, root decomposability and soil C accumulation.

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Fine roots represent a large fraction of annual primary production in many terrestrial ecosystems and their decomposition rates have important implications for soil organic matter formation. The role of plant species in controlling decomposition through their influence on litter quality is well-established for leaves. However much less is known about the role of root morphology and chemical composition on root decomposition and soil C accumulation.

In this study we investigated the intrinsic effects of species on fine root decomposability of 18 Mediterranean herbaceous species differing by their successional status, life history and taxonomic group. We tested i) whether differences in root decomposability are related to root chemical and morphological traits (ii) the relationship between root decomposability, root traits and soil dissolved organic carbon (C), iii)the existence of a common pattern between root and leaf decomposability and traits.

Fine root decomposability showed a 5-fold variation among species. Root decomposability is higher for Asteraceae and Fabaceae than for Poaceae and Lamiaceae, while it is not affected by the life history and the successional status of species. Root chemistry strongly influenced the rate of decomposition, which is positively correlated with the root soluble compound and phosphorus concentrations and negatively correlated with root cellulose concentration. Surprisingly, root morphological traits (specific root length, diameter, density) did not influence root decomposability.

Soil extractable C accumulation is improved by species with large root systems, characterized by low root decomposition and respiration rates, a high carbon and root dry matter concentration and a low nitrogen concentration. This suggested that soil extractable C accumulation resulted from at least three processes governed by root traits: i) an increase in the rate of rhizodeposition assessed by a larger biomass, ii) a decrease in C lost through reduced root respiration, ii) a decrease in root decomposition rate associated with a lower root tissue quality.

Roots and leaves showed strong similar pattern of analogous traits. Fine root and leaf decomposition rates are positively correlated, even if roots decomposed twice slower than leaves; leaf and root decomposability rates are both explained by differences in chemical concentration. This bears considerable prospects of predicting belowground plant functions from the aboveground components alone.

Keywords: chemical composition, functional traits, interspecific variability, morphology, roots, root decomposition, soil dissolved organic carbon

Spatial distribution and contribution of above- and belowground carbon input to SOC stocks in Norway spruce and European beech stands

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Soil organic carbon (SOC) stocks of forest soils are characterized by pronounced small scale spatial heterogeneity caused by a multitude of factors. The patchy distribution of trees and ground vegetation may have major impact on SOC variability and stability at the small scale. Nevertheless, our knowledge about spatial correlations between the pattern of tree and ground vegetation, SOC stocks in different soil depths and the contribution of root- vs. shoot-derived carbon to different SOC fractions is scarce. The aliphatic biopolyesters cutin and suberin are suggested to be useful tracers for the contribution of root- vs. shoot-derived carbon to SOC in different soil horizons and fractions. Thus the main objectives of this study were (i) to elucidate the relative abundance of cutin and suberin in different particle size and density fractions of a Norway spruce and a European beech site in the Nationalpark Bayerischer Wald (Germany) with increasing distance to stems, and to (ii) analyse the spatial pattern of cutin and suberin stocks in different soil depths in relation to tree and ground vegetation distribution. Both sites were sampled using a geostatistical grid sampling approach that included a large scale design with distances between 5 and 25 m with a small-scale nested sampling ranging within 0.5 to 2.5 m to allow estimating the order of magnitude in which spatial (auto-)correlation occurs. Soil samples, root, bark and needle/leave samples were analyzed for their cutin and/or suberin signature. Previous to isolation of bound lipids, solvent extraction was used to remove free lipids and other solvent extractable compounds. Cutin- and suberin-derived monomers were extracted from the samples using base hydrolysis. Before analysis by Gas Chromatography/Mass Spectrometry (GC/MS), extracts were derivatized to convert compounds to trimethylsilyl derivatives. The sources of some compounds, which were found in the soil samples are unspecific. Nevertheless, our statistical analysis identified eight variables which discriminated significantly between cutin and suberin based on their structural units. The eight variables where subsequently subjected to a factor analysis which resulted in two factors with an eigenvalue >1. High loadings for factor a are indicative for cutin/aboveground carbon, whereas high loadings for factor b are indicative for suberin/belowground carbon. We found a relative enrichment of cutin and suberin contents in the order of sand < silt < clay at both sites that decreased with increasing distance to the trees. However, the spatial range of significant enrichment in the fine fractions at the beech site was twice as high compared to the spruce site. Moreover, the spatial pattern of cutin and suberin contribution to SOC stocks in different soil depths differed significantly between the two sites. We conclude from our results that (i) patchy above- and belowground carbon input caused by heterogeneous distribution of trees and ground vegetation has major impact on SOC variability and stability at the small scale, (ii) tree species is an important factor influencing SOC heterogeneity at the stand scale due to pronounced differences in above- and belowground carbon input among the tree species and that (iii) forest conversion may substantially alter SOC stocks and spatial distribution. Thus an assessment of the spatial distribution of total SOC stocks in forest stand gives only rough information about sequestration processes detailed information about the spatial distribution of different SOC compounds (e.g. biomarkers) is needed.

Keywords: aliphatic biopolyesters, cutin, suberin, spatial variability

Role of ligno-cellulosic enzymes in the biodegradation of maize residue in soil: Influence of plant residue quality

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Intrinsic characteristics of plant residues which correspond to the substrate for microbial growth and enzyme activities is a key factor determining the kinetics of decomposition in soils (Bertrand et al., 2006; 2009). These processes are partly mediated by extra-cellular enzymes involved in degradation, transformation and mineralization of plant residues (Sinsabaugh et al., 2009). Thereby, exoenzyme assays can provide functional information to further understand the relationships between soil microbial activity and the nature of carbon entering the soil (Sinsabaugh et al., 1991).

The main objective of this study was to analyse from a dynamic point of view the relationships between contrasted carbon mineralization kinetics due to different residue quality and enzyme activity profiles. Enzyme activities in soil and on the decomposing residues were compared to achieve functional interpretation of enzyme action.

To do so, incubations of aerial parts (leaf) and underground parts (root) of maize plants were performed in an agricultural loamy soil. These incubations were performed under controlled conditions for 43 days at 15°C and a water potential of -80kP with mineral nitrogen added. A dynamic characterization of plant residue quality (polysaccharide and lignin contents), of specific-enzymes activity (Xylanase, Cellulase, CBH-1 and Laccase), of microbial biomass C and of residue C mineralization was performed. Our results showed that, after short term incubation,, maize leaves mineralized significantly more C than maize root. Indeed this contrasted C kinetics was related to different chemical composition of the residues, with leaves having higher cyto-soluble content and lower Klason Lignin content than roots. Enzymes activities determined directly on plant residue were systematically higher in leaves than roots. High xylanase and cellulase activities measured at the start of incubation while laccase activity was low which is more pronounced in case of roots.

References: Bertrand et al. 2006, Plant and Soil 281: 291-307; Bertrand et al. 2009, Bioresource Technology 100: 155-163; Luxhøi et al. 2002, Soil Biology & Biochemistry 34: 501–508; Magid et al. 1997, Soil Biology & Biochemistry 29:1125–1133; Sinsabaugh et al. 1991, Agriculture Ecosystems & Environment 34: 325-335; Sinsabaugh et al. 2009, Soil Biology & Biochemistry 462: 795-U117

Keywords: Decomposition, Plant residue, chemical quality, enzyme

Root-derived incorporation of C in deep subsoils – assessment using rhizoliths

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Rhizoliths are a special form of pedogenic carbonate formed by encrustation of roots. They occur in soils and underlying sediments and are assumed to develop during any stage of pedogenesis. Due to their relative persistence once they originated, they yield potential to reflect past environmental conditions. Additionally, organic matter (OM) inside rhizoliths can be protected against degradation, leading to a conservation of root-derived OM in soils and subsoils. Depending on the rooting depth of plants, rhizoliths can be observed several m below recent soil surface and even in underlying sediments. Such an example was desrcibed at the Nussloch site (SW Germany), where rhizoliths have been found in terrestrial sediments (loess) at depths of 8 m below recent soil surface. In the vicinity of rhizoliths a relative enrichment of root-derived C is most likely. As initial C_{org} content is commonly low in subsoils and terrestrial sediments like loess, root-derived C associated with deeply rooting plants and thus rhizoliths can account for significant proportions of C_{org} in these substrates. However, attempts to assess root-derived C associated with rhizoliths are scarce.

We determined source vegetation of rhizoliths and assessed overprinting of initial OM in subsoil and terrestrial sediments at the Nussloch site using geochemical proxies. To obtain information on the source vegetation of rhizoliths and to differentiate this from OM in surrounding materials, we investigated loess and OM remains in rhizoliths using alkane and fatty acid (FA) molecular proxies.

Source vegetation of OM in recent soil and underlying sediments could be clearly differentiated. Molecular proxies indicated grass vegetation in surface soil as a result of agricultural use during the past decades, whereas OM of subsoil horizons indicated stronger degradation and was not indicative for a special type of vegetation. Loess OM reflected steppe like vegetation, confirming the assumption of deposition during glacial periods with scarce grass vegetation cover. In contrast, root biomass of woody plants was found to be the origin of the rhizoliths. This, together with radiocarbon data from the same section, disproved the prevalent opinion about rhizolith formation taking place simultaneously with loess sedimentation and/or recent formation at the Nussloch site. While loess sedimentation occurred under steppe-like conditions and ceased 15–17 ky before present, roots entered the loess later (radiocarbon ages of rhizoliths: 3–4 ky) under different climatic conditions, and consequently derive from different vegetation. Hence, rhizoliths at this site represent remains of a vegetation cover prior to actual anthropogenic agricultural use, i.e. a proposed open forest vegetation.

For quantification of the post-sedimentary input of root-derived OM in loess and differentiation of the different biogenic sources, the lipid composition was compared in transects from rhizoliths via rhizosphere loess towards root-free loess at a distance of 50–70 cm, using several alkane and FA molecular proxies: amounts of mono- and polyunsaturated FA (MUFA, PUFA), carbon preference index (CPI) and average chain length (ACL). A significant contribution of root-derived OM in loess adjacent to rhizoliths was found. In comparison to rhizoliths and root-free loess, stronger degradation of OM, together with a large content of microorganism-derived FA in the former rhizosphere indicated rhizodeposition associated with high microbial activity in loess adjacent to rhizoliths, at least up to a distance of 5 cm. Based on PUFAs, we quantified the amounts of root-derived OM incorporated into loess adjacent to rhizoliths by comparison with reference loess from the same depth, which accounted for at least 70% of the OM adjacent to rhizoliths.

More research is necessary for elucidation of the influence of deeply rooting plants on the composition of OM in deep subsoils and underlying sediments.

Keywords: root OM, loess, post-sedimentary input, lipid molecular proxies, alkanes, fatty acids

Root derived biomarker are slower degraded than leaf derived compounds

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Up to now there is only a poor understanding of the sources contributing to organic carbon in forest soils, especially the contribution of leaves and roots. Compounds being specific for leaves and roots might be a promising tool to improve our knowledge of different sources of soil organic matter (SOM). A first step for accurate use of such plant part specific biomarkers is the determination of their stability and their altered decomposition products during litter decomposition. This information is necessary if we want to assess the dynamics of these compounds in soils and to use them for source estimations. Surprisingly, information about the dynamics of root and leaf-derived biomarkers during litter decomposition is scarce.

We analyzed the chemical composition of samples from a 3-year litterbag decomposition experiment with roots and leaves of spruce, pine and birch which was conducted in Finland.

In this study we focused on the following questions:

(I) Which compounds are characteristic to identify certain plant parts and plant species?

(II) How stable are these compounds during the first 3 years of litter decomposition?

Additionally to mass loss, carbon and nitrogen contents, free lipids were extracted and non soluble components were analyzed by TMAH Curie-point Pyrolysis. In addition to the identification and quantification of a variety of different compounds and compound ratios we used statistical classification methods to find stable and indicative patterns which can be used for source identification in soils.

The mass loss was largely different between the litter species and we always observed larger mass loss for leaf-derived litter in comparison to root derived litter.This trend was also observed by molecular analysis. The increase of the ratio of vanillic acid to vanillin was negatively correlated to the mass loss of the samples over time. Lignin oxidation was stronger for leaves and needles than for roots per unit mass loss. Needles and leaves could be best identified by the contents of alkanes, which decreased significantly within 3 year, but the ratios of C21, C27 and C31 alkanes remained stable over this period of time. The alkane contents of roots were much lower than the alkane contents of needles and leaves, but root alkanes appeared to be more stable than leaf and needle Alkanes.

Preliminary results showed, that roots had higher contents of certain hydroxy fatty acids and epoxy fatty acids than needles and leaves which seem to be stable within the first three years of litter decomposition.

This promising results show that through biomarker analysis already degraded litter material can be successfully related to the originating material. For further approaches of quantification the different decomposition dynamics of roots and needles/leaves have to be considered.

Keywords: biomarker, litter decomposition, roots, needles, forest ecosystem, cutin, suberin

Posters - Session 1

Poster S1-P1

^{13}C isotopic signatures of cutin and suberin biomarkers to assess root and shoot C contribution to soil organic matter

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Cutin and suberin biopolyesters have been suggested to significantly contribute to the stable pool of soil organic matter (SOM). They might be used as tracers for the above- or belowground origin of plant material. The aim of this study was to evaluate the dynamics of shoot and root-derived biomarkers in soils using a wheat/maize (C_3/C_4) chronosequence. Analysis of plant tissues suggests that a,w-alkanedioic acids can be considered as root specific markers and mid-chain hydroxy acids as shoot specific markers of wheat and maize in this agricultural soil. The changes of the ^{13}C isotopic signatures of these markers with years of maize cropping after wheat evidenced their contrasted behaviour in soil. After 12 years of maize cropping, shoot markers present in soils probably originated from old C_3 vegetation suggesting that new maize cutin added to soils was mostly degraded within a year. The reasons for long-term stabilisation of shoot biomarkers remain unclear. By contrast, maize root markers were highly incorporated into SOM during the first six years of maize crop, which suggested a selective preservation of root biomass when compared to shoots, possibly due to physical protection. The contrasting distribution of the plant-specific monomers in plants and soils might be explained by different chemical mechanisms leading to selective degradation or stabilization of some biomarkers.

Keywords: cutin, suberin, roots, shoots, compound specific isotopic analysis, dynamics, C3/C4 chronosequence

Poster S1-P2

A functional approach to estimate root decomposition rates and litter quality delivered to the soil.

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In the context of changing climate, this project aims at increasing knowledge and prediction abilities of root decomposition rates, which are partly responsible for carbon fluxes from the plant to the soil organic matter. In order to go beyond taxonomic barriers, a functional and comparative approach is tested here, based on specific morphological and biochemical characteristics.

This study focuses on ten tree species and is based on an intact soil core technique. Roots are left intact in there surrounding soil, placed in a plastic tube and sealed with nylon micro-mesh. This method has been chosen to get results as close as in situ conditions as possible.

The evolution of allometric relationships between biomass and total root length during decomposition process resulted in two major trends : (i) species with low specific root length (SRL in m.g-1) showed a sequential decrease in biomass, and then in length; (ii) species with high SRL simultaneously loose biomass and length since the first stages of decomposition. In other words, species with coarser roots need more time to fall apart, especially considering their fine roots.

Principal componant analysis with 6 biochemical root traits resulted in a segregation of the species belonging to the two trends explained above.

The evolution of biochemical traits during decomposition evokes an influence of microorganisms, sometimes going against expected results from the functional approach.

Thus, root morphological characteristics and biochemical traits seem to play an important role in the different decomposition stages, in the biomass loss and root fragmentation dynamics. However, rhizosphere microorganisms seem to be able to inverse predictions in terms of quality and rate of litter delivery to the soil.

Keywords: functional trait, root decomposition, root litter quality

Poster S1-P3

Assessment of shoot vs. root derived plant biomass in soil using long chain fatty acids (>C20)

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Assessment of soil organic matter (SOM) deriving from shoot vs. root derived plant biomass is difficult for natural soils. In laboratory experiments aboveground biomass contribution could be easily avoided, which allows for determination of exclusively root derived OM. However, the contribution of root and shoot derived organic matter in soils commonly cannot be differentiated easily in one experiment using natural soils. We used long chain *n*-fatty acids (>C_{20}) for this assessment, where different compounds derive from cutin/cutan (aboveground biomass) and suberin/suberan (root biomass).

Laboratory experiments as well as long term field experiments are used for the determination of long chain fatty acids to SOM. While laboratory experiments were used to quantify the contribution of root derived fatty acids to root-free soil and rhizosphere, several long term trials allowed for a determination of the contribution of root and shoot derived fatty acids to SOM.

Abundance of long chain fatty acids is different in aboveground and root biomass. Commonly, aboveground biomass is characterized by a larger abundance of fatty acids with a longer chain length than corresponding root biomass. Typically, root biomass is enriched in C_{20-24} fatty acids, while aboveground tissues of the same plant are characterized by an enrichment of fatty acids with a chain length that is two to six carbons longer than most abundant long chain compounds in root biomass. By comparing these most abundant compounds in roots and shoots with SOM, an assessment of root and shoot derived carbon is possible. We show data for arable, grassland and forest soils, where we assessed the contribution of root vs. shoot derived OM based on the composition of long chain fatty acids.

Keywords: shoot vs. root biomass, long chain fatty acids

Poster S1-P4

Biofuel Feedstocks: Implications for Sustainability and Ecosystem Services

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Global energy use projections predict that biomass will be an important component of primary energy sources and a main source of renewable energy in the coming decades. Cellulosic crops will be a major component of this biomass. However, concerns have been raised about the sustainability of biofuel cropping systems. Understanding the basis for sustainable biofuel production systems is crucial for the long-term success of these systems. The objective of the present study is to gather sustainability data that documents soil physical, chemical and biological properties; quantify the total root biomass for different energy crops; characterize soil microbial diversity and abundance under each bioenergy crop as well as environmental implications of the various biofuel feedstocks candidate for cellulosic ethanol production. Soil and root samples were taken from a field site to a depth of 120cm. Additional soil quality indicators for soil structural stability, soil microbial abundance and diversity from 0 to 30cm will be evaluated. For each bioenergy crop, root biomass was quantified in increments of 0-5, 5-15, 15-30, 30-45, 45-60, 60-75, 75-90 and 90-120 for inter-rows, between plants and at the center of the plants respectively. For the annual crops, root biomass was concentrated in the surface 15 cm (>90%). Switchgrass (*Panicum virgatum*) and Miscanthus (*Miscanthus giganteus*) had significant root biomass to 90 cm with 15 and 30 % root biomass respectively below 30 cm. The greater rooting depth of the perennial crops may result in a much lower carbon turnover rate and thus greater soil organic matter stabilization. Despite differences in root biomass production among energy crops and within the soil profile, differences in soil carbon between energy crops were not significant after 3 years and averaged 260 Mg C ha^{-1} to a depth of 120 cm. Utilizing the bioenergy plants, miscanthus (*Miscanthus giganteus*), switchgrass (*Panicum virgatum*), big blue stem (*Andropogon gerardii* Vitman), different varieties of sorghum (*Sorghum bicolor*) and corn (*Zea mays*) we can examine feedbacks of these systems on soil properties and C and N cycles. Specifically we are addressing changes in soil microbial diversity and soil structural stability between these energy crops. Soil microbial community composition will be characterized using phospholipid fatty acid (PLFA) analysis. We will provide quantitative values to classify the different energy crops based on a soil sustainability index.

Keywords: root biomass, soil carbon, microbial community, energy crop, soil sustainability index

Poster S1-P5

Carbon stocks and organic matter composition in subtropical Oxisols as affected by pasture management

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At the highland soils, located at the north eastern part of Rio Grande do Sul State, South Brazil, cattle raising is one of the main economic activities. Burning of vegetation at the end of winter has been replaced in the last years by other management strategies like lower grazing intensity and frequency, introduction of new forage species, grassland cutting and soil liming and fertilization(1). The present work aimed to investigate the effect of pasture management on the quality and stocks of soil organic matter (SOM) of a Red Oxisol. Soil samples (0-5cm) were collected (three replicates) from: non-managed native pasture without burning in the last 41 years and grazed with 1.2 animal ha^{-1} (NP), native pasture without burning in the last 8 years and grazing of 0.5 animal ha^{-1} (BP), native pasture without burning in the last 41 years, grazed with 1.2 animal ha^{-1} and ameliorated by liming and fertilization in the last 17 years (AP) and native forest (NF). Physical fractionation was performed by the densimetric method (politungstate solution, $\rho = 2$ g cm^{-3})(2) resulting in free light fraction (FLF), occluded light fraction (OLF) and heavy fraction (HF). Carbon and nitrogen contents were determined by dry combustion and carbon stocks were calculated. SOM in physical fractions was investigated by thermo-gravimetric analyses (TGA) between 40°C and 800°C under synthetic air and a chemical recalcitrance index was calculated(3):$\Delta m_{(3º)}/\Delta m_{(2º)}$. From the Fourier Transformed Infrared spectroscopy (FTIR) spectra, relative intensities of the main absorptions were obtained and an aromaticity index was calculated(3). Soil C stock was greater in the ameliorated pasture (38 Mg ha^{-1}) than in the BP environment (27 Mg ha^{-1}), while an intermediate value was found in NP (30 Mg ha^{-1}). This result is related to the higher forage production in the ameliorated pasture in comparison to the non-managed pastures. Therefore, the greater input of vegetal residues (above and below ground) in the former environment promoted C sequestration in spite of its higher grazing intensity, when compared to the more recently burned pasture (BP).

The same behaviour was followed by C stocks in the physical fractions. The increase in C stocks in the ameliorated pasture in comparison to BP occurred in all three fractions, and the values were 7.0 Mg ha^{-1} for FLF, 4.7 Mg ha^{-1} for OLF and 26.1 Mg ha^{-1} for the heavy fraction. C stocks shown by BP were the smallest ones: 2.2; 3.1 and 21.4 Mg ha-1, for FLF, OLF and HF, respectively. Both light fractions of the BP environment showed high C/N values (28 and 19), indicating the occurrence of a different forage (FLF) and of a more recalcitrant OLF in this environment in comparison to NP and AP. These results were corroborated by the FTIR data, where the lowest intensities of N-H bands were found for OLF and FLF of BP. Additionally, these two fractions showed the smallest relative intensity of the 1630 cm^{-1} band and greatest of the 2920 cm^{-1} band in comparison to their respective counterparts of the other environments. The opposite occurred with the HF. It follows that the forage species developed under BP were more aliphatic and less aromatic than in the other environments. The heavy fraction from BP, due to the lower residue input was enriched in aromatic structures along humification. TGA data confirmed partially these findings. Fertilizing and liming of the subtropical pastures in South Brazil highlands proved to be an appropriate management strategy to improve soil C sequestration. However no impact on the SOM quality was detected. Ceasing fire, without any subsequent pasture amelioration, deplete C stocks and increase SOM aromaticity in the heavy fraction.

References: (1) Heringer et al., Pesq. Agro. Bras., 37, 399-406, 2002; (2) Conceicao et al., Rev. Bras. Ci. Solo, 32, 541-549, 2008.; (3) Potes et al, Rev, Bras. Ci. Solo, 34, 11-21, 2010

Keywords: physical fractions, humification, C sequestration, chemical composition

Poster S1-P6

Carbon stocks in profiles of Brazilian subtropical Oxisols as affected by soil management systems

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The intensive use of agriculture soil in tropical and subtropical regions may lead to the degradation of its chemical, physical and biological properties. Among these, carbon (C) stock is one of the most affected. In tropical and subtropical soils, conservationist soil management systems, e.g. no-tillage (NT), have proved to promote an increase of C stocks at surface layers(1). This effect is related to non revolving of soil and to maintenance of vegetal residues on the soil surface. Results obtained about quality and quantity of soil organic matter (SOM) in soil physical compartments indicated that the SOM stabilyzing mechanisms are affected by soil type and soil management system(2). So far, little scientific information is available about C sequestration in soil profiles in subtropical agriculture soils. Therefore, the main objective of this work was to investigate the effect of soil management systems on the SOM stock and quality in profiles of a Red Oxisol (28°30'S, 54°27W) and of a Brown Oxisol (25°33'S, 51°29W), located in South Brazil. Soil samples were collected (triplicates) in 9 layers until 100 cm depth from long term experimental areas (30 years) under NT, under conventional tillage (CT) and under native forest (NF). Physical fractionation (0-5, 5-10, 10-20 cm) was performed by the densimetric method (politungstate solution, $\rho = 2$ g cm^{-3})(4) resulting in free light fraction (FLF), occluded light fraction (OLF) and heavy fraction (HF). Carbon and nitrogen contents were determined by dry combustion and carbon stocks in whole soil and physical fractions were calculated. SOM quality was investigated by laser induced fluorescence (LIF) and an humification index was determined(3). Soil C stocks of the Red Oxisol varied between 5.6 and 28 Mg ha^{-1} under NT, 4.5 and 26 Mg ha^{-1} under CT, and from 9.5 to 27 Mg ha^{-1} under NF. In the first 5 cm soil layer and in the three deeper layers (40-60 cm, 60-80 cm and 80-100cm) C stocks were greater under NT in comparison to CT. When compared to native vegetation, this soil presented larger values for C stocks under NT in the layers deeper than 40 cm. The obtained values for the Brown Oxisol were alwayslarger than those for the Red Oxisol, and varied from 9.7 to 45 Mg ha^{-1} under NT, from 6.4 to 39 Mg ha^{-1} under CT, and from 12 to 43 Mg ha^{-1} under NF. In this soil, however, no differences in C stocks were found between soil management. The colder and more humid climate of the Brown Oxisol site (MAT: 16,5°C; MAP: 2022 mm y^{-1}) attenuated the impact of the CT on the SOM mineralization in comparison to the hotter and dryer Red Oxisol site (MAT: 19,5°C; MAP: 1850 mm y^{-1}). Similarly to the Red Oxisol, in the Brown Oxisol, C stocks in the 40 to 80 layers were larger under NT than under NF. Regarding the physical fractions of the Red Oxisol, only the OLF and the HF of the 0-5 cm layer under NT presented greater C stocks than under CT. Conversely, for the Brown Oxisol, differences in C stocks were found only in the OLF in all three analysed layers.

The magnitude of the effect of no-tillage in C sequestration depended on soil type and climate, due to the different mineralization rates and diverse organo-mineral interactions. Soil subsurface layers are important C sinks and the SOM dynamics along the profile is affected by the soil management.

Aknowledgements: CNPQ, CAPES and DAAD.

References: (1) Bayer et al., Plant and Soil, 238, 133-140, 2002; (2)Dieckow et al., Europ. J. Soil Sci. 60, 240-249, 2009; (3) Milori et al., Soil Sci. Soc. Am. J. 70, 57-63, 2006; (4) Conceicao et al., Rev. Bras. Ci. Solo, 32, 541-549, 2008.

Keywords: physical fractions, humification, C sequestration, no-tillage,

Poster S1-P7

Contribution of labile compounds to C storage in the detritusphere during plant residue decomposition in soil

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The "detritusphere" is the zone of soil adjacent to decomposing organic residues and affected by carbon released from these residues. For decades, the dominant paradigm of plant residue decomposition has been that C from complex and structural plant molecules was retained longer in soils than C from soluble molecules. However, recent works have shown turnover times less than 20 years for lignin (Bahri et al, 2006) and over 40 years for polysaccharides (Gleixner et al, 1999). By using ^{14}C- labeled pure compounds in soil incubations some authors (Ladd et al., 1995, Vinten et al., 2002) observed that C from glucose persisted longer than C from more complex molecules such as cellulose. Gaillard et al., 1999, demonstrated the transfer of organic compounds from plant residues to the adjacent soil, i.e. in the "detritusphere" and hypothesized that this organic fraction would have a different dynamic from that of the complex structural fraction of plant residues. The aims of the present study were to analyze the diffusion and fate of soluble C from plant residues in soil, using ^{13}C enriched plant material in incubation

Incubation soil cores were realised from a cultivated loamy soil. Plant residues were placed on the surface of the core and separated from soil with a 30 µm mesh grid. The residues were 1-2 mm fragments of ^{13}C labeled bean leaves. We used two types of labeled plant materials in parallel :

- (TE) totally labeled leaves from plants grown during two weeks under ^{13}C-CO$_2$ enriched atmosphere at 600‰. TE leaves had a bulk signal of 222.3 ‰
- (LE) partially labeled leaves from bean plants grown under normal atmosphere and only exposed to ^{13}C-CO$_2$ enriched atmosphere for 21 hours (pulse chase labeling). In this case, only the carbon from soluble compounds resulting from photosynthesis and the starch were highly labeled, with 226.3‰, and the structural carbon from leaves was low labeled: 53.4‰ (Girardin et al, 2009).

From totally labeled leaves incubations (TE) we measured the total carbon input from bean leaves in soil. These results were used with those from soluble labeled leaves (LE) to adjust on the same values the carbon inputs on both experiments using a least-squares formulation. From this we deduced how much of the carbon input derived from the residues soluble + starch carbon and from the structural carbon.

The incubations were conducted on 650 days to determine medium term processes for carbon. For the spatial dimension, the cores sampled at different dates were sectioned in six 1 to 4mm thick slices parallel to the residues layer. Each slice was analysed separately for its labeled C.

After 650 days, about 12% of the plant residues carbon was found in the core, 79% was mineralised and 9% was kept in place on the surface of the core. For the soluble + starch C, 17% of its initial amount was localised in the soil after 650 days versus 10% of the plant structural carbon. Plant residues derived carbon was recovered at 12 mm from the residues layer, a much greater distance than commonly admitted for the detritusphere, i.e. 4 to 5 mm (Gaillard et al, 1999). A large fraction of this carbon was found in the microbial biomass: 50% until 63 days and 12% at the end of the incubation.

Soluble and starch fractions of the plant residues, which are a fraction generally considered to be very labile, diffused in soil where it was partly stabilised. We suggest that the microbial biomass plays a major role by assimilating the diffusing C and releasing microbial compounds which would be stabilised.

References: Bahri, H & al, 2006. Soil Biology and Biochemistry 38:1977; Gaillard, V & al, 1999. European Journal of Soil Science 50:567-578; Girardin, C. & al,2009. Rapid Communications in Mass Spectrometry, 23(12), 1792-1800; Gleixner, G & al, 2002. Organic Geochemistry 33:357-366.; Ladd, J.N & al, 1995. Soil Biology Biochemistry 27:777-783; Vinten, A.J.A & al, 2002. Biology and Fertility of Soils 36:190.

Keywords: Soluble carbon - Detritusphere - ^{13}C

Poster S1-P8

Contribution of shoot- versus root-derived litter to soil respiration

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Introduction

There are strong evidences that aerial plant parts decompose more rapidly and contribute less to stable humus than root-derived. However, knowledge about the decay rates of shoot and root-derived C and their yields of "stable" humus is still lacking for a satisfactory evaluation of alternative managements of arable soils for CO_2 sequestration. The purpose of this study is to quantify the decomposition rate of shoots versus root-derived C of a cereal and a grass/clover ley, and their contribution to occluded C in the soil, using plants labelled with ^{13}C –CO_2 in the field. Results from the first incubation period are presented.

Methods

Since the onset of the growing season a green-manure mixture (*Festuca pratensis* L, *Phleum pratense* L, *Trifolium pratense* L, *Trifolium repens* L.) and spring oats were exposed almost weekly to 99% ^{13}C-CO_2, using transparent chambers (about 1 m^3) on aluminum frames (4 replicates per treatment). The chambers were placed inorganically managed field on a clayey loam of marine origin at Ås, Norway (59º N, 10º E). The ^{13}C-CO_2 dose was increased with the expected growth rate. At oats maturity all shoots were removed, soil samples collected and wet sieved before filling into 1 L bottles (400 g dry soil $bottle^{-1}$). Six treatments were established: soils with *in-situ* grown and ^3C-labeled roots of green-manure or of oats, soils from similar but unlabeled oats plots without any addition, and the same soil to which 1.5 g $bottle^{-1}$ dry matter of either labeled oats straw, labeled grass shoot or labeled clover shoot was added. Four air-tight bottles per treatment were incubated at 15° C. Oxygen was monitored and added as needed in order to maintain the system aerobic. The mineralized CO_2 was collected using 10 ml 2 M NaOH in plastic cup inside the bottle, which was sampled and recharged (through an air-tight tube) at increasing time intervals. CO_2 was recovered by adding 2M H_2SO_4 and the amount was measured with a GC. In addition the ^{13}C atomic percentage was determined on three (roots) or two (shoots) replicateswith an IRMS.

Results

Based on the ^{13}C atomic percentage of the soil and of the evolved CO_2, about 7 (oats) to 10% (green manure) of the *in-situ* root-derived C present in the soil was mineralized after 104 days of incubation. Based on the same method (^{13}C enrichment of shoot and of evolved CO_2) the decomposition rate of the shoots was about three times as fast (28 of straw and 34 % of grass). However, the difference "CO_2-evolved-from-soil-with-shoots minus CO_2-evolved-from-soil-without-shoots" showed that the shoot-induced respiration varied from 44% (clover) to 52% (grass and straw) of the shoot C. This indicates that the addition of (labelled) shoot has increased the mineralization of (non-labelled) SOC present in the soil, a considerable priming effect corresponding roughly to 20% of the C added in grass and straw. The ratio between the mineralization rates by the two methods indicates that the priming effect was still active after 100 days of incubations. We are presently checking this by prolonging the incubation trial and expanding the isotope determination to all four replicates. Decay rates of shoot and root-derived litter estimated by optimization of a dynamic SOC model will also be presented. The model enables a more precise estimate of the decay rate as it takes into account the gradual decrease of the litter substrate and transfer of ^{13}C to the microbial and humus pools.

Keywords: litter decomposition, mineralization rate, decay rate, soil organic carbon

Poster S1-P9

Distribution of cutin and suberin biomarkers specific for various plant tissues to Mediterranean forest soils

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Each plant species has a unique chemical composition, and also within a given plant the various tissues differ from one another in their chemistry. Since plant molecular structures are considered as a driver of C stabilisation in soil, tracing plant tissues and soil organic matter (SOM) can clarify SOM accumulation mechanisms. Recent investigations have addressed macromolecules such as cutins and suberins as effective markers for above and belowground plant tissues.

The aim of this work was to understand the fate of plant organic matter (OM) in Mediterranean forest soils by evaluating the incorporation of cutin and suberin biomarkers. These biopolyesters contain structural units specific for different litter components (leaves, acorns, woody component, flowers) and for root biomass and might be subject to changes according to water stress.

Soil samples and litter components were collected in two mixed Mediterranean forests of *Quercus ilex* (holm oak) in costal stands in Tuscany (central Italy) differing for their ecological features, a mesic site (Colognole, CL) and xeric site (Cala Violina, CV), and for their litter production, phonological behaviour and chemical composition of leaf litter because of different edaphic conditions (water availability).

Samples were extracted using dichloromethane/methanol in order to remove free lipids. The residues were submitted to saponification in order to depolymerize cutins and suberins and release specific structural units of cutins and suberins. The identification and quantification were carried out using gas chromatography-mass spectrometry (GC-MS).

Identification of cutin and suberin biomarkers in plant tissues highlighted aliphatic monomers specific for cutins, as short chain (C_{14}-C_{18}) hydroxy- and epoxy acids, and for suberins, as long chain (C_{20}-C_{32}) aliphatic acids, diacids and w-hydroxy acids. Differences in specific biomarker distributions were evidenced in the two types of soils, suggesting contrasted dynamics of the different plant tissues.

Keywords: cutins, suberins, Mediterranean, forest soils

Poster S1-P10

Effect of grazing on C partitioning in Tibetan montane pasture revealed by $^{13}CO_2$ pulse labeling

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Since 1959 settle programs change the grazing activity on the Tibetan Plateau. Near the villages grazing pressure increases, leading to land degradation. The opposite effect is visible in remote areas where grazing pressure decreases and thus leads to changes in vegetation pattern, e.g. tall grasses become more abundant. To clarify the effect of land use changes on carbon (C) cycle on the Tibetan Plateau, it is necessary to characterize the differences in belowground C allocation of both grazed and ungrazed grassland to ascertain if the system functions either as C source or sink. In situ $^{13}CO_2$ pulse labeling was accomplished on 1) a montane *Trigonella-Kobresia* grassland that is used as winter pasture for yaks, and 2) on a grazing exclosure plot simulating decreasing grazing pressure where large grazers are excluded since 2002, both on the Qinghai-Tibetan Plateau in 3440 m a.s.l. The average partitioning pattern of assimilated C was chased from July 27 until August 22, 2009. At the end of the chase period the percentage of labeled C incorporated into structural shoot components did not differ significantly, amounting for 43% ^{13}C of recovery in the grazed grassland and for 38% ^{13}C of recovery in the ungrazed grassland. However, in contrast to the aboveground, the ^{13}C allocation in all belowground pools was significantly different. The grassland under grazing pressure allocated 40% ^{13}C of recovery belowground which is twice the amount of the ungrazed plot. The least portion was incorporated into structural root components in both cases amounting for 2% in the grazed and 0.6% in the ungrazed grassland. Within the belowground pools, 20% ^{13}C of recovery in the grazed plot and 9% ^{13}C of recovery in the ungrazed plot was mineralized to CO_2 within 27 days. In the soil of the grazed plot 18% ^{13}C of recovery was not decomposed but remained in soil, which is significantly more than that of the ungrazed plot amounting for 10% ^{13}C of recovery, which is in accordance to the significant higher soil C content and stock in the layer 0 – 5 cm of the grazed grassland. The amount of newly assimilated ^{13}C lost via shoot respiration was significantly higher in the ungrazed grassland amounting for 42% ^{13}C of recovery compared to 17% ^{13}C of recovery in the grazed grassland. The dynamics of assimilate allocation in shoots show an exponential decrease within the chase period in both plots. Recovery of ^{13}C did not differ significantly between grazed and ungrazed grassland in any sampling step indicating that the dynamics of C allocation in shoots is similar for both grazed and ungrazed grassland. Total quantity of ^{13}C that was allocated from shoots to subsequent carbon pools amounted to 36% ^{13}C of recovery in the grazed plot and 52% ^{13}C of recovery in the ungrazed plot over 27 days. In the grazed plot however significantly less C is lost by shoot respiration and significantly more is translocated to belowground pools. The combined decomposition rate of rhizodeposits and organic substances used for root respiration was determined by fitting a single first-order kinetics to the intensity of $^{13}CO_2$ efflux from soil within the chase period. Decomposition rate amounted for 0.36 ± 0.09% of assimilated $^{13}C\ d^{-1}$ and 0.18 ± 0.04% of assimilated $^{13}C\ d^{-1}$ for grazed and ungrazed grassland, respectively.

Since belowground ^{13}C allocation and the amount of ^{13}C remaining in soil of the grazed plot was significantly higher than in the ungrazed plot combined with the higher soil C content in the layer 0 – 5 cm, a positive effect of grazing on C sequestration in soil was revealed.

Keywords: ^{13}C pulse labeling, carbon partitioning, montane Kobresia pasture, grazing, SOC, Qinghai-Tibetan Plateau

Poster S1-P11

Effect of mycorrhiza on the rhizosphere volume of Zea mays, nutrient depletion and microbial activity

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The rhizosphere is known for the intensive interactions between plant roots, microorganisms and soil constituents. Through the continuous release of easily available organic compounds (root exudates), plants are able to modify solubility, sorption and transport of nutrients to the roots. The microbial activity and turnover of microbial biomass as well as the soil structure itself is also affected by this process. For this reason the rhizosphere and its processes are part of intensive scientific research.

For the investigation of the spatial extension of the rhizosphere *Zea mays* plants were grown in a three compartments vessels (photoperiod of 14h). The two side parts were separated from the root containing mid section by monofilament gauze with 30 and 1 µm mesh size, respectively. The gauze of 30 µm could be penetrated by root hairs and mycorrhizal hyphens, whereas exclusively root exudates could diffuse through the 1 µm gauze. Therefore, the experimental design allowed separating the effects of root exudation and nutrient uptake by mycorrhiza and root hairs on the rhizosphere dimension of *Zea mays* within one growing system.

After 30 days of growth, about 90 % of the gauze was covered with roots. Succeeding, plants were labelled in a closed chamber by addition of $^{14}CO_2$ to trace the distribution of the exudates and their uptake by the microbial biomass depending on the presence of mycorrhizal hyphens. Two, four, and six days after labelling, the plants were harvested destructively and the root free soil was cut into a total of twelve 0.5-, 1- and 2-mm-thick slices using a microtome. Spatial gradients of root exudates and nutrients in the rhizosphere were calculated based on analysis of organic C, ^{14}C, N, P in the single cuts. Microbial biomass was extracted by means of chloroform-fumigation-method and ^{14}C activity of microbial biomass was determined. The gradients of ^{14}C distribution from roots and its incorporation in microbial biomass were related to gradients of nutrients. It was supposed that from a distance exceeding 10 mm, no more exudates or exudate-induced microbial activity can be expected.

Keywords: rhizosphere - spatial dimension - root exudates

Poster S1-P12

Influence of soil tillage systems on soil organic matter dynamics in some soils of Transylvania (Romania)

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The energetic function of the soil expressed through the potential energy accumulated through humus, the biogeochemical function (the circuit of the nutrient elements) are significantly influenced by its hydrophysical function and especially by the state of the bedding- consolidation, soil capacity of retaining an optimal quantity of water, and then its gradual disponibility for plant consumption. The understanding of soil functions and management including nutrient production, stocking, filtering and transforming minerals, water, organic matter, gas circuit and furnishing breeding material, all make the basis of human activity, Earth_past, present and especially future.

The minimum tillage soil systems – paraplow, chisel or rotary grape – are polyvalent alternatives for basic preparation, germination bed preparation and sowing, for fields and crops with moderate loose requirements being optimized technologies for: soil natural fertility activation and rationalization, reduction of erosion, increasing the accumulation capacity for water and realization of sowing in the optimal period.

Our study presents the influence of conventional plough tillage system on soil structure and humus conservation in comparison with the alternative minimum tillage system: paraplow, chisel plow and rotary harrow (which 30% of the crop residue remains on the soil surface). The influence of tillage soil system was studied on several soil types at the University of Agricultural Sciences and Veterinary Medicine of Cluj-Napoca, Romania.

The experimental soil tillage systems were as follows: *Classic system:* V_1 – classic plough + disc –2x. *Minimum tillage systems*: V_2 – paraplow + rotary harrow, V_3 – chisel plow + rotary harrow, V_4 – rotary harrow. The rotation crops were: maize - soybean - wheat and potato. The results of the water stable aggregates and humus content were statistically analysed by ANOVA and Duncan_test.

Statistical analysis of the results showed that the differences in humus content depended on the variants of soil tillage and type of soil. Our results clearly demonstrate the complex effects of the minimum tillage systems what determine an increasing process of the humus content with 0.8-22.1% and an increasing of the hydro stabile aggregates content with 1.3-13.6%, on 0-30 cm depth towards the conventional system.

The increase of organic matter content and even of humus content is due to the vegetal remnants partially incorporated and to an adequate biological activity in this system. In the case of humus content and also the hydro stability structure, the statistical interpretation of the dates shows an increasing positive significance of the minimum systems appliance while the soil fertility and the hydro stability of the macro-aggregates were initially low, the effect being the conservation of the soil features and also their reconstruction, with a positive influence upon the permeability of the soil for water. More aggregated soils permit more water to reach the root zone. This not only increases productivity, it may also reduce runoff, and thus erodibility potential.

Minimum tillage, with or without straw, results in enhanced soil humus conservation and soil structure stability during crop growth. As a consequence, the root mass, yield components, and yield increased. Carbon management is necessary for a complex of matters including soil, water management, field productivity, biological fuel and climatic change.

The advantages of minimum soil tillage systems for Romanian pedo-climatic conditions can be used to improve methods in low producing soils with reduced structural stability on sloped fields, as well as measures of humus and water and soil conservation on the whole ecosystem.

References: 1. Horn, R., J.J.H. van den Akker and J.Arvidsson, 2000, *Subsoil compaction. Disstribution, Processes and Consequences.* Advances in GeoEcology 32, Germany ; 2. Jitareanu, G., C. Ailincai and D.Bucur. 2006. *Influence of Tillage Systems on Soil Phsical and Chemical Caracteristics and Yield in Soybean and Maize Grown in the Moldavian Plain (North – Eastern Romania).* In Soil Management for Sustainability, 370-379 pp, IUSS, Catena Verlag, Germany. ; 3. Mark, A. Licht and Mahdi Al-Kaisi, 2004, *Strip-tillage effect seedbed soil temperature and other soil physical properties.* Soil and Tillage Research, volume 80, Issues 1-2, 233-249 pp. ; 4 Riley, H.C.F., Bleken, M.A, Abrahamsen, S., Bergjord, A.K. and Bakken, A.K., 2005. *Effects of alternative tillage systems on soil quality and yield of spring cereals on silty clay loam and sandy loam soils in the cool, wet climate of central Norway*. Soil and Tillage Research, volume 80, Issues 1-2, 79-93 pp. ; 5 Rusu, T., 2001, *The influence of Minimum Soil Tillage upon the soil, yield and efficiency*. PhD Thesis, University of Agricultural Sciences and Veterinary Medicine of Cluj-Napoca. ; 6. Rusu, T., P. Guş, Ileana Bogdan, I. Oroian and Laura Paulette. 2006. *Influence of minimum tillage systems on physical and chemical properties of soil*. Journal of Food, Agriculture & Environment, vol. 4(3-4/2006), p. 262-265, Helsinki, Finlanda. ; 7. Ulrich, S., B. Hofmann, S.Tischer and O.Christen, 2006, *Influence of Tillage on Soil Quality in a Long Term Trial in Germany*. In Soil Management for Sustainability, 110-116 pp, IUSS, Catena Verlag, Germany.; 8 MESP, 1987. *Podologic Studies Elaboration Metodology*. Pedologic and Agrochemical Ins. Bucharest. Vol. 1-3. ; 9 PoliFact, 2002. *ANOVA and Duncan_test pc program for variant analyses made for completely randomized polifactorial experiences*. USAMV Cluj-Napoca. ; 10. SRTS, 2003. *Romanian System of Soil Taxonomy*. Ed. Estfalia, Bucharest, 182 pp.

Keywords: organic matter dynamics, minimum tillage

Poster S1-P13

Investigating biochar impacts on plant roots and root carbon

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There is growing interest in the use of charcoal or 'biochar' to sequester carbon in soil and improve soil fertility (Lehmann and Joseph 2009). Biochar is the charred biomass produced by pyrolysis, whereby organic material is heated under controlled temperatures (300-500 ºC) in the absence of oxygen. The charred product has a high carbon content (>60% C), making it a potential tool for long-term soil carbon storage as it is largely resistant to decay. Biochar has additional agronomic benefits – adding charcoal to soil is an ancient agricultural practice, and it is likely that biochar has similar benefits. However, biochar is a highly variable material, depending on the quality of the original feedstock and pyrolysis conditions, and many questions arise on the value of biochar to modern farming, and importantly, on its impacts on soil function. Roots make an important contribution to soil C cycling, providing a direct route for transfer of plant photosynthates to soil microbes. The quantity and quality of root-derived C and subsequent effects on microbial activity and C storage are likely to be affected by the addition of biochar. For example, there is evidence that adding biochar increases root biomass, yet little is known about any changes to root C and the subsequent long-term implications for soil C storage. As a first step towards understanding the impact of biochar on plant roots, studies on the changes to root architecture and rhizosphere characteristics were conducted. Cereal seedlings were grown in root boxes to compare differences in root extension rates, root density, nutrient capture and rhizosphere pH between biochar-amended and non-amended soils: plants in amended soils produced denser root patterns and lowered rhizosphere pH. The subsequent impacts of these changes to root C inputs and soil C cycling will be discussed.

References: Lehmann, J. and Joseph, S. (2009) Biochar for environmental management: science and technology.

Keywords: biochar; charcoal; roots; soil carbon storage

Poster S1-P14

Management effects on the inputs and fate of crop residue C and turnover of soil organic matter

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A field study was set out in 1990 to quantify the sequestration of C derived from agricultural crop residues in a loamy sand soil, managed under conventional (CT) and reduced tillage (NT) practices in continuous corn, winter rye-tobacco and winter wheat-soybean crop sequences. A field technique of pulse labeling was used to produce mature ^{14}C-labeled, above- and below-ground plant residues and to quantify relative contributions of root, extra-root and shoot C to C storage as stable soil organic matter (SOM). Decomposition of these crop-C inputs and their fate was measured as labeled-C remaining during 15 yr continuous cropping. In addition, natural ^{13}C abundance techniques ($\delta^{13}C$) were used to quantify the sequestration of corn-derived C and the turnover of C_3-C derived soil organic matter. Highlights of this ongoing experiment will be presented. The main finding is that reduced tillage does not promote sequestration of crop residue derived-C or slow the turnover of SOM. Levels of SOM are controlled by the quantity of crop C inputs, with ~15% of the residue-C converted to SOM.

Keywords: crop and soil tillage, crop C inputs, C sequestration, crop residue decomposition

Poster S1-P15

Mechanisms of organic carbon sequestration in pasture soils along management chronosequences in the South Ecuadorian Andes

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Understanding the mechanisms controlling belowground C transformation processes is a prerequisite to predict land-use driven changes of soil organic carbon (SOC) and nutrient stores and therefore soil functionality.

In the South Ecuadorian Andes natural forests have often been converted to pastures by slash-and-burn practice. Frequently, the pasture grass (*Setaria sphacelata*, a C4 plant species) is displaced through competition by tropical bracken fern (*Pteridium arachnoideum*, a C3 plant species) leading to the abandonment of this unproductive pastures. Hitherto, data on SOC and microbial biomass stocks are available for the topsoils along the land-use gradient forest - 17 year old pasture - 50 year old pasture - abandoned pasture - succession. In the mineral topsoil (0-10 cm depth) SOC stocks increased from 41 t ha^{-1} in forest over 46 t ha^{-1} in 17 year old pastures to 66 t ha^{-1} in 50 year old pastures. This was related to an increase in SOC content and not to changes in bulk density. The stocks of microbial biomass carbon (MBC) and nitrogen (MBN) were significantly highest in the 17 year old pasture soil resulting in an about three times wider ratio of microbial biomass to soil organic carbon (MBC/SOC) in comparison to all other sites. The 50 year old pasture still showed higher microbial biomass stocks in 0-10 cm depth as compared to forest, abandoned pasture and succession (Hamer et al., in prep.). However, until now the mechanisms behind are still uncertain and the following key questions arise:

- To which degree does above- and belowground vegetation affect the structure and fate of the soil organic matter?
- Which plant derived organic matter / fire impacted organic matter is stabilized preferentially in different pools of soil organic matter?
- Are the interactions between organic substrates and soil microbes mainly driven by the chemical composition of solid or dissolved organic matter?

To gain more insight into the land-use induced changes of factors and mechanisms responsible for the mobilization and sequestration of soil organic matter in the Ecuadorian mountain soils, the biochemical composition of different fractions of soil organic matter (particulate, “heavy”, H_2O_2-resistant and water extractable organic matter) will be determined using a diverse array of molecular characterisation methods (Py-GC/MS, NMR, BPCA, SEC-MALLS, d^{13}C-signature, degradability). The methodological approach as well as first results will be presented.

Keywords: SOC, sequestration

Poster S1-P16

Mechanistic modeling of the vertical soil organic matter profile in terrestrial ecosystems

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Modelling and measuring studies of soil organic carbon have traditionally focused on the 30 cm of the soil. In the recent past however, interest in the vertical distribution of soil carbon has increased due to 1) estimates suggesting that the deep soil globally stores a large amount of carbon, and 2) increasing evidence that soil carbon stabilization is be controlled by different processes at different depths that are likely to respond varyingly to future global changes. Hence, a more vertically explicit approach in SOM models is needed, but development and parameterization of such models is hindered by lack of understanding of the processes involved in SOM profile development. SOM may be deposited in the mineral soil by root turnover or transported from the surface by biological mixing (bioturbation) and with infiltrating water. The comparative strength of these processes is still poorly known. Our aim is to quantify these processes and develop a vertically explicit SOM model that mechanistically simulates them.

In this scope we have developed SOMPROF, a new soil carbon model that dynamically simulates the vertical profile of the SOM fraction in the mineral soil, as well as the storage of organic matter in organic surface horizons L, F and H. The model includes two mechanisms of vertical organic matter transport: 1) diffusion, representing bioturbation (mixing of the soil matrix by soil biota), and 2) advection, representing downward movement with liquid phase. Furthermore organic matter may be input directly at depth by root turnover. The model includes 5 organic carbon pools that differ with respect to their transport behavior and decomposability.

We parameterized the model for two European forests with strongly contrasting soil types based on soil carbon measurements. Since the comparative contribution of the three processes cannot be inferred from soil carbon measurements alone we used measured turnover rates at different depths and the profile of the radiogenic lead isotope ^{210}Pb. ^{210}Pb is a useful tracer for SOM transport since it is input only at the surface, binds strongly to organic matter and has a fixed decay rate. We used a Monte Carlo Markov chain approach to explore the parameter space for different parameter sets that can explain the measurements. Without prior information, the model inversion shows that the three processes (root turnover, bioturbation and liquid phase transport) can equally well explain the data. However, when prior information on parameter values is added, the liquid phase transport remains as the dominating process for OM deposition in the mineral soil.

Keywords: soil organic carbon

Poster S1-P17

Molecular proxies indicate root biomass as main source for lipids in mineral subsoil horizons in a mixed deciduous forest

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Most studies on forest soils attribute litter as main source for carbon in the whole soil profile. While it is clear that litterfall is the main source of litter and organic horizons, organic matter enters mineral soil horizons in various ways. Soil solutions transferring dissolved organic carbon from surface to deeper soil layers, bioturbation and degradation of organic matter are regarded to be the most relevant sources of soil organic matter in mineral soil. In the last decades it has been observed that rhizodeposits and exudates significantly contribute to soil organic matter. However, for hydrophobic substances like lipids, the sources and contribution from various sources are still not clear. In this study, we investigated the lipid composition in soil profiles under four different trees species in a mixed deciduous forest, where for each tree species one tree was kept under ambient and the other under elevated CO_2 concentration for 9 years.

Fatty acid and alkane composition differed in soil profiles under all tree species, whereas there was no significant effect of elevated CO_2 concentration. While the organic layer at the top of the soil profile clearly reflected the lipid composition of the aboveground biomass with an admixture of leaf and woody tissues of the individual tree species, mineral soil horizons differed in their composition from the organic layer. This was determined for saturated and unsaturated fatty acids (C_{16} and C_{18}) and long chain alkanes (C_{27-31}). The Ah horizons yielded a lipid signal of aboveground biomass, which was modified due to degradation of litter and incorporation of root biomass. Especially lipids in deeper soil horizons reflected biomass contribution by roots of the individual trees or an admixture of so far unknown carbon sources, including ‘old’ carbon. This old carbon must have remained in the soil for more than hundred years from the vegetation that existed prior to establishing the deciduous forest. We show several molecular proxies including the average chain length (ACL) and carbon preference index (CPI) of fatty acids and alkanes to assess different sources of lipids in the soil profiles.

Keywords: lipids, molecular proxies, mineral soil, mixed deciduous forest

Poster S1-P18

Roots contribute relatively more than shoots to soil carbon

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The “Ultuna continuous soil organic matter experiment” was started in 1956 on a field close to Uppsala in Sweden, and the field has probably been under agriculture for several hundreds of years. The main aim of the experiment is to test the long-term effects of different organic and mineral N fertilizers on crop yields and soil characteristics, such as carbon content. The experiment consists of 15 treatments including a bare fallow treatment replicated in four blocks, 60 plots in total. Approximately the same amount of C is added in ten of the treatments biannually as different organic amendments such as straw, green manure, farmyard manure, sawdust, peat and sewage sludge. Since some treatments receive N fertilizer only, some receive organic amendments only and some receive both, differences in crop yield (mostly spring cereals) are considerable. In accordance with the equivalent soil mass concept, we determined changes in the depth of the topsoil layer developing over time using two different methods i) precise measurements of plot elevation and ii) mass balance calculations considering all in- and outputs of mineral matter and changes in bulk density. Equivalent topsoil depth, which differed by up to 6 cm between the treatments according to both methods, was used together with bulk density and carbon concentration measurements to calculate a time series of topsoil C stocks. A single exponential function was fitted to these time series for estimating rates of C stock change. Carbon inputs from crops (shoots, roots plus rhizosphere deposition) were estimated from crop yields using allometric functions. Inputs of organic matter with the same approximate composition are expected to result in similar and proportional changes in C stocks. We classified the quality of C input into the following six categories: shoots, roots (including rhizosphere deposition), manure, peat, sewage sludge and sawdust. Thereafter, we used a least-square method for estimating the ‘humification’-values characterizing the impact of the different types of organic materials on changes in soil carbon stocks. These values represent the proportions of C input that has not yet been released from the topsoil. As indicated by previous studies, these values were highest for peat, followed by sewage sludge, sawdust and manure. The new and most interesting result from the current high-precision field measurements is that the calculated weight for root-derived carbon was similar to that of manure and about twice as high as that from above-ground plant material. These findings strongly support the hypothesis that roots contribute more to relatively stable soil C pools than the same amount of shoot-derived plant materials does.

Keywords: Agriculture, carbon balance, carbon storage, long-term field experiment, roots, rhizosphere, SOM stabilization

Poster S1-P19

Soil moisture conditions in sandy soil influence the composition of rhizosphere microbial communities

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Soil moisture conditions alter the availability of carbon (C) and nutrients in soil ecosystems. Especially sandy soils can become highly water and nutrient limiting due to their poor water holding capacity. The objective is to show how different soil moisture conditions influence activity and composition of rhizosphere microbial communities in a sandy heathland ecosystem. The target plant species is the typical heathland grass *Deschampsia flexuiosa* which accounts for about 65 % of cover at the field site.

Simulation of different soil moisture regimes will be performed in 2010 (drought exclusion, irrigation and control). In addition, soil moisture manipulations will be done in a mesocosm experiment over a period of four weeks. Soil and atmospheric temperatures will be chosen to simulate late summer temperatures at the field site. In both experiments, highly enriched $^{13}CO_2$ pulse-labelling will be used to tag atmospheric C into the rhizosphere microbes. The usage of this approach will not alter the natural ecosystem and the rhizosphere microbial communities can be characterized without disturbances.

Carbon pools within an ecosystem are characterized by different contents of stable isotopes (^{13}C and ^{12}C), where the ratio of heavy to light isotope ($^{13}C/^{12}C$) reflects the origin of the C sources. Using *in-situ* $^{13}CO_2$ pulse-labelling, the ^{13}C content will increase compared to natural background levels. The increased $^{13}C/^{12}C$ ratio can then be used to trace atmospheric CO_2 through the plants (by means of CO_2 fixation via photosynthesis) into the rhizosphere and further into the soil. Microbes will incorporate the transferred heavy and light C isotopes into various membrane and storage fatty acids that can then be analyzed for their $^{13}C/^{12}C$ ratio (GC-C-IRMS). Some phospholipid fatty acids (PLFAs) and neutral lipid fatty acids (NLFAs) are characteristic for certain microbial functional groups (e.g. gram-positive and gram-negative bacteria, mycorrhizal fungi and saprophytic fungi) and are thus, suitable biomarkers. Therewith, a detailed insight into C fluxes of rhizosphere microbial communities can be achieved.

C compounds derived from plant roots (exudates, dead plant material) serve as main substrate for rhizosphere microbes. Limited water availability will alter plant physiology and performance; photosynthesis will decrease and so will exudation rates of C compounds into the rhizosphere. Furthermore, low soil water content will reduce the mobility of C compounds and mineral nutrients. Therefore, we assume that the microbial communities will change in composition and activity in response to soil moisture contents.

Keywords: carbon stable isotopes, in-situ pulse-labelling, rhizosphere microbial communities, biomarkers, PLFA, NLFA

Poster S1-P20

Temporal dynamics of ^{14}C partitioning and ^{14}C budget within different carbon pools in plant and soil

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Organic compounds released by roots play a key role in the rhizosphere since they stimulate microbial activity in the soil. However, the time lag between carbon (C) assimilation and incorporation in different pools is not known. We investigated the time lag by means of multiple $^{14}CO_2$ pulse labeling, which combines the advantages of single pulse and continuous labeling. Furthermore, the C budget was determined with each sampling to evaluate the C distribution between the different pools.

Maize shoots were labeled with $^{14}CO_2$ three times a day during 9 days. Plants and soil were destructively sampled during the labeling period on day 1, 2, 3, 5, 7 and 9 after the initial pulse. Additional sampling was done on day 11, 13 and 17 after labeling. The ^{14}C activity in the pools: shoots, roots, soil, microbial biomass and dissolved organic carbon (DOC) was determined.

Increasing numbers of ^{14}C pulses raised the ^{14}C activity in all pools, but at different rates. The highest rates were observed in the shoots, the lowest in the DOC. A shorter time lag between the above ground assimilation and the C incorporation into microbial biomass compared to that into DOC indicates that microorganisms ingest the root exudates, and that DOC originates from microorganisms.

At the first sampling (day 1) 87% of total assimilated ^{14}C remained in the shoots, 7% in the roots, 4% was recovered in the soil, 0.5% in DOC and approximately 2% in microbial biomass. Interestingly, the percentage of assimilated C recovered in microbial biomass did not differ during the whole experiment. The ^{14}C activity in the shoots decreased by 22% after the last pulse. This decrease can be explained either by shoot respiration or by translocation to the roots. Since, the ^{14}C activity in the roots was still increasing within 4 days after the last pulse, the decrease in the shoots can be attributed to translocation.

Multiple pulse labeling is a suitable method to gain a better understanding of the temporal dynamics of partitioning within C pools in soil and plant.

Keywords: multiple labeling, time lag, rhizosphere, microbial biomass, DOC, soil-plant

Poster S1-P21

The influence of actively growing roots and root exudates on nitrogen mineralization from soil organic matter in paddy rice soils

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As plants interact with the soil to acquire and mobilise nutrients, their roots alter the soil biologically, chemically and physically over variable distances from its surface, defining the extent of the rhizosphere by the respective processes considered in space and time (Paterson, 2003). To date, very little is known on the influence of root growth and rhizodeposition of root exudates (i.e. mainly sugars and polysaccharides, organic and amino acids, peptides and proteins) on N turnover in paddy rice soils. Classical N mineralization experiments are done using uncropped soil, thus completely neglecting the influence of roots and root exudates on the N mineralization process. In this research we explicitly have taken into account this influence. Two experiments were conducted, one is an incubation experiment with artificial root exudates and the other, is a pot experiment with actively growing rice crops. In the first experiment, the effects of rice root exudates on net nitrogen mineralization were investigated in a six week incubation study at 25°C with three different paddy soils from Bangladesh under saturated conditions. This study consisted of four different treatments with artificial root exudates applications, namely (1) low molecular weight organic acids (a mixture of malic, tartaric, succinic, citric and lactic acid at a C-ratio of 80:9:5:4:2), (2) carbohydrates (glucose), (3) a mixture of organic acids and carbohydrate solutions (at a C-ratio of 50:50) along with a (4) control. Root exudates were artificially injected into the soil column at three fixed locations each week at a rate of 103 µg C g^{-1} $week^{-1}$. An inconsistent treatment effect was found on the nitrogen mineralization over three different rice soils under saturated condition. In only one of the three studied sites, enhanced N mineralization was observed in all amended treatments. Hence the stimulatory effect on the N mineralization might derive from a ‘priming effect’. A second experiment was conducted to investigate the influence of rice roots on nitrogen mineralization from soil organic matter. Five selected soils from Bangladesh were filled in large plastic boxes (e.g. 0.4*0.6*0.2m) with 15 kg in each boxes and brought under saturated condition.Thirty five days old seedlings were transplanted in the plastic boxes. During the entire growing period, soil samples were taken to measure the mineralized $NH4^+$ and $NO3^-$ at every two weeks interval from three spots of each plastic box at the middle of two hills with the help of a small augur. The total N uptake by the crop was measured at two occasions (during 35 days after transplanting and harvesting period). In four out of five soils, the sum of the N uptaken by the crop and N mineralization in cropped soil was found to be higher than the N mineralization in uncropped soils. Higher N mineralization in cropped soils than the uncropped soils suggests that there is a positive effect of actively growing roots on N mineralization. However, more experimental research is ongoing to reach a concrete conclusion.

References: Paterson, E. (2003). Importance of rhizodeposition in the coupling of plant and microbial productivity. European Journal of Soil Science, 54, 741-750.

Keywords: Rice Root Exudates, Nitrogen Mineralization, Soil Organic Matter

Poster S1-P22

The new view on soybean

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Introduction : Soybean is the most import grain legume all over the world with a production of 231 million tonnes covering arable land of more than 97 million ha. Above ground biomass production and related below ground inputs of soybeans vary widely depending on site conditions, environmental factors and management practices. Only little knowledge exists on carbon (C) and nitrogen (N) which is deposited below ground by the roots and on the effect of cropping systems on these inputs under field conditions.

The objective of our study was to examine the effect of different cropping systems, i.e. conventional and organic, on i) the amount of C and N rhizodeposition and total below ground C and N (roots + rhizodeposition) derived from soybean and ii) the fate of root derived C and N in functional soil organic matter pools.

Materials and methods : Investigations were carried out in the DOK experiment, near Basle, Switzerland which compares two organic and two conventional cropping systems at two fertilization levels (1=50% and 2=100% of the systems standard fertilization) since 1978 (Mäder et al., 2002). We included the following cropping systems and fertilization levels: bio-organic (ORG1, ORG2), conventional with both mineral and organic fertilization (CON2), conventional receiving exclusively mineral fertilizers (MIN2) and an unfertilized control (NON). In 2008 four soybean plants per micro plot (tubes of Ø 29cm, 50cm depth) were ^{15}N / ^{13}C double pulse labelled with 99 atom % ^{15}N urea and 98 atom % ^{13}C glucose solution using the cotton wick technique (Mayer et al., 2003; Wichern et al., 2007).

Soybean and the soils in the micro plots were harvested at the end of pod filling. C and N rhizodeposition (CdfR, NdfR) were determined from the soil ^{13}C and ^{15}N signals after removal of all visible roots. The fate of CdfR and NdfR in functional soil organic matter pools as dissolved organic C (DOC) and dissolved N (DN), mineral N and microbial biomass C and N were determined by sequential extraction of the soil.

Results and discussion : The mean above ground C and N uptake of soybean plants constituted 349 g m^{-2} (251 – 440 g m^{-2}) and 22.4 g m^{-2} (16.6 – 28.7 g m^{-2}), respectively . As expected, the highly fertilized treatments MIN2 and CON2 showed higher values as organic and no fertilization treatments and decreased in the order MIN2>CON2>ORG2>ORG1>NON. Exceptionally for N, CON2 had the same level as ORG1.

First results suggest mean below ground C and N inputs of 412 g m^{-2} (251 – 705 g m^{-2}) and 26.0 g m^{-2} (15.7 – 33.4 g m^{-2}), respectively. However, the treatments did not differentiate in the same order as observed for above ground uptake. C input decreased in the order NON>ORG2=ORG1>MIN2>CON2. For N inputs treatments followed the order ORG2=NON=MIN>ORG1>CON2. The differences in treatment order observed between above ground and below ground C and N can be related to the extent of rhizodeposition. It accounts in average for 35% of total C and 39% of total N. In NON however, with the highest absolute and relative values, rhizodeposition inputs were observed with 576 g C m^{-2} or60% of total plant C, and 23 g N m^{-2} or 51% of total plant N.

CdfR and NdfR were quickly incorporated in ”dead” soil organic matter fractions. Only a small portion could be recovered in soluble forms or as microbial biomass. The mean percentage of total C and NdfR recovered in DOC and DN was 1.0% and 3.9%, respectively. For microbial C and N it constituted 13.1% and 6.6%, respectively. Sequestration of CdfR and NdfR in stabilized soil organic matter pools is still under evaluation.

References: Mäder et al. (2002), *Science* 296:1694-1697; Mayer et al. (2003), *Soil Biology & Biochemistry* 35: 21-28; Wichern et al. (2007), *Soil Biology & Biochemistry* 39: 2527-2537.

Keywords: Soybean, below ground C, below ground N, rhizodeposition, cropping systems

Poster S1-P23

The rate of tree roots growth and decomposition in young forest ecosystems of Central Siberia

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Investigation were carried out in the Siberian Afforestation Experiment, when the plantations were 25 years old. This common-garden plantation used all 6 tree species that commonly dominate forest landscapes in Siberia: Siberian pine (*Pinus sibirica*), Scots pine (*Pinus sylvestris*), Siberian larch (*Larix sibirica*), Norway spruce (*Picea abies (=Picea obovata*), aspen (*Populus tremula*) and birch (*Betula fruticosa*). Seedlings of each species were planted in single plots at a common site where the top of soil had been mixed (to increase homogeneity) and respread across the site. The soil is a dark-grey forest weakly podzolized gleyish soil developed on chestnut-brown clay. Because the tree plantations are developing under the similar soil and climatic conditions all differences that appearing in soil are consequence of the tree species influence.

The series of field and laboratory experiments were conducted to determine the rate of tree roots growth, death and decomposition.

It was found that in the 25 years old plantations of coniferous species the tree root growth makes up from 6.3 (for larch) to 44.5 (for spruce) gC*m^{-2} per year, and for deciduous species it reach only about 4.3-8.2 gC*m^{-2} per year. It accounts about 22% of the root storage of coniferous species and not more than 2.5 – 7.1% - for deciduous species and larch. The annual root death was observed make up to 0.3-1.7 gC*m^{-2} for all species, that was only about 1% of total root storage in the soil under Scots pine, Siberian pine and spruce, and from 1.7% (birch) to 3.5-3.8% total carbon storage of tree roots under the aspen and larch stands.

Decomposition rate of woody thin roots makes up from 7.7 to 15.4% per year (decomposition constant changes from 0.08 (larch) to 0.17-0.18 (aspen and spruce)). The one-year roots decomposed almost similar rate that the woody thin roots and they annually lost from 8.2% (spruce) to 14.3-15.3% (aspen and Siberian pine) of the initial mass.

The most part of the carbon lost during decomposition of the woody and one-year roots was mineralized (from 76 to 98% of total carbon loss). Decomposition of one-year roots differs with higher mineralization rate in comparison with thin woody roots.

The carbon input to the soil from decomposed roots makes up from 9.3% of the total carbon loss for birch to 12.6-28% for coniferous species and 35.5% of the total carbon loss from aspen roots. It accounts from 2.5 to 11.4% of the initial carbon storage in the decomposed roots. Decomposition of one-year roots gave to the soil not more than 3.2 % of their initial carbon, and up to 86% of this input is, probably, humification products that can be taken up by soil. The rest part is dissolved organic matter that can be as well mineralized.

The rate of root decomposition in the soil is 3.5-13.0 times lower than for the forest litter of the same species. At the same time the rate of carbon mineralization is 2.5-15.0 times higher during the forest litter decomposition in comparison with tree roots on the same plots, but humification of root organic matter (as carbon was absorbed by the soil) is 1.4 – 3.0 times higher than for forest litter under the Scots pine and larch, and only 1.5-2.5 times lower under Siberian pine, spruce, aspen and birch.

Thus, at 25 years old tree stands the root contribution to the soil carbon pool can be sufficient, because root storage accounts from 41 to 68% of total plant residues pool in these forest ecosystems and the rate of their organic matter humification is higher, than in forest litter.

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Keywords: tree roots, growth, death, decomposition, carbon input

Poster S1-P24

Tracing cover crop root versus shoot carbon into soils in conventional, low-Input, and organic cropping systems

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We investigated the fate and rate of stabilization of root- versus shoot-C and the role of microbial communities within soil aggregates in root- versus shoot-derived C accumulation within long-term conventional (annual mineral fertilizer applications), low-input (mineral fertilizer and cover crop applied in alternating years), and organic (annual manure and cover crop additions) maize-tomato systems (*Zea mays* L.- *Lycopersicum esculentum* L.). Both hairy vetch (*Vicia dasycarpa*) roots and shoots were ^{13}C-labeled during the cover crop growing season and then traced into whole soil samples and three soil organic matter (SOM) fractions [coarse particulate organic matter (CPOM; >250 µm), microaggregates (53-250 µm), and silt-and-clay (< 53 µm)] during the maize growing season. We coupled stable isotope probing with phospholipid fatty acid analysis (^{13}C-PLFA) to elucidate the role of microbial community composition in the short-term processing of root- versus shoot-C within the mineral SOM fractions (i.e.,microaggregates and silt-and-clay). At the end of the maize growing season, ~52% of the root-derived C was still present in the soil, while only ~4% of shoot-derived C remained. These results suggest that root C input contributes more to overall C stabilization than shoot-C, which supports a nascent body of research demonstrating greater retention of root-derived C than shoot-C in SOM. The ratio of root- over shoot-derived C (i.e., an indicator of relative root contribution) was higher in the microaggregates and silt-and-clay fractions than the CPOM of low-input and conventional systems. In contrast, relative root contribution was greater in the whole soil of the organic (6.76) than the conventional (1.43) and low-input cropping systems (3.24), and particularly greater in the CPOM of the organic system (7.53). Although total PLFA-C derived from roots was over four times greater than from shoots, relative distributions (mol%) of root- and shoot-derived C into the microbial communities were very similar among the three cropping systems. Furthermore, the microbial community assimilating root- versus shoot-C was not different between the microaggregates and silt-and-clay particles. However, more C was processed in the microaggregates by fungi, suggesting that the microaggregate is a relatively unique microenvironment for fungal activity. We conclude that (i) the greater short-term microbial processing of root- than shoot-C can be a mechanistic explanation for the higher relative retention of root- over shoot-C, but microbial community composition did not influence long-term C sequestration trends in the three cropping systems and (ii) the higher relative root contribution associated with the CPOM of the organic system mirrored long-term soil C stocks across the cropping systems, i.e., organic > low-input = conventional, and suggests that the CPOM fraction is pivotal to short-term accumulation of root-derived C and, ultimately, to long-term C sequestration under organic crop management.

Keywords: root, shoot, SOM stabilization, SOM fractions, relative root contribution

Session 2 – NATURAL MOLECULAR STRUCTURES AS DRIVERS AND TRACERS OF ECOSYSTEM FUNCTIONS

Oral presentations – Session 2

Keynote lecture

Molecular-level studies of soil organic matter composition in a changing world

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Soil organic matter (SOM) is critical to ecosystem functions and sustainability. Variation in the earth's climate has raised concerns about the stability of SOM stocks in various regions around the world. Part of this uncertainty stems from the lack of molecular-level information about SOM and its response to environmental change. The chemical complexity and heterogeneity of SOM requires the use of advanced, molecular-level methods to determine SOM responses to ecosystem changes. The combination of SOM biomarkers (as measured by gas-chromatography/mass spectrometry: GC/MS) and analysis by nuclear magnetic resonance (NMR) facilitates a detailed analysis of SOM components. These methods were applied to three different field studies: 1) an *in situ* 14-month soil warming in a mixed forest in southern Ontario, Canada, 2) enriched CO_2 and N addition in the Duke Forest, USA, and 3) permafrost disturbance the Canadian Arctic. The objective was to measure and quantify molecular-level changes to SOM composition in varying environments using SOM biomarkers and NMR.

Enhanced lignin oxidation and cuticular carbon sequestration was observed with soil warming. In addition to this, labile constituents such as carbohydrates decreased significantly. Fungal activity, as measured by phospholipid fatty acids (PLFAs), increased. This study demonstrated that lignin, which is sometimes believed to be stable, was indeed susceptible to enhanced degradation by soil fungi. In addition, increased cuticle preservation and a reduction of usable carbon suggest that SOM composition was shifting to a more recalcitrant form over time.

We also employed molecular-level methods to investigate the composition and degradation of SOM from the Duke Forest Free Air CO_2 Enrichment (FACE) experiment. Increased fresh carbon inputs into the forest floor under elevated CO_2 were observed. The ratios of fungal to bacterial PLFAs and Gram-negative to Gram-positive bacterial PLFAs decreased in the mineral soil with N fertilization, indicating an altered soil microbial community composition. Moreover, the acid to aldehyde ratios of lignin-derived phenols increased with N fertilization, suggesting enhanced lignin degradation in the mineral soil. This suggested that microbial decomposition of SOM constituents, such as lignin and cuticle-derived compounds, was promoted under both elevated CO_2 and N fertilization.

High temperatures and substantial rainfall in July 2007 in the Canadian High Arctic resulted in permafrost active layer detachments (ALDs) that redistributed soils throughout a small watershed in Nunavut, Canada. Increased concentrations of extracted bacterial PLFAs and large contributions from bacterial protein/peptides in the NMR spectra at recent ALDs suggested increased microbial activity. PLFAs were appreciably depleted in a soil sample where ALDs occurred prior to 2003. However an enrichment of bacterial derived peptidoglycan was observed by solution-state NMR and enhanced SOM degradation was observed by ^{13}C solid-state NMR. These data suggest that a previous rise in microbial activity, as is currently underway at the recent ALD site, led to degradation and depletion of labile SOM components. Collectively, these studies highlight the detailed insight into ecosystem function that can be obtained using a combination of molecular-level techniques. The techniques and application to study SOM dynamics in changing ecosystems will be presented and discussed in detail.

Keywords: biomarkers, nuclear magnetic resonance, climate change, phospholipid fatty acids, lignin degradation, cuticular carbon

DRIFT mapping of SOM composition at intact surfaces of preferential flow path

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In structured soils, interaction of percolating water and reactive solutes with the soil matrix is restricted to surfaces of preferential flow paths. Aggregate and biopore surfaces are mostly covered by soil organic matter (SOM) that finally controls wettability, sorption and transfer properties of such flow paths. However, directly at the flow path surfaces the SOM-properties are largely unknown to date since the surface cover is relatively thin and vulnerable.

The objective of this study was to compare the physicochemical properties of SOM and their distribution at the surfaces of preferential flow paths with the wettability of the surfaces. The Fourier transformed infrared spectroscopy in diffuse reflectance method (DRIFT) was applied to determine maps of CH/CO-ratios on undisturbed surfaces of preferential flow paths (DRIFT mapping; 1 x 1mm grids), such as earthworm burrows, root channels, and aggregate coatings. By the help of temporally high-resolution contact angle measurements the water repellency of these defined surface areas was observed. The spatially distributed CH/CO-ratios were compared to the water repellency at the same locations. Relatively high CH/CO-ratios of a coated sample corresponded with higher water repellency as for organic coatings on root channels or litter residues, while quartz-sand grains corresponded with relatively lower CH/CO-ratios on aggregate surfaces.

The results show that SOM coatings at preferential flow path surfaces differ in terms of composition, distribution and water repellency. This indicates specific properties of the coatings concerning the interaction of percolating water and reactive solutes.

References:

Ellerbrock, R.H., Gerke H.H, Böhm C. 2009. In situ DRIFT characterization of organic matter composition on soil structural surfaces. Soil Sci. Soc. Am. J. 73, 531-540 plus corrigendum 73,1439.

Leue M, Ellerbrock R.H, Gerke H.H 2010. DRIFT-mapping of organic matter composition at intact soil aggregate surfaces.. Vadoze Zone Journal in press

Keywords:

DRIFT mapping, preferential flow path, wettability

Stabilization of microbial biomass carbon in soil - a significant contribution to the formation of refractory soil organic matter

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The properties of soil organic matter (SOM) strongly depend on its chemical composition which is at least partly inherited from its precursor material. Recently, a significant contribution of microbial biomass carbon to SOM has been reported which is reflected in high concentrations of microbe-derived biomolecules. Therefore we analyzed the fate of microbial-derived C in an agricultural soil in a laboratory incubation experiment. We added ^{13}C-labeled *Escherichia coli* cells to the soil material and incubated the mixture in columns at 20°C and 60% of the water holding capacity of the soil for up to 8 months. During incubation, the formation of CO_2 was monitored, and samples from different times of incubation were analyzed for the survival of the *E. coli* cells, as well as for carbon balance, fatty acids and amino acids. We also visualized the residues of the microbial biomass in the soil material by scanning electron microscopy (SEM). The *E. coli* died rapidly but most of the carbon remained in the system. After 224 days of incubation, about 50% of the *E. coli*-derived carbon was mineralized. The lipids were degraded faster than bulk biomass carbon, and the data show that the microbial-derived C was redistributed from microbial biomass to non-living SOM. Total proteins were much more stable than both lipids and bulk microbial biomass, showing only insignificant changes during incubation. However, the microbial portion decreased during the first phase of incubation, again indicating a redistribution of biomass-derived C from microbial biomass to non-living SOM. At the end of the experiment, 10% of the *E. coli*-derived C added initially was cycling in the microbial food web, and 40% was found in the non-living SOM. We visualized the microbial residues in the soil samples by SEM. Only rarely, intact cells were detected, which is in line with data on bacterial abundance in soil and its specific surface area. Instead, we frequently encountered 100 - 500 nm wide fragments of unknown origin covering the mineral surfaces. A possible microbial origin of these patchy fragments and a significant contribution to SOM formation as suggested by the C balance of our inbucation experiment may explain many properties of SOM including the low C/N ratio and the abundance of microbial-derived biomolecules.

Keywords: SOM formation, microbial biomass, ^{13}C label

Relating soil organic matter dynamics to its molecular structure

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Understanding the dynamics of soil organic matter(SOM) relative to ecosystem functioning and global change relies on a knowledge of it biochemical complexity and protection by the soil matrix. The molecular structure of SOM was determined in 98%, sand soils to eliminate the protective effects of clays and aggregation on the amount and turnover rate of SOM constituents derived from cedar and pine. Cedars increased SOM contents above that of the native prairie. The ^{13}C content showed that 82% of the native soil C still remained after 55 of yr cedar growth. The first order, decay rate constant, for the change in native soil C under cedars, represented a mean residence time (MRT) of 278 yr for both the surface and subsurface SOM but less for an intermediate depth. Long–term incubation and kinetic analysis of soil CO_2 evolution curves indicated an active fraction of 10%, one of the highest we have encountered. Pines accumulated extensive litter but caused a 65% loss of the native prairie soil C resulting in a calculated MRT of 66 to 90 yr for the prairie derived C. The uptake of Ca, at depth and reincorporation in surface soil is thought to be responsible for SOM stability under cedars but not pine. The non hydrolysable fraction, considered to be resistant, represented 39% of the soil C in the surface soil for both cedar and pine but increased to 72% in the subsurface of the pine relative to 57% in the cedars. This suggests that the loss in SOM, due to pines, came largely from the active and slow pools.

The SOM molecular structure was determined with pyrolysis –molecular beam mass spectrometry (py-MBMS) and diffuse reflectance, mid infra red spectroscopy at 400-4000 cm^{-1} (MiDIR). Seventy percent of this sandy soil C was pyrolyzed compared to 50 to 55% in medium textures soils. The m/z diagrams of the pyrolysis products showed significant differences in the composition of plant inputs and high molecular weight components with depth. Carbohydrate and phenolic-derived peaks dropped significantly with depth. Nitrogenous compounds, considered to be mostly amino compounds, underwent compositional changes with depth even though the proportion of N compounds stayed the same. This showed the effects of microbial transformation of the plant materials and conservation of the soil N as decomposition progressed. Sterols were highest in the litter and at depth. The high molecular weight signals, that were often unidentified in py-MBMS, rose from 12% of the sum of the ionization products in the plant biomass to 35% in the subsurface soil indicating production of soil specific compounds that differed from the original vegetation. Mid infrared (MiDIR) spectroscopy, also clearly differentiated the vegetation effects. It was especially sensitive to changes brought about by the cedar growth in the top soil layers while showing few depth effects in the prairie.

Although clay protection is probably more important than biochemical complexity in most soils, the large molecular weight compounds produced in soil contribute to inherent resistance especially in combination with the stabilizing effects of Ca. The analysis of a sandy soil, together with multiple analytical approaches, made it possible to measure molecular structure effects with out the interference of the clays common in most soils. The measurement of SOM dynamics by tracers such as ^{13}C and ^{14}C, fractionation and long-term incubation when combined with py-MBMS and MiDIR analysis of soils with a known management history. is providing important information on the role of molecular structure in soil dynamics.

Keywords: SOM dynamics,molecular structure, tracers, ^{13}C, py-MBMS, MiDIR

Black carbon quantity and quality unchanged after 55 years of organic matter depletion in a Chernozem

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Pyrogenic carbon (PyC) comprises a significant fraction of soil organic carbon (SOC) and the understanding of its quantity and turnover in Chernozemic soils is growing rapidly (e.g. Hammes et al., 2008, Brodowski. et al. 2006, Rodionov et al. 2006, 2010). To assess the long-term stability we took advantage of an existing field experiment near Kursk, Russia. 63 years ago native steppe (typically with annual wildfires) was converted to bare fallow, and no wildfires occurred thereafter.

We analyzed the soil horizons down to 80 cm in increments of 10 cm for OC and PyC after 55 years in light ($\rho< 2$ g/cm^3) and heavy fractions (>2.0 g/cm^3). PyC content and quality was analysed using Benzene Polycarboxylic Acids (BPCA) as molecular markers (Glaser et al., 1998; Brodowski et al., 2005, Schneider et al., 2009). Briefly, the concentrations of BPCA can be used to determine the presence of fire derived OC, and the relative proportions of the individual four types of BPCA reflect the size of the condensed aromatic clusters.

Initially OC concentrations were typical for Chernozems (Brodowski. et al. 2006, Rodionov et al. 2006, 2010) decreasing from the topsoil to 80 cm depth (64 to 23g/kg soil), and PyC concentrations were smaller (1.9 to 1.2 g/kg). OC stocks were 259 t/ha whereas the stock of PyC in the equivalent soil mass was 12.3 t/ha. In the first two decades of bare fallow, total OC stocks decreased rapidly by 33% and then leveled off. The PyC stocks, however, decreased only very little (7%), despite the fact that no new PyC had been added during this time. The observed PyC loss is smaller than in a similar fire exclusion experiment, where ¼ of the initial PyC stock was lost within a century (Hammes et al., 2008). Most of the PyC (70%) was associated with the heavy fractions (>2 g/cm^3), less (30%) with the light fraction (< 2 g/cm^3), consistent with results from Brodowski et al. (2006). After 55 years of black fallow PyC stocks did not change in the heavy fraction, among which clay contributes >90 % of PyC content. Thus, the 7 % loss of PyC occurred in the fraction < 2 g/cm^3, although the PyC quality (determined as proportions of individual molecular markers) remained unchanged. The fact that we did not observe any change in the chemical structure of BPCA favors a physical relocation (erosion, leaching) over a chemical degradation as an explanation for the observed decline.

To conclude, over 55 years of bare follow soil organic matter stocks decreased drastically, but PyC quantity did not (only by 7%). In the clay fraction PyC quantities did not change, although the underlying mechanism remained unclear. It could be that highly dispersed condensed aromatic structures form hydrophobic bonds within organic matter adsorbed on clay particles, thus reinforcing its aggregation/occlusion and promoting co-stabilization of SOM.

References: Brodowski S., et al. 2006. European Journal of Soil Science, 57, 539-546
Hammes et al. 2008. Biogeosciences, 5, 1339-1350.
Glaser B, et al. Organic Geochemistry 29, 811-819.
Brodowski S., et al. 2005. Organic Geochemistry 36, 1299-1310.
Schneider M.P.W., et al., Organic Geochemistry. in review.
Rodionov A. et al. Journal of Plant Nutrition and Soil Science, 169, 363-369, 2006.
Rodionov A. et al. Global Biogeochemical Cycles, in press, 2010.

Keywords: organic matter decomposition, black carbon, molecular marker

Integrated transfers of terrigenous organic matter to lakes at their watershed level: a combined biomarker and GIS analysis

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Terrigenous organic matter (TOM) transfer from a watershed to a lake play a key role in contaminant fate and greenhouse gazes emission in these aquatic ecosystems. In this study, we linked physiographic and vegetation characteristics of a watershed with TOM nature deposited in lake sediments. TOM was characterized using lignin biomarkers as indicators of TOM sources and state of degradation. Geographical information system (GIS) also allowed us to integrate and describe the landscape morpho-edaphic characteristics of a defined drainage basin. Combining these tools we found a significant and positive relationship (R^2=0.65) between mean slope of the watershed and the terrigenous inputs estimated by l8 in recent sediments. The mean slope also correlated with the composition of TOM in recent sediments as P/(V+S) and 3,5Bd/V ratios significantly decreased with the steepness of the watersheds (R^2=0.57 and R^2=0.71 respectively). More precisely areas with slopes comprised between 4 and 10 degrees have a major influence on TOM inputs to lakes. The vegetation composition of each watershed influenced the composition of recent sediments of the sampled lakes. The increasing presence of angiosperm trees in the watershed influenced the export of TOM to the lake as l8 increased significantly with the presence of this type of vegetation (R^2=0.44). A similar relationship was also observed with the S/V ration, an indicator of angiosperm sources for TOM. The type of vegetation also greatly influenced the degradation state of OM. In this study we were able to determine that low sloped areas (0 to 2 degrees) act as buffer zones for lignin inputs and by extension for TOM loading to sediments. The relative contribution of TOM from the soil organic horizons also increased in steeper watersheds. This study has significant implications in our understanding of the fate of TOM in lacustrine ecosystems.

Keywords: Terrigenous organic matter, Lignin biomarker, Lake, Watershed, Sediment, GIS

Towards a database and on-line analysis tool for soil molecular research

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Molecular databases have been identified as an important tool by the ESF MOLTER networking programme (www.molter.no). The aim is to produce a widely-used online resource, which will generate the scientific synergies and advance European research in the field of soil molecular research, in agreement with the mandate of ESF networking programmes (www.esf.org). To reach this general goal, multiple possibilities exist in terms of scope, format, and analysis tools. In this context, MOLTER sponsored an exploratory workshop in Oslo in May 2010 on the development of soil molecular databases.

The overall framework of the database is to help our understanding of the complexity and composition of soil organic matter. Archiving is the first function of the database. However, this function is not sufficient in itself for ensuring the successful creation of wide scientific synergies in the research community. Indeed, an archiving database is at risk of both being underused and receiving insufficient data inputs. On-line visualisation and processing of archived raw data is a second function of a computational database. A third function consists in performing basic and advanced statistical analyses on the processed data. Combining these first three functions, i.e. archiving, processing and statistical analysis, appears to be the primary objective of modern soil molecular database efforts developed at the level of the individual research laboratory or institute. Examples of such efforts under development are the soil infrared spectral database of the CEMAGREF in Grenoble – France, and the soil lipidomics database at Kansas State University. In other words, modern soil molecular databases are mostly developed at the institute level for optimizing data analysis for one particular research method. The transition towards an international computational database for soil molecular data will require additional functions.

Exploring the impact of environmental drivers on SOM molecular composition in a spatially explicit way represents the fourth desired function of the computational database. Within the MOLTER network, a prototype database for soil lignin composition across European environmental conditions has been developed. A first evaluation of the prototype suggests that this type of database is best geared towards one defined international collaborative project. A modern international soil database would need, in addition, to accommodate multiple data types (from single data to entire spectra) and integrate online analyses tools within an interactive user interface. These analyses should include multivariate statistics (e.g. PCA, PLS) and data fusion techniques to cross-compare and cross-calibrate multiple molecular techniques, with the aim of better understanding the complexity and composition of soil organic matter.

Our vision is that of a soil molecular database that would be of service to a large scientific community through online freeware analysis tools, enabling both secured raw data processing and statistical analyses, together with the possibility for users to share personal raw datasets with the community. Such a database would need to be originally seeded with multiple sets of analyses conducted on standard samples. As the database grows from user and manager validated new inputs, the associated statistical tools will help us infer series of molecular properties from a single type of measurement, e.g. infrared spectra, thermogravimetry. Finally, the computational database should have a long-term goal of integrating expert-system functions, which would aim at estimating key soil ecological parameters (e.g. SOM stability, potential N_2O emission) based on soil spectral and molecular measurements.

These concepts will be presented together with a first prototype of computational database for soil molecular research based on the platform of the CEMAGREF model, which will integrate functions for archiving, processing and analyzing multiple types of raw data sources and their associated environmental metadata.

Keywords: Database, MS, NIR, MIR, NMR, TG/DSC, OMICS

Posters – Session 2

Poster S2-P1

Aromatic condensation as a measure of black carbon stability: A NMR study

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Black carbon (BC) represents a significant sink in the global carbon cycle as part of the slow-cycling carbon pool (Lehmann et al., 2006). In recent years, this has sparked scientific interest due to its potential importance in carbon sequestration processes. However the complexity and heterogeneity of BC's origin, morphology and chemistry has caused difficulties in identifying and quantifying the contribution of BC to soil and sedimentary carbon budgets and to the overall global carbon cycle. Little is known about BC loss processes including BC degradation. Although BC has been found to be abundant in soils and sediments, estimating stocks is hampered by the lack of reliable analytical techniques for identifying and quantifying BC in such matrices. There has been limited progress with the calibration of analytical techniques for a better interpretation of BC analysis. This was identified in a study by Hammes et al. (2007) which found the BC concentration determined for a set of samples varied considerably among available BC analytical techniques. This was, in part, attributed to BC being a continuum of materials of variable chemical composition, with no clear cut boundaries. The different methodologies are restricted to, or more sensitive to, different "windows" of the BC continuum. In other words, each technique has a different definition of what BC is.

A chemical feature of BC that somewhat defines its continuum is the degree of aromatic condensation or 'graphiticness'. BC exists as extensive sheets of hexagonal arrays of carbon atoms. These become larger and purer (more condensed) at higher production temperatures. We have developed an easy method using nuclear magnetic spectroscopy (NMR) to measure the degree of aromatic condensation of BC and have validated the method with a thermosequence (200-1000°C) of charcoals. "Standard" NMR analysis showed that the % aromatic carbon rapidly increases through the production temperature range 250- 450°C. On the other hand, aromatic condensation was quite insensitive to differences between chars up to 400°C, but increased steadily up to 1000°C. This illustrates changes in char chemistry are still occurring at these higher temperatures. This method was also applied to a range of biochars of variable starting materials and production temperatures. We found that not only production temperature but starting materials influenced aromatic condensation.

This new technique holds promise for a wide range of applications in identifying BC in the environment. It represents a major advance in BC analysis, enabling us to "see" the BC spectrum not just in black and white, but in all its shades of grey.

References: Hammes, K., M.W.I. Schmidt, R.J. Smernik, L.A. Currie, W.P. Ball, T.H. Nguyen, P. Louchouarn, S. Houel, O. Gustafsson, M. Elmquist, G. Cornelissen, J.O. Skjemstad, C.A. Masiello, J. Song, P. Peng, S. Mitra, J.C. Dunn, P.G. Hatcher, W.C. Hockaday, D.M. Smith, C. Hartkopf-Froeder, A. Boehmer, B. Luer, B.J. Huebert, W. Amelung, S. Brodowski, L. Huang, W. Zhang, P.M. Gschwend, D.X. Flores-Cervantes, C. Largeau, J.N. Rouzaud, C. Rumpel, G. Guggenberger, K. Kaiser, A. Rodionov, F.J. Gonzalez-Vila, J.A. Gonzalez-Perez, J.M. de la Rosa, D.A.C. Manning, E. Lopez-Capel, and L. Ding. 2007. Comparison of quantification methods to measure fire-derived (black/elemental) carbon in soils and sediments using reference materials from soil, water, sediment and the atmosphere. Global Biogeochemical Cycles 21.

Lehmann, J., J. Gaunt, and M. Rondon. 2006. Bio-char sequestration in terrestrial ecosystems - A review. Mitigation and Adaptation Strategies for Global Change 11:403-427.

Keywords: Black Carbon, Charcoal, NMR Spectroscopy, Biochar, Aromatic Condensation, Ring Currents

Poster S2-P2

Chemical transformation of coarse woody debris and leaf litter during decomposition in boreal forests

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Coarse woody debris (CWD) constitutes an important reserve of carbon in boreal forests. CWD is characterized by chemical and physical structures different from those of leaf litter and lower decomposition rates, thus CWD could be a source of more stable forms of soil carbon. The objectives of this project are: (1) to characterize and compare the chemical composition of decaying wood and leaf litter for three boreal species of contrasting litter quality; and (2) to study the chemical composition along a chronosequence of decaying logs of the same species.

The study is set in the SAFE Project, located within the Lake Duparquet Research and Teaching Forest (LDRTF, 80 km2), in the southern part of the eastern Canadian boreal forest. In control stands of the project (3 aspen stands, 3 mixed-aspen stands and 3 mixed post budworm outbreak stands), 150 litterbags containing wood blocks or leaf litter from three species (trembling aspen, balsam fir, white spruce) were left on the forest floor and collected one to six years after the start of the experiment. A chronosequence of decaying logs for each species was also established in the same stands. The chronosequence included logs of five decay classes with a diameter superior to 10 cm for a total of 102 logs. Chemical analyses included solid-state ^{13}C CPMAS NMR spectroscopy and NIR spectroscopy, lignins monomers by cupric oxide oxidation and gas chromatography, and C and N concentrations using a LECO CNS 2000 analyzer.

Results showed that initial concentrations of O-alkyl compounds in wood blocks, mainly from carbohydrates, were higher than those of leaves while concentrations of nitrogen were lower. After 5 to 6 years of decay, wood blocks had a lower weight loss than leaf litter, despite a lower proportion of alkyl and aromatic compounds (lignins, tannins, cutin), considered as the more recalcitrant components. Only balsam fir wood blocks had a higher proportion of aromatic compounds than leaves, and were the litter with the lowest decay rates. Contrary to expectations, the proportion of alkyl compounds in aspen and balsam fir leaves decreased after the first year of decomposition while the proportion of O-alkyl compounds increased. Syringyl to vanillyl phenols ratios were higher in aspen than conifers and decreased with decay.

In natural logs, nitrogen and lignin concentrations and the alkyl/O-alkyl ratio increased with decay while cellulose and hemicelluloses concentrations and the C/N ratio decreased. A higher proportion of carbonyl and alkyl compounds was found in trembling aspen logs than in conifer species, whereas conifer species were characterized by a higher proportion of aromatic compounds, including lignins and tannins.

The physical structure of CWD and its proportion of aromatic compounds, mainly its higher amount of lignins, could explain its lower decomposition. CWD could therefore lead to longer carbon retention in soil than leaves. The nature of lignin in conifers, which was found to be richer in vanillyl phenols when compared to that of aspen, could result in a higher recalcitrance of their lignin in the course of decay. The alkyl compounds, more abundant in leaves and in aspen could play a role in retaining carbon in more advanced decay stages.

Keywords: Coarse woody debris, decomposition, NMR, stable forms of carbon, boreal forests

Poster S2-P3

Dissolved organic matter analysis with metal complexation by total luminescence quenching

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The complexation between Dissolved Organic Matter and metal ions leads to fluorescent activity stabilization of DOM as well as toxicity decreasing of metal ions. It happens in all environments including soils, sediments and aqua-systems.

The DOM-Metal complexation propriety is accessible by fluorescence quenching (FQ). During a fluorescence quenching, the complexing sites of fluorescence relative contribution vary. By parallel factor analysis (PARAFAC) applied on excitation-emission matrix (EEM) it is possible to extract fluorescent components (Components 1 and 2, Figure 1).

[Cu^{2+}] titration onto a tropical river water sample from Brazil ([C]=5 mg of C.L^{-1}, initial [Cu^{2+}]=1.68 10^{-9} mol.L^{-1}, pH=4.5) from initial copper concentration to 10^{-3} mol.L^{-1} is done (I=0.1 mol.L^{-1}, pH=8) with 50 EEM analysed by PARAFAC. Two fluorescent components are extracted from the EEM : C_1 (λ_{ex}=235 nm /λ_{em} = 420-425nm) and C_2 (λ_{ex} = 250-260 nm and 345-355 nm / λ_{em} = 470-480 nm). These components correspond to those found in literatures. This method confirms that the extraction of fluorophores and their respective contribution of EEM modelling give better results from the whole matrix.

Moreover, this experiment is done at two NOM concentrations range. One in the linear domain for the Berr-Lambert law where fluorescence is supposed to be linear function of the concentration and the other in the inner filter effect domain. The goal of this experiment is to treat at the same time the quenching phenomena and the inner filter effect of the sample by both previous data treatment and PARAFAC decomposition.

References: COBLE (P.G.) «Characterization of marine and terrestrial DOM in seawater using excitation-emission matrix spectroscopy», *Marine Chemistry*, vol.51, p. 325-346, 1996;

MOUNIER (S.), «FLUORESCENCE 3D DE LA MATIÈRE ORGANIQUE DISSOUTE DU FLEUVE AMAZONE (THREE-DIMENSIONAL FLUORESCENCE OF THE DISSOLVED ORGANIC CARBON IN THE AMAZON RIVER)», *Water Research*, vol.33, p. 1523-1533, 1999;

BRO (R.), «A new efficient method for determining the number of components in PARAFAC models», *Journal of Chemometrics*, vol. 17, p. 274-286, 2003;

BAKER (A.), «Thermal fluorescence quenching properties of dissolved organic matter», *Water Research*, vol. 39, p. 4405-4412, 2005;

ESTEVES DA SILVA (J. C. G.), «Multivariate curve resolution of multidimensional excitation-emission quenching matrices of a Laurentian soil fulvic acid», *chemosphere*, vol. 64, p.1939-1948, 2006;

LUCIANI (X.), «Tracing of dissolved organic matter from the SEPETIBABay (Brazil) by PARAFAC analysis of total luminescence matrices», *Marine Environmental Research*, vol.65, p. 148-157, 2008.

Keywords: Complexation Stability, Fluorescence spectroscopy, Total Luminescence Quenching, EEM, PARAFAC

Poster S2-P4

Dynamics of lignins in a cultivated soil studied using two procedures: CuO oxidation and 'Milled Wall Enzymatic Lignin' isolation.

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In soils, lignins are commonly studied after release of phenolic monomers using CuO oxidation (Kögel et Bochter, 1985). However, the amount of lignins quantified probably underestimates the actual amount of native lignins since the CuO oxidation does not completely depolymerize the macromolecule (Otto and Simpson, 2006). The objective of this study is to use an isolation method named 'Milled Wall Enzymatic Lignin' (MWEL – Pew, 1957, Lapierre et al., 1986) to obtain access to a different part of the macromolecule and to evaluate its complementarity to CuO for the study of lignin dynamics in soils.

In a C3/C4 chronosequence, soil and plant lignins were isolated following the MWEL procedure in plots cultivated in wheat (C3) or maize (C4) since 3, 6, 9 and 12 years. Prior to lignin isolation, about 300 g of soil sample were demineralised using 10 % hydrofluoric acid. Lignin derived products (calculated as the sum of vanillyl, syringyl and cinnamyl units, VSC) were also released from the same samples with the CuO oxidation method. The ^{13}C isotopic signature of the CuO oxidation products was measured by gas chromatography coupled to an isotope ratio mass spectrometer via a combustion interface (GC-C/IRMS). The ^{13}C signature of the MWEL isolated were measured by elementary analysis/ IRMS. The purity of isolated lignin was evaluated by the combination of pyrolysis-gas chromatography/mass spectrometry (py/GC/MS) and nuclear magnetic resonance (NMR) spectroscopy.

In soils, the amount of MWEL and VSC were in the same range (0.10 to 0.35 mg OC g^{-1} soil). The $\delta^{13}C$ values of the MWEL lignins (-30 to -26‰) were similar to those measured with the CuO method (-33 to -25‰). For the plants, similar results were obtained as well with the two methods. This suggests the efficiency of the MWEL method for the study of lignins in soils. Moreover, py/GC/MS and NMR spectoscopy showed that the MWEL procedure is more efficient for soils than for plants, the isolated lignins being less contaminated by polysaccharides and less lignins remaining in the isolation residue (Dignac et al., 2008). To conclude, the MWEL isolation procedure can be used in combination with the CuO oxidation method to characterize lignins in soils, estimate their dynamic *in situ* using isotopic method and increase our knowledge about lignin degradation and stabilization processes.

References:

Dignac M.-F, Péchot N., Thevenot M., Bahri H., Lapierre C., Bardoux G., Rumpel C., 2008. *Journal of Applied and Analytical Pyrolysis, Accepted.*

Kögel I., Bochter R., 1985. *Soil Biology & Biochemistry* 17, 637-640.

Lapierre C., Monties B., Rolando C., 1986. *Holzforschung* 40, 113-118.

Otto A., Simpson M.J., 2006. *Biogeochemistry* 80, 121-142.

Pew J;C., 1957. *Tappi* 40, 553-558.

Keywords: lignin, carbon dynamics, soil organic matter

Poster S2-P5

Fully automated thermochemolysis for high-throughput monitoring of soil biomarker abundance

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Lignin is an abundant and recalcitrant biopolymer that provides information on past vegetation and soil OM stabilisation. The degradation and quality of organic matter is also detectable with these biomarkers. The influence of historically forest-derived organic matter contributions on contemporary pastoral soils is of particular interest in New Zealand, where lignin biomarkers can track forest-grassland transitions that do not leave C isotope evidence from C3-C4 shifts. Thermally-assisted hydrolysis and methylation (THM) can be used to rapidly determine the lignin content of soil samples. However, this method requires the controlled application of tetramethylammonium hydroxide (TMAH). Pyrolysis systems are not set up for automated chemical additions and manual addition requires either low throughput single sample runs and/or variable reaction times. To overcome this challenge, we have interfaced a liquid sampler with a pyrolysis system to automate and control the addition of TMAH for thermochemolysis.

We are utilizing a GC-MS system equipped with both a pyrolysis unit and a Combi-PAL liquid autosampler, typically used as two distinct methods of GC operation. By interfacing these two operational modes, the Combi-PAL can be used to dose soil samples prior to pyrolysis. We have modified the AutoShot Sampler of a Frontier Double Shot Pyrolyser, fitting it with a metal block that serves as an “injector” over the open sample cup tray. A CTC Combi-PAL autosampler, elevated to an appropriate height above the pyrolysis unit using a pneumatic switch, has been interfaced to run by a switching valve on the GC. The Agilent GC-MS triggers the Combi-PAL to inject TMAH in the next sample to be run by the pyrolyser. Subsequently, the GC-MS triggers a normal run of the pyrolyser to analyse the sample.

This automated thermochemolysis system allows for high throughput analysis of many samples. In particular, this rapid data collection facilitates the comparison of unlabelled and ^{13}C-labelled TMAH to differentiate lignin and tannin-derived phenolic contributions to soils. Furthermore, the rapid, automated TMAH addition technique minimizes exposure of the laboratory atmosphere to the hazards of TMAH, including its unpleasant odour. It also regulates the incubation time of TMAH in each sample.

We have applied this new automation to analyse re-sampled soils in New Zealand for carbon losses and/or gains dependent upon type and quality of organic matter contributions. The amount of data generated by this automation including comparisons of labelled and unlabelled thermochemolysis facilitates the development of a database characterizing New Zealand soils at the molecular level. NIST AMDIS software provides a functional deconvolution tool for data analysis that compliments hardware automation. Considering the large proportion of SOM seen by thermochemolysis, we see lignin biomarkers as simply a starting point for highly automated analysis and discovery of molecular structures in soil organic matter.

Keywords: thermochemolysis, pyrolysis, lignin, soil organic matter

Poster S2-P6

Humic substances as drivers of carbon flow and source of biogeochemical proxies for climate change

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Recent literature on the long-term accumulation of soil organic matter (SOM) has emphasized the importance of preservation factors. Such research in general does not address to its just extent the role in the SOM resilience of the molecular composition of humic substances (HS). This is investigated in the present study from a three-sided approach: 1) Molecular-level analysis of SOM facing to define its biogeochemical stability, 2) Structural laboratory transformations of model humic molecules to check for its effect on biodegradability, and 3) Empirical, statistical approaches taking advantage from the natural variability of the SOM, supplying s*tructural humic resilience proxies*:

1) In structural studies on HS, we empirically assume that resistance to biodegradation should parallel stability against wet chemical laboratory degradation. Multi-step degradation of humic acids with reagents selected to break specific chemical bonds indicates: (i) ester-bonded units removed by BF_3-MeOH transesterification means labile lipid polymers, cutin and suberins; (ii) carbohydrate-like structures are evidenced by ether-cleaving treatments (e.g. hydroiodic acid); (iii) a recalcitrant degradation residue was found to include not only typical polycyclic aromatics but also a condensed, ‘subfossil’ nonhydrolyzable paraffinic domain and N-containing structures. These features could be assimilated to a SOM model based on open, continuously-growing ‘megamolecule’ consisting of disordered C–C and C–O bonds, with structures not specifically recognized by soil enzymes and entrapping heavily altered (or selectively preserved) biomacromolecular domains in a threedimensional backbone of variable geometry where enzyme diffusion is hampered.

2) The second approach suggest that controlled changes in the HS functional groups (oximation, nitration, amidation, amonification…) is not the chief constraint for biodegradability in laboratory conditions (probably due to the high degree of functional redundancy in the structure of HSs) but lead to indirect effects on skeletal features. The concentration of O-containing pseudomelanoidins or Maillard-type substances prevail on that of aromatic constituents as regards biodegradability. The multiple regression models reinforce the idea that resilience factors in HS depend mainly on structural diversity in disordered three-dimensional skeletal structures.

3) Finally, statistical approaches screening for common features in SOM of known biodegradability, formed in different environmental matrices, confirmed the possibility to forecast an additional portion of the variability explaining the potential of soils to act as carbon sinks. This suggest the potential of using surrogate descriptors (geographical-scale dependant) of the HS formation pathways, such are some structural features of HS like the content in alkyl and *O*-alkyl C-types, or the guaiacyl/syringyl ratio (higher in the most recalcitrant humic fractions), which also shows the importance of internal cross-linking in the residual lignin domains.

Because HSs represent the major pool of organic C in the Earth’s surface, we encourage future research lines explaining its stability and bearing on C circulation as emergent properties derived from the complexity of its progressive molecular levels. Chemical biodiversity (e.g., Shannon indices or coefficients from multivariate data models) ought to be applied to analyze the molecular assemblages yielded by SOM degradation methods (or for interpreting quantitative information after pattern recognition techniques applied to derivative spectra). This would facilitate assessment of the extent to which the original biomass has been microbially reworked, or diagenetically transformed into newly-formed chaotic structures with non-repeatable units. Macromolecular complexity could then inform on the long-term C sequestration in soil through *resilience proxies* (e.g., atomic ratios, optical density, and stable free-radical content) valid to forecast at least a portion of the total variance in SOM biodegradability.

Keywords: humic substances, soil carbon sequestration, selective preservation, molecular complexity, humification processes

Poster S2-P7

Heat- and moisture-dependent water repellency induced by the Basidiomycete Agaricus bisporus, and the extraction of hydrophobins from soil

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Soil water repellency has been reported from many soils, but the mechanistic role of soil biota for its occurrence is poorly understood. In this paper we report that the water content during the cultivation of *A. bisporus* on soil as well as the drying temperature of the soil after the incubation experiment highly significantly affected soil water repellency (WR). WR was determined by water drop penetration time (WDPT). It ranged from 0.5 s in the samples cultivated at high soil water content that were subsequently freeze dried, to > 161.6 min in the soils kept at the low water content that were subsequently dried at 80°C. This is, to our knowledge, the first experimental demonstration of a very strong heat- and moisture- dependency of WR induced by soil biota. Furthermore, we obtained a putative hydrophobin and analysed it by sodium dodecyl sulfate polyacrylamide gel electrophoresis (SDS-PAGE). Hydrophobins, ubiquitous proteins found in filamentous fungi, had previously not been shown to be produced or occur in soils. Conversely, no hydrophobins could be isolated from hyphae grown in soil, which suggests that the fungus may release the majority of these proteins into the soil. Taking both parts of our study together, we have provided evidence for a strong link between fungal hydrophobin production and the development of soil WR.

References: Spohn, M., Rillig, M.C. (in prep.). Heat- and Moisture-Dependent Water Repellency Induced by the Basidiomycete *Agaricus bisporus,* and the Extraction of Hydrophobins from Soil.

Keywords: Hydrophobin, Water Repellency, Soil Hydrophobicity, Soil Protein, Protein Extraction, Heat, Water Content

Poster S2-P8

Incomplete recovery of mineral-bound lignin-derived phenols by CuO oxidation

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Carbon sequestration in soils is dependent on processes that promote accumulation and stabilization of soil organic matter (SOM). Current conceptual models nearly all incorporate intimate associations between organic matter (OM) and minerals, whether through sorptive mechanisms in which minerals afford protection to otherwise labile OM, or through aggregation in which OM is protected by mineral "cages". Among the most surface-reactive organic compounds in soils appear to be those derived from partial degradation of polyphenols, such as lignin. However, despite numerous studies on lignin and lignin-derived phenols, we still do not have a clear understanding of their role in the accumulation and stabilization of SOM, in part because of the inability of current techniques to detect all lignin-derived phenols, especially when attached to minerals. We hypothesized that there is a significant portion of lignin-derived phenols that is irreversibly sorbed to mineral surfaces, thus escaping detection. To test this, we ran a series of batch sorption experiments carefully designed to measure the portion of lignin-derived phenols not extractable by the CuO oxidation method. We used aqueous leachates of different plant litter (blue oak, foothill pine, annual grass), with dissolved lignin-derived phenols of contrasting composition, and minerals with different sorption properties (ferrihydrite, goethite, kaolinite, illite, montmorillonite). We determined the sorption characteristics of all minerals and solutes, based on the uptake of dissolved organic carbon (DOC) and chromophoric compounds from solutions. Then, larger scale batches were carried out, in which we tested the sorption of lignin-derived phenols under conditions where the maximum possible loading of each mineral was not approached. The produced organic–mineral associations as well as the dried-down leachates and equilibrium solutions were subjected to CuO oxidation. Lignin-derived compounds sorbed and not extractable by the CuO oxidation procedure were calculated by difference.

Sorption of DOC was strongest for the two iron oxides, goethite and ferrihydrite, followed by kaolinite, montmorillonite and illite. Carbon uptake by minerals was strongest for the blue oak and weakest for the annual grass leachate. The decrease in UV absorption of solutions after reaction with minerals indicates preferential sorption of chromophoric compounds, likely phenols. However, the overall DOC sorption did not match the leachates' contents of lignin-derived phenols. This suggests differential sorption of lignin-derived phenols of different origin. The CuO oxidation results on the produced organic–mineral associations showed a complete recovery of sorbed phenols for ferrihydrite, because of the complete dissolution of the mineral under heated alkaline conditions. The unchanged ratios of individual phenolic compounds recovered from ferrihydrite as compared with those calculated for sorbed phenols suggests that there is no interference of the mineral matrix with phenolic compounds during the CuO oxidation procedure. For all other minerals, the recovery of sorbed phenolic compounds was incomplete (up to 44% of the sorbed phenols), with kaolinite and goethite retaining the largest portion of sorbed lignin-derived phenols. Along with the incomplete recovery, we found a change in ratios of individual phenolic compounds, which we attributed to their differential desorption, thus their different bonding strength.

Our results show that a substantial portion of lignin-derived phenols is irreversibly bound to minerals and escapes extraction even under harsh conditions, except for when the entire mineral becomes dissolved. The differential extractability of phenolic compounds has implications for use of ratios of individual phenols for assessing organic matter transformation in a mineral matrix.

Keywords: dissolved organic matter, sorption, minerals, lignin-derived phenols, CuO oxidation, extractability

Poster S2-P9

Investigation of carbon turnover and CO_2 evolution in soil organic carbon from Japanese forest soils: Insight from radiocarbon analysis of soil density fractions and soil respired CO_2

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Radiocarbon data from soil organic matter and soil respiration provide powerful constrains for determining carbon dynamics (Trumbore 2000). Here, the data from six sites in Japanese cool-temperate forests were used to determine the turnover time and rate of CO_2 production from heterotrophic respiration. For these sites, the average age of bulk carbon above 20 cm ranges from modern to 790 yr. In each case, the average includes components such as recognizable litter fragments with much shorter turnover times, humified or mineral-associated organic matter with much longer turnover times.

We also used soil density fractions to interprete as organic matter pools with different carbon turnover times, ranging from years to decades or centuries, and different functional roles for carbon dynamic. We will show the results and comparison of the ^{14}C in soil respiration with soil organic matter to indicate a contribution from decomposition of organic matter at this meeting.

References: S. Trumbore (2000) Age of Soil Organic Matter and Soil Respiration: Radiocarbon Constraints on Belowground C Dynamics, Ecological Applications, Vol.10 (2), 399-411

Keywords: Radiocarbon, Soil density fraction, Soil respiration, Turnover time

Poster S2-P10

Lignin, cutin, and suberin decomposition and stabilization in C saturated soils

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Evidence of soil C saturation with increased C inputs, elevated CO_2, or total SOC as a proxy for C input challenges biogeochemical model assumptions of linear SOC sequestration with increased C input. At high levels of C input, soils exhibiting C saturation provide the opportunity to examine controlling mechanisms in C sequestration with increasingly limited C stabilization potential. Examination of one such study, a manure experiment in Lethbridge, Alberta, in which SOC at equilibrium time responded asymptotically to increased manure input levels, allowed assessment of changes in C biochemistry with increased soil C saturation. Lignin, an aromatic plant-derived SOC component and cutin and suberin, aliphatic plant-derived SOC components, were quantified using CuO oxidation and coupled gas chromatography-mass spectroscopy in whole soils and soil fractions across manure treatments. C normalized lignin signatures increased with increased manure input in the bulk soil and the chemically protected silt + clay fractions, while lignin signatures decreased in the non-protected and physically protected particulate organic matter (POM) fractions. C normalized cutin and suberin signatures did not significantly differ across manure input treatments for any of the measured fractions. The rate of change in C normalized lignin signatures from bulk soil to each soil fraction differed significantly across treatments for the POM fractions but not for the silt + clay fractions. The rate of change in C normalized cutin and suberin C signatures from bulk soil to each soil fraction was not significantly different across treatments. These results indicate that with C saturation, and decreasing stabilization potential, the preservation of lignin, cutin, and suberin in chemically protected silt + clay fractions does not change. In the non-protected fractions, the depleted lignin C signature with C saturation indicates that lignin is preferentially decomposed. These findings question the role of innate lignin recalcitrance in the POM fractions, while demonstrating that lignin, cutin, and suberin biochemistry does not play a major role in silt + clay chemical stabilization across a soil C saturation gradient.

Keywords: lignin, cutin, suberin, saturation, stabilization, biochemistry

Poster S2-P11

Linking biological and thermal soil organic matter quality in different soils

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The use of thermal analysis techniques in soil science has a long history, but they have been typically used for the identification and quantification of soil mineral constituents and only sporadically to characterize soil organic matter (SOM). In recent years, their use has been frequently proposed as a means to analyze soil organic matter in bulk soil samples without prior physical or chemical treatment. The underlying assumption of the method is that thermal stability of SOM is related to its biogeochemical stability. However, the number of tested soils and fractions has not yet been large enough to test this hypothesis, and additional experiments must be performed to link thermal analysis to conventional methods of assessing SOM decomposability.

Surface soil samples were collected from five sites along a continental mean annual temperature gradient, each with native vs. cultivated, or forest vs. pasture land uses. All samples were incubated at 35°C for 588 days and CO_2 respiration was determined periodically. Carbon contents were determined by dry combustion, and a STA 409 PC Netzsch thermal analyzer was used to perform thermogravimetry (TG) and differential scanning calorimetry (DSC) analysis (10 °C/min heating rate; Pt-Rh crucible and 30 mL min^{-1} synthetic air atmosphere) for all samples before and after incubation. Energy density (J mg^{-1} OM) was determined by dividing energy content (mJ) by thermogravimetric mass loss (mg) calculated for the range of 190 °C to 600 °C where the main exothermic reactions associated with SOM oxidation were observed to take place.

Soil C concentrations and proportions of mineralizable C differed significantly among the five sites and land use treatments. Soil C concentrations and proportions of mineralized C were higher for native than for cultivated soils and for forest than pasture soils. DSC thermograms obtained reflected characteristic patterns associated with each type of soil and also with the C losses due to mineralization during the incubation experiment. Strong correlations were found between CO_2 respired as a proportion of initial SOC and the energy density of each sample before incubation.

These results obtained for this small set of soils provide an important first step in establishing thermal analysis as an alternative way to quantify SOM quality in bulk soils by establishing a link between thermal and biogeochemical stability of SOM. However, further work must be done to assess additional expressions of thermal analysis data to provide a rapid and inexpensive way to determine SOM quantity and quality without previous fractionations.

Keywords: Soil organic matter; laboratory incubation; thermogravimetry; differential scanning calorimetry

Poster S2-P12

Molecular and isotope characterization of soil lipids along a savannah (C4)/eucalyptus (C3) chronosequence (Pointe-Noire, Congo)

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The surfaces dedicated to forestry are rapidly increasing throughout the world, especially in the tropics (FAO 2003). The impacts of such a rapid afforestation on global carbon cycle and soil that is one of its key compartment, is therefore a critical issue (Garcia-Quijano et al. 2005). Stable carbon isotope characterization of C_4/C_3 chronosequences has proven useful in assessing the dynamics of organic carbon in soils (Cerri et al. 1985). Lipids are important contributors to organic matter in soils since they can influence aggregate

stability, water retention and fertility. Nevertheless, little is known on the effects of afforestation on lipid composition and dynamics in tropical soils. The sylviculture located in the area of Pointe-Noire (Republic of Congo) is a prime field to study the impact of afforestation on organic carbon dynamics. Indeed, a eucalyptus forest (C_3) have been planted progressively on savannah (C_4) during the last 30 years (Schwartz et al 1986). Lipids were solvent-extracted from the top soil (0-20 cm) of stands planted for 7, 17, 30 years, of a reference plot of the initial savannah, as well as of the main plants growing on the two vegetation types.

Lipids accounted for 0.3 to 0.9 wt % of the dried soils. Gas chromatography-mass spectrometry analyses of soil lipids revealed a complex mixture comprising more than 100 identified constituents, belonging to diverse chemical families (e.g. fatty lipids, triterpenes, sterols, glycerols). Most of these molecules correspond to plant components, emphasizing the importance of this source of organic matter for soil lipids. Afforestation did not appear to affect significantly bulk lipid yields and most of the identified components are present all along the chronosequence. Nevertheless, quantification of the main compounds revealed, for some of them, significant trends related to the vegetation changes: (i) decrease of savannah grasses markers (very long chain fatty lipids, pentacyclic triterpene methyl ethers), (ii) increase of eucalyptus contribution (long chain fatty lipids) and (iii) increase of microbial marker (cholesterol). Compound-specific carbon isotope analyses are under progress in order to better constrain the dynamics of these changes.

References: C. Cerri, Ch. Feller, J. Balesdent, R. Victoria and A. Plenecassagne, Application du traçage isotopique naturel en ^{13}C à l'étude de la dynamique de la matière organique dans les sols, C.R. Acad. Sci., Sér. D, 300 Sér. II 9 (1985), pp. 423–427.

FAO, State of the World_Forests, Food and Agriculture Organization of the United Nations, Rome (2003) 151 pp.

J.F. Garcia-Quijano, G. Deckmyn, E. Moons, S. Proost, R. Ceulemans and B. Muys, An integrated decision support framework for the prediction and evaluation of efficiency, environmental impact and total social cost of domestic and international forestry projects for greenhouse gas mitigation: description and case studies, Forest Ecol. Manage. 207 (2005), pp. 245–262

D. Schwartz, A. Mariotti, R. Lanfranchi and B. Guillet, ratios of soil organic matter as indicators of vegetation changes in the Congo, Geoderma 39 (1986), pp. 97–103

Keywords: lipid, ^{13}C, C_4, C_3, triterpene, sterol

Poster S2-P13

Nano-scale spatial biogeocomplexity of organomineral assemblages using NEXAFS spectromicroscopy

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Soil represents the largest reservoir of terrestrial organic carbon (C) on the global scale. In light of predicted climate change and a more unified approach to mitigate greenhouse gas emissions, the soil's ability to accumulate and retain C has received growing interest. Although organomineral assemblages are a unique niche in biogeochemical C cycling, with large capacity for storing anthropogenic C introduced in the environment, the fundamental nature of these micro- and nano-composites and the interactions between C and soil mineral components is not yet well understood. Thus, the underlying geobiological mechanisms for the long-term stabilization of C in soils and the full potential for C sequestration in the Earth's surface remains unknown.

In the present study, we will discuss basic nano-scale architectural features of organomineral phases and the in situ spatial association of organic C functionalities such as lipids, protein and polysaccharides with Ca and Fe compounds in free stable microaggregates. Our results clearly indicate the intimate association between the filament-like microbial structure, the Ca and Fe compounds associated with it and microbial C with various inorganic minerals derived from both Ca and Fe within the soil organomineral assemblages.

Keywords: Key words: Carbon, microaggregates, nano-scale, organomineral associations

Poster S2-P14

Occurrence and distribution of GDGTs in temperate and tropical podzol profiles

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Lipids are important constituents of soil organic matter (SOM), due to their high resistance to degradation, their influence on soil characteristics and their interactions with many pollutants. They can also provide information on the sources and degree of degradation of SOM. Until recently, most of the studies on soil lipids were focused on compounds of relatively low molecular weight (< 500 Da). However, an increasing number of studies are dealing with complex lipids of high molecular weight (>1000 Da) such as glycerol dialkyl glycerol tetraethers (GDGTs). GDGTs are present in cell membranes of archaea and some bacteria. Archaeal membranes are formed predominantly by isoprenoid GDGTs with acyclic or ring-containing biphytanyl chains. Another group of GDGT lipids containing branched instead of isoprenoid alkyl chains was recently discovered in soils. Alkyl branched tetraethers were suggested to be produced by unknown anaerobic bacteria. The relative distribution of bacterial GDGTs was shown to be determined primarily by two environmental parameters: air temperature and soil pH [1]. Several recent studies have supported the use of bacterial GDGTs for the reconstruction of continental temperatures [2, 3].

Lipids in soils can take two broad forms: extractable, i.e. recoverable via solvent extraction, and non-extractable, linked to the soil matrix. Within the extractable pool, “free” (i.e. core) and “bound” (i.e. intact polar and/or ester-bound) lipids can be distinguished. These three lipid fractions may respond to environmental changes in different ways and the information derived from these three pools may differ. The aim of the present work was therefore to compare the abundance and distribution of the three GDGT pools in two contrasted podzols: a temperate podzol located 40 km north of Paris and a tropical podzol from the upper Amazon Basin. Five samples were collected from the whole profile of the temperate podzol including the litter layer. Five additional samples were obtained from three profiles of the tropical soil sequence, representative of the transition between a latosol and a well-developed podzol.

Vertical and/or lateral variations in GDGT content and distribution were highlighted. In particular, in the tropical sequence, GDGTs were present at relatively low concentrations in the early stages of podzolisation and were more abundant in the well-developed podzolic horizons, where higher acidity and increased bacterial activity may favour their stabilization. Concerning the temperate podzol, GDGT distribution was shown to vary greatly with depth in the soil profile, the methylation degree of bacterial GDGTs being notably lower in the surficial than in the deep soil horizons. Bacterial GDGTs were also detected in the litter layer of the temperate podzol, suggesting the presence of branched-GDGT producing bacteria in the litter, probably in anoxic microenvironments.

Last, we showed for the first time that substantial amounts of non-extractable GDGTs could be released after acid hydrolysis of solvent-extracted soils, since non-extractable lipids represented in average ca. 25% of total (i.e. extractable + non-extractable) bacterial GDGTs and ca. 30% of total archaeal GDGTs. This implies that extractable GDGTs can be incorporated into the organic and/or mineral matrix of soil. We also observed that, extractable and non-extractable GDGTs could present different distribution patterns. This shows that (i) some extractable GDGTs might be preferentially transferred to the non-extractable pool and/or might be preferentially degraded by soil microorganisms and that (ii) the extractable and non-extractable pools potentially reflect different proxy records of air temperature and soil pH. In this study, MAT values derived from non-extractable lipids were shown to be more consistent with MAT records, implying that MAT estimates obtained from the non-extractable pool might be more reliable.

References: [1] Weijers et al., 2007. Geochimica et Cosmochimica Acta 71, 703-713; [2] Schouten et al., 2008. Geology 36, 147-150; [3] Rueda et al., 2009. Organic Geochemistry 40, 287-291.

Keywords: Glycerol dialkyl glycerol tetraethers; non-extractable lipids; bacteria; archaea; podzols

Poster S2-P15

Organic matter humification character in bogs depending on the peat properties

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In the carbon biogeochemical cycle of key importance is the transformation of living organic matter into refractory part of organic matter - humic substances – humification. Both degradation and synthetic processes during decay of living organic matter are described as humification and in general it describes transformation of numerous groups of substances (proteins, carbohydrates, lipids etc.) and individual molecules present in living organic matter into groups of substances with similar properties (humic substances). The humification in the peat take place in very much differing conditions both at spatial scale, both under temporally changing conditions.

The aim of this study is to analyse relations between the peat properties and humification degree on example of analysis of peat profiles in ombrotrophic bogs in Latvia.

From this perspective we have studied peat properties in bogs of similar age, located spatially closely, but with very much differing peat column stratigraphy and peat column botanical composition as well as decomposition degree. Basic peat properties can be analysed using peat elemental (C, H, N, O, S) composition. It has been found that the elemental composition of peat is comparatively variable and reflect the changes in the peat decomposition degree and peat type. Much more informative than elemental composition of peat is elemental ratio. The peat formation process was examined using van Krevelen graphs frequently applied for the analysis of carbon biogeochemical cycle and genesis of fossil fuel. The atomic ratios O/C, H/C, and N/C indices are useful in the identification of structural changes and the degree of maturity of peat in different depositional environments. The graph of H/C atomic ratio versus O/C atomic ratio reveals changes in the properties associated with coalification reactions.

Spectral analysis both of intact peat both of peat alkaline extracts largely confirms the before mentioned conclusions, but allows to identify the structural and molecular features ongoing during humification process. The UV and fluorescence spectra allows to study development of aromatic structures during humification process.

Absorption at 540 nm in the Vis spectra of peat alkaline extracts can be used as an simple indicator of humification process. This humification index demonstrates expected differences and the changes can be associated both with the peat decomposition degree, both with the differences in peat composition.

Better quantification of aromaticity during humification proves fluorescence spectra where two well expressed peaks can be observed, one of them (490 - 520 nm) clearly associated with aromaticity of the studied material. If in the upper layers of both bogs the intensity of fluorescence signals of aromatic structures is much lower than intensity of signals associated with fluorophores in aliphatic structures, then in deeper layers the aromaticty of the studied materials evidently increases. Thus the ratios of the fluorescence intensities at different wavelengths can be used as humification indicators and in this study we tested possibilities to use fluorescence intensities.

The changes in the character of FTIR spectra show the character of changes in the intensity of functional groups with peat material humification (increasing age, depth and decomposition degree). The changes in the functional groups of the peat organic material at first can be related to relative amounts of –OH, -COOH, -C=O, CH groups.

As it has been found in this study the transformation process can be described using multiproxy analysis of peat elemental composition, elemental ratios and spectral characterization of the peat organic matter and peat alkaline extracts. This approach supports not only better understanding of the peat properties and their relation both with peat decomposition processes, both with original living organic matter.

Keywords: peat, Latvia, humification indicators, multiproxy study

Poster S2-P16

Preservation patterns of lipid fractions in cultivated and non-cultivated soils under subtropical climate (Tenerife Island)

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Physical speciation patterns of soil lipids within different aggregate sizes could inform on the mechanisms involved in C stabilisation in soil microcompartments. Lipids could act as source indicators (plant or microbial) and as proxies of the transformation processes of soil organic matter (Wiesenberg et al., 2004), in particular on the preservation degree of soil plant material (Otto and Simpson, 2005). In this study lipid assemblages in aggregate size fractions (1–2 mm, 0.5–1 mm and < 0.5 mm) of undisturbed and banana-cultivated subtropical soils (Tenerife Island, Spain) were analysed. The lipids were Soxhlet-extracted with petroleum ether (40–60ºC), methylated with trimethylsilyldiazomethane and analyzed by GC/MS and GC/FID. Additional information was obtained from isotope analyses ($\delta^{13}C$).

In non-cultivated soils the coarsest aggregates represented 498 $g \cdot kg^{-1}$, whereas smallest aggregates amounted 154 $g \cdot kg^{-1}$. In cultivated soils, the proportion of the coarsest aggregates was conspicuously reduced (168 $g \cdot kg^{-1}$), with a concomitant increase in the finest fraction (598 $g \cdot kg^{-1}$). Both C and N values increased as the aggregate size decreased, mainly in the cultivated soil. The preservation of lipids observed in the finest fraction was interpreted as the effect of the reduced accessibility of enzymes to soil organic matter. The calculated values of $\delta^{13}C$ were similar within different soil fractions and comparatively higher in the cultivated soil.

The relative amount of alkanes and fatty acids respect to terpenes in the non-cultivated site markedly increased as the aggregate size decreased (from 34.9 to 62.4%), suggesting physical protection as the main mechanism of preservation of these labile compounds. In the cultivated site, the labile fraction in the medium and smallest aggregates represented about 67% of total soil lipids, and 71,8% in the biggest aggregates. This slight increase suggests that contribution of these compounds from the crop and/or the organic amendments would be greater than their decomposition rate.

The Carbon Preference Indices (CPI) of fatty acids (even/odd C-number) indicated predominance of even C-numbered compounds (2.86–5.75 in the non-cultivated site and 7.26–9.15 in the cultivated one). On the other hand, the ratio between long chain (≥20C) and short chain

References: Otto A., Simpson M. (2005). *Biogeochemistry,* 74: 377–409.
Wiesenberg G.L.B., Schwarzbauer J., Schmidt M.W.I., Schwark L. (2004). *Org. Geochem*. 35: 1371–1393.

Keywords: signature lipids, cultivated soils, aggregate size, sterols, triterpenoids

Poster S2-P17

Short-term transformation of alanine in soil assessed by position-specific labeling

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Transformation of low molecular weight organic substances (LMWOS) in soil is one of the most important processes in the turnover of organic matter as all high molecular substances pass the stage of LMWOS during decomposition. We suggested using a unique feature of isotope applications – the position-specific labeling – to get a closer look on LMWOS fate in soil. This tool allows to distinguish the flux of the complete molecule from the splitting of the substance into metabolites and tracing these metabolites within any pools.

We assessed short-term turnover of the different positions of the amino acid alanine: Uniformly and position-specifically labeled ^{14}C-alanine were mixed with soil, centrifuged and ^{14}C activity was measured at increasing time steps. Different sterilization treatments of the soil-mixture allowed to differentiate between the potential mechanisms of a declining ^{14}C activity in the solution: sorption, exoenzyme activity and microbial activity removed alanine from the unsterilized soil; only sorption and exoenzymatic degradation was possible by inhibition of the intracellular metabolism by NaN_3, whereas in treatment with total protein denaturation by $HgCl_2$, sorption was the only process removing ^{14}C activity from the supernatant. Sorption mainly occured as a whole molecule, whereas C from different positions of alanine showed different patterns of exoenzymatic degradation and microbial utilization. The carboxyl group was mainly affected by microbial decomposition and most of these processes occured in microbial cells and not by exoenzymes. In contrast the CH_3- and the C_α-positions of the amino acid showed a comparably fast and high microbial utilization, but they got mainly incorporated into microbial biomass und were less decomposed to CO_2. We showed that C from different positions of alanine has differing fate in soil, even in short-term experiments.

An additional factor with considerable influence on the fate of LMWOS in soil is their concentration. We simulated the concentration typical for hot spot nearby dying root cells with a 0.5 mM alanine solution and conditions typical nearby degraded proteinogenous plant material with a 50 µM alanine solution. We used a 5 µM concentration as this is the mean concentration in soil solution and 0.5 µM concentration for simulating root free soil. The LMWOS concentrations sufficient for microbial growth led to a different fate of single C atoms compared to concentrations leaving microbial community under steady state.

Desorption of the LMWOS after drying and rewetting of the soils revealed to which extent alanine is irreversibly bound to the mineral surfaces and thus stabilized by mineral-LMWOS-interactions.

We showed that the application of position-specifically labeled substances opens a new way to investigate the LMWOS-transformations in soil. The transformations of single C atoms allow conclusions about the individual transformation steps, their rates on a submolecular level and improve our understanding of soil carbon fluxes.

Keywords: position-specific, labeling, alanine, low molecular weight organic substances

Poster S2-P18

Soil organic carbon dynamics of an alpine chronosequence

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Newly formed or exposed landscapes provide a natural experiment to investigate the build-up of the soil organic matter and its composition through time, and the roles various mechanisms of OM stabilization may play. We present insights in the early development of high Alpine soils that were gradually exposed after glacier retreat in Central Switzerland. An exponential increase in TOC content along the 150 year long chronosequence clearly shows initial SOC accumulation. Because of glacier re-advances, soils that formed between 1900 and 1928, and 1950-1990, were overrun. This has led to three different e groups_n the forefield, divided by moraines. Chemical and physical separation techniques combined with chemical fingerprinting techniques of size and density fractions along the chronosequence give insight in the build-up and relative importance of SOC pools through time. Analysis of a suite of specific biomarkers by GC/MS and HPLC gives further insight in the sources of SOC, e.g. plant input and fungal or bacterial (re)cycling, and their relative importance in younger and older soils. In addition, the use of radiocarbon analysis of specific fractions and individual compounds, as natural tracer for the age of various organic carbon pools is explored.

Comparing the results of the chronosequence data with a conceptual model that is based upon the conversion of primary production and it_radiocarbon signto different organic matter pools with different stability indicates that a significant pool of SOC is relatively stable, and stays in the soil for at least a few decades.

Besides the factor time that can be investigated using the chronosequence, primary production and soil respiration are also influenced by climatic parameters like temperature and snow cover / growth season length. Assuming other driving factors constant, like nutrient availability or moisture limitation, the extent of annual primary productivity can be estimated by cumulative degree-days while soil respiration continues in winter under the snow cover at 0˚C. Using daily meteorological data from the forefield and region for the last century, an estimate could be made of the relative balance between annual primary productivity, and hence SOC input, and annual respiration. Relatively small changes turn out to have a marked effect on this balance between input of SOC and respiration, and can explain the drops in SOC between the different soil age groups.

The SOC dynamics are also linked with other soil forming and ecological processes like mineral weathering, clay formation, nutrient uptake by plants, and microbial processes. Comparison of the various results, obtained by a larger group of interdisciplinary researchers from the same location, leads to a further understanding of the important factors that play a role in initial soil forming processes.

Keywords: Chronosequence, radiocarbon, carbon pools, biomarkers

Poster S2-P19

Soil organic matter and carbon sequestration in rehabilitated mine soils

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Soils hold a large pool of C in the form of soil organic matter (SOM). Open cut mine soils are heavily disturbed through the mining and rehabilitation processes and contain low levels of organic matter. Natural soils in the Bowen Basin, one of the major coal mining regions of Australia, range from < 0.5 to 4% organic C. It has been shown from studies in other coal mining regions of the world that rehabilitated mine soils can accumulate and store higher levels of organic C than undisturbed sites with similar land cover. An important part of the rehabilitation process is the improvement of mine soils by the accumulation of SOM to sustain plant life and reestablish ecosystem processes. Rehabilitation of coal mines include back-filling pits with mine spoils, covering with a layer of stored topsoil and direct seeding of cover plants. A chronosequence of sites aged from 3 to 15 years since rehabilitation will be evaluated at multiple Australian coal mine sites along with reference sites that have not been mined. Quantification of soil organic carbon (SOC) is complicated by the occurrence of coal and black carbon, the products of incomplete combustion of organic matter. Black carbon is an important pool of C and represents a significant amount of plant-derived organic matter that enters the soil. Characterization of SOC will initially be undertaken using mid-infrared spectroscopy and validated using other methods to distinguish the effects of differences in rehabilitation management practices on the levels of SOM and SOC. Results from this study may be used to increase the accuracy of soil carbon models (i.e. Roth-C and Century) for rehabilitated mine soils.

Keywords: Soil organic carbon, black carbon, mine soils, coal, rehabilitation

Session 3 – MICROBIAL COMMUNITIES AS DRIVERS OF ORGANIC MATTER DYNAMICS

Oral presentations – Session 3

Keynote lecture

Relationships between microbial diversity and organic matter transformations: more species than we need

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Soil microbial communities are extremely diverse and all members of these communities are involved, to some extent, in transformations of organic matter. First-generation molecular techniques have dramatically increased estimates of soil microbial diversity, with suggestions of richness values approaching 1 million 'species' per gram soil. This 'species' diversity is implicitly assumed to reflect similarly high levels of functional diversity. The high diversity and complexity of soil communities derive from two-way interactions with physicochemical complexity of soil itself, including the chemical complexity of organic matter and the different physical forms in which it exists. Quantitative analysis of these interactions is difficult and there is little understanding of the links between microbial diversity and the nature and dynamics of organic matter transformations and other soil ecosystem processes. Molecular studies of microbial communities are now being influenced by high-throughput sequencing technology and 'omics' approaches, which have enormous potential, but only if placed within a conceptual framework, which is currently lacking. Different approaches to investigating the mechanisms driving soil microbial diversity and links between diversity and soil processes will be considered, along with the experimental and methodological requisites for greater understanding, quantitative prediction and control of soil organic matter transformations.

Keywords: Soil microbial communities

Relationship between plant diversity, carbon compound diversity and functioning and diversity of denitrifiers in grassland soils

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Global changes affect biodiversity, particularly biodiversity of grassland plants species (Rustad L.E. 2006). Recent works showed this plant diversity modification affect soil functioning, as denitrifying bacteria functioning (Le Roux *et al*. submitted). Denitrification is an anaerobic respiration bacterial process by which bacteria are able to reduce nitrate (NO3-) and/or nitrite (NO2-) to nitrous oxide (N2O) and eventually to elemental nitrogen (N2). This essential process for soil functioning crosses both nitrogen and carbon cycles and is therefore of particular concern because it bears multiple environmental outcomes such as i) the reduction of nitrate leaching to groundwater, ii) the atmospheric emission of greenhouse gases (nitrogen oxides), and iii) the competition with plants for nitrate nutrition.

Denitrifying bacteria are heterotrophic and use therefore organic compounds as energy source, which are mainly released by plants. Though **quantity and quality of carbon** compounds amended on soil are known to influence activity and diversity of denitrifying bacteria, we still lack *in situ* approaches to study the link between plant diversity, soil carbon compounds diversity and its effect on these microorganisms.

We hypothesized that increased plant diversity implied an increase in carbon sources diversity available at the ecosystem scale, with a cascading effect on the number of ecological niches available for heterotrophic bacteria. Consequently, plant diversity would influence the denitrifying community in terms of activity, abundances and diversity.

Diversity of soil organic compounds was assessed by chromatographic profiling of phenolic compounds after extraction by liquid-solid accelerated solvent and analyzed using an HPLC to establish a "phenolic compounds fingerprint" of various soils. This analysis was hence performed for grassland soil plots harboring increasing plant *specific richness* (0 to 16 species) and increasing *functional group richness* (1 to 4 functional groups among grasses, tall herbs, small herbs, legumes). Measure of the potential N2O emission was used as a proxy for denitrification activity. The genetic diversity of denitrifying communities was estimated by pyrosequencing three genes involved in the denitrification process: *nir*K, *nir*S, and *nos*Z. Abundances of denitrifying bacteria were assessed by quantitative PCR of the gene *nirK*.

Our first results show a positive effect of plant diversity, and particularly of the functional group richness for a given species richness level (16 species), on the diversity of phenolic organic compounds detected in soils. Data acquisition concerning denitrification are ongoing.

References: Roustad L.E. 2006. From transient to steady-state response of ecosystems to atmospheric CO_2 enrichment and global climate change: conceptual challenges and need for an integrated approach. *Plant Ecology*, 182: 43-62

Le Roux X. et al. Which components of plant diversity drive nitrifying and denitrifying enzyme activities in soil? Results from a large plant assemblage experiment. submitted

Keywords: Soil, Denitrification, Phenolic compounds, Bacterial diversity, Plant diversity

Soil microbial respiratory up or down-regulation after exposer to short term temperature differences: acclimation, adjustment or what?

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It is still a matter of debate whether an acclimation or adjustment of soil microbial communities to temperature is meaningful in determining rates of organic matter decomposition (Luo et al. 2001; Hartley et al. 2008; Bradford 2008). After a temperature increase, initially high heterotrophic respiration rates are known to decrease with time, a phenomenon that is usually explained by a decrease in substrate availability. Since substrate quantity and quality are in constant change in any soil system with an active microbial population, the hypothesis of temperature acclimation or adjustment is difficult to test. Isolating such effects from those related to substrate properties is the main challenge.

Next to measurement difficulties lies the need to precisely define the ideas to be tested. With respect to microbial communities, the terms acclimation and adaptation are not clearly defined. ¬climation_roperly refers to physiological changes in an individual adjusting to different environmental conditions, while -aptation_n the biological sense refers to an evolutionary process involving genetic and phenotypic changes in a species. However, when referring to soil microbial temperature response, these terms have been used in a more relax way to signify any kind of adjustment, either physiological or at the community level. Instead of discussing the applicability of acclimation and adaptation, we prefer using the term ‘adjustment’, to include physiological or community level changes in the short and mid-term. In soils, physiological changes may occur very quickly, while a shift in the community composition may occur in a number of days; an evolutionary adaptation of microbial populations, on the contrary, will not be significant in the period of a few days or months but may become important in longer time scales.

To determine the effects of microbial adjustments to short term temperature conditioning on respiration rates, we carried out a laboratory experiment combining temperature treatments, the addition of labelled glucose, and microbial biomass measurements, which aimed at excluding substrate limitation as a constraint in order to obtain clearer information on biotic responses. Our results showed that after only two weeks of separately conditioning samples at 5 and 15 °C, a difference in respiration rates induced by glucose additions was apparent. The results indicate an up-regulation of microbial decomposition potential after incubation at higher temperatures, so that soils conditioned at 5 °C showed lower respiration rates next to those conditioned at 15 °C, when measured under the same temperature and substrate amounts. This difference was not explained by microbial biomass differences. These results go against the general idea of an acclimation of soil microbes progressively dampening the immediate effects of temperature. Instead, they suggest that as microbes adjust to higher temperatures, their decomposition potential could increase, and further, this potential is maintained when temperatures decrease.

Competitive shifts in the microbial community composition are expected in a period of a few days and, together with physiological adjustments at the cell level, are likely to influence respiration rates. These changes do not necessarily imply a down-regulation of respiratory activity. On the contrary, better adjusted microbes should be able to perform better, meaning more rapid growth and higher rates of substrate use and respiration, explaining the observations. From this hypothesis we would expect, after any temperature change, a gradual increase in respiration rates. Again, this is difficult to observe given the confounding effect of substrate use. Our results show decomposition dynamics in the scale of days to a week. The question of how fast microbes adjust to new temperatures remains unsolved, but a quick adjustment is expected given the short conditioning period applied here.

References: Bradford, Mark A. 2008. Thermal adaptation of soil microbial respiration to elevated temperature. *Ecology Letters* 11: 1316–1327 ; Hartley, Ian, David Hopkins, Mark Garnett, M Sommerkorn, and Philip Wookey. 2008. Soil microbial respiration in arctic soil does not acclimate to temperature. *Ecology Letters* 11: 1–9 ; Luo, Y., S. Wan, D. Hui, and L. L Wallace. 2001. Acclimatization of soil respiration to warming in a tall grass prairie. *Nature* 413, no. 6856: 622–625.

Keywords: soil microbes, decomposition, soil respiration, acclimation, temperature, soil organic matter, carbon

Microbial regulation of carbon cycling at the soil-litter interface

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An important challenge for future research is to combine processes operative at the cellular, organism and community scale with phenomena active at the microhabitat or plot scale. A microcosm approach was designed to link the abundances of bacteria and fungi to microhabitat functions of soil microbiota. In microcosms, we used MCPA (2-methyl-4-chlorophenoxyacetic acid) as a model organic substance due to its well-known degradation pathways (*tfdA* genes) and due to the availability of primers targeting the *tfdA* gene encoding the enzyme responsible for the first step in degradation of this compound. We used maize litter to create a well-defined soil-litter interface (detritusphere). We studied microbial degradation, microbial abundance of degraders, adsorption, desorption and transport of MCPA along a gradient of decreasing availability of dissolved organic matter. Isotopic data ($^{14}CO_2$, $^{14}C_{mic}$, ^{14}C-DOC, $^{14}C_{org}$, ^{14}C-MCPA, ^{14}C in the leachate) and molecular data (*tfdA*, 16S rDNA and 18S rDNA sequence copy numbers) were used as input variables for a mechanistic model. Transport of litter compounds was identified as important process, which might regulate the activity of the MCPA degrading community at the soil-litter interface. The increased *tfdA* abundance and MCPA degradation at the soil-litter interface can be explained by complex regulation mechanisms of MCPA degradation: (1) At the cellular level, co-substrate availability and laccase abundance might be important regulators, and (2) at the microhabitat level, interaction between MCPA degraders and organo-mineral surfaces as well as transport processes might be important regulators. Therefore, the concept of hierarchical regulation of MCPA degradation will be included into the modelling of small-scale microbial growth, MCPA transport and MCPA degradation near the soil-litter interface.

References:

Ingwersen J., Poll C., Streck T., Kandeler E. (2008) Micro-scale modelling of carbon turnover driven by microbial succession at a biogeochemical interface. Soil Biology and Biochemistry 40, 872-886.

Poll C., Marhan S., Ingwersen J., Kandeler E. (2008) Dynamics of carbon turnover and microbial abundance in a rye detritusphere. Soil Biology and Biochemistry 40, 1306-1321.

Poll C., Brune T., Begerow D., Kandeler E. (2010) Small-scale diversity and succession of fungi in the detritusphere of rye residues. Microbial Ecology 59, 130-140.

Keywords: microhabitat, soil-litter interface, carbon cycling, functional genes, tfdA, MCPA

Impact of mycorrhizal organic nutrient uptake on ecosystem carbon storage

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Soil carbon (C) storage is particularly high in systems that are dominated by ectomycorrhizal (EcM) and ericoid mycorrhizal (ErM) rather than arbuscular mycorrhizal (AM) plants, even after accounting for latitude and associated climate. Understanding what drives this accumulation of soil C is fundamental to our understanding of C dynamics, and is essential to be able to predict how these systems may respond to climate change. Most research on the impact of plant communities on soil C storage and cycling focuses on litter quality and plant growth rates, and it has been suggested that low litter quality is one of the main drivers of the high soil C under EcM and ErM plants (Cornelissen *et al.*, 2001; Read *et al.*, 2004). More recently it has been recognised that the mycorrhizal symbionts associated with plants vary considerably in their traits (Read *et al.,* 2004). However, the impact of such variation on ecosystem processes such as soil C accumulation has not been investigated to date.

One mycorrhizal trait that is common among EcM and ErM fungi, but is thought to be largely absent in AM fungi, is their ability to produce enzymes capable of decomposing complex organic substrates (Read *et al.*, 2004). This means that nutrient uptake by EcM and ErM plants is not dependent on saprotrophic mineralization. Because mycorrhizal fungi get most of their C from their photosymbiont rather than from organic matter, their ability to release nutrients is decoupled from substrate carbon (Read & Perez-Moreno, 2003). EcM and ErM may therefore have a competitive advantage over other saprotrophs, and preferentially target nutrient-rich substrates. The net effect of mycorrhizal organic nutrient uptake from such substrates may be that the C: nutrient ratio of the remaining organic matter increases, potentially resulting in reduced decomposition rates and increased soil C accumulation (Read *et al.*, 2004). At the same time, increased access to nutrients due to reduced competition with saprotrophs might result in increased plant growth and so increased C inputs to soil.

Testing the importance of these kind of mechanisms experimentally is fraught with difficulty, as soil fertility, litter quality, and the degree to which mycorrhizae can access organic nutrients tend to co-vary, and could all independently have an impact on C accumulation. A logical way around this is to use a modelling approach. Here, we incorporate the ability of mycorrhizal fungi to use organic nutrients into a new carbon, nitrogen and phosphorus model (MySCaN: Mycorrhizal Status, Carbon and Nutrient cycling), based partly on the Century model. We ran the model under different soil fertilities and with different degrees of access to organic nutrient sources to determine to what extent mycorrhizal organic nutrient uptake could affect soil C accumulation, how important it might be relative to reductions in litter quality, and under what circumstances it might contribute significantly to soil C accumulation. Results suggested that mycorrhizal organic nutrient uptake can cause reductions in soil C: N ratios and increased plant growth, especially if soil fertility is low, and that these changes can increase soil C accumulation. We therefore propose that mycorrhizal organic nutrient uptake should be incorporated into global climate change models.

References: Cornelissen, J. H. C., Aerts, R., Cerabolini, B., Werger, M. J. A. & van der Heijden, M. G. A. (2001) Carbon cycling traits of plant species are linked with mycorrhizal strategy. Oecologia, 129, 611-619.

Read, D. J. & Perez-Moreno, J. (2003) Mycorrhizas and nutrient cycling in ecosystems - a journey towards relevance? New Phytologist, 157, 475-492.

Read, D. J., Leake, J. R. & Perez-Moreno, J. (2004) Mycorrhizal fungi as drivers of ecosystem processes in heathland and boreal forest biomes. Canadian Journal of Botany-Revue Canadienne De Botanique, 82, 1243-1263.

Keywords: ectomycorrhizae, ericoid mycorrhizae, arbuscular mycorrhizae, organic nutrient uptake, carbon storage, model

Wheat addition affects microbial resistance and resilience to drying and rewetting in saline soils

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Soil salinity and fluctuations in soil matric potential lead to water stress in soil microorganisms and reduced plant productivity. Consequently, soil organic matter production and turnover are reduced. Climate change is predicted to lead to an extension of saline soils experiencing more severe drought; the prolonged droughts will be accompanied by more sporadic rainfall events. Therefore, the following questions are of great interest: (i) are microorganisms and their activity in saline soils more or less tolerant to drying and rewetting (DRW) stress than those in non-saline soils and (ii) can amelioration strategies such as adding plant residues, increase the tolerance of microorganisms and their activity to DRW stress? An experiment with 3 different $EC_{1:5}$ levels: 0, 2 and 4 dS/m (EC0, EC2, EC4), with and without wheat amendment, and two drying and rewetting events (1 week dry, 1 week moist then again 1 week dry followed by 24 days moist to measure resilience), was carried out. Respiration was measured throughout the incubation and microbial community structure was determined by phospholipid fatty acid (PLFA) analyses on days 0, 15 (before first DRW), 35 (after second dry period), and 59 (after 24 days moist incubation). Resistance and resilience (recovery) were calculated for microbial activity and microbial biomass. Resistance to water stress of a given parameter was expressed as the ratio between the value of the DRW soil and that in the constantly moist soil. Recovery to water stress was calculated as the ratio of resistance at the end of the experiment (day59) and the end of the second dry period (day 35).

At the end of the dry period, respiration rate was very low in water stressed soils (< 0.001 mg CO_2-C g soil^{-1} day^{-1}) but high in moist soils (up to 0.04 mg CO_2-C g soil^{-1} day^{-1}). Respiration in moist wheat amended soil was higher than in non wheat amended soil. Respiration was highest at EC0. On day 59 respiration rate in soils with wheat amendment was significantly higher than in soils without wheat. There was no significant difference between respiration rate of DRW and moist soils expect in EC2 with wheat in which respiration rate was higher in water stressed samples than in moist samples. The resistance of respiration to DRW increased with increasing EC in treatments without wheat amendment. In wheat amended treatments however, EC had no significant influence on resistance of microbial activity. Irrespective of wheat addition, resilience of microbial activity increased with increasing EC. Salinity did not influence the resistance or resilience of total microbial biomass or bacterial biomass. However, resistance of fungal biomass to DRW decreased with increasing EC in non wheat amended soils. On day 59 microbial community structures differed significantly between EC levels in wheat amended soils irrespective of water stress. Wheat addition influenced microbial community structure at all EC levels. At EC2 and EC4, wheat amendment significantly decreased PLFA richness in DRW treatments. DRW did not influence microbial community structure except in wheat amended soil at EC2.

Keywords: microbial community structure, PLFA, respiration, salinity, residue addition

The microbial biogeochemistry of drought

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At least 1/3 Earth’s land experiences regular drought, and climate models suggest this will increase. However, the biological processes occurring during the dry season have only been studied by inference from what happens when the rains return. Important dry soil phenomena remain unexplained, such as the Birch Effect--the pulse of respiration on rewetting a dry soil. Important and surprising processes occur during the dry season. For example, during the California summer, in grasslands, soils are dry and plants are dead, but microbial biomass increases, even though their activity is very limited. One hypothesis for this is would be that the increased biomass is associated with microbial osmolytes, which would be respired away on rewetting. As the biomass is predominantly bacterial, pure culture studies predict that these osmolytes should be amino compounds. However, the only likely such compound we could detect was glutamate, and it’d dynamics do not suggest a role as an osmolyte. Thus, the increase in biomass appears to reflect actual population growth. This increase, however, only occurs when soils are extremely dry, suggesting they result from disconnections in soil water films in dry soil and limit substrate diffusion and organismal movement.

Keywords: microbes, drought, rewetting, diffusion

Posters – Session 3

Poster S3-P1

Biochar amendments change microbial community structure and activity and nutrient dynamics in Flemish loamy soils

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Increasing levels of greenhouse gases in the atmosphere have lead to the search for new technologies to mitigate climate change. The use of biochar, which includes all kinds of carbonized biomass types, is believed to sequester carbon (C) into soils. However the addition of biochar to soils may also change physico-chemical soil properties, microbial activity, nutrient dynamics and consequently soil productivity (Glaser et al., 2002). Due to the excessive historic addition of manure and mineral fertilizers, Flemish soils are prone to nutrient losses, and especially nitrogen (N) leaching, with detrimental effects on the environment. The addition of biochar changes the availability of nutrients into soils (Gundale and DeLuca, 2006) and may even prevent N leaching from these soils (Steiner et al., 2008).

An incubation experiment was conducted over 98 days into two silty loamy soils, with different management histories, to which four different types of biochar were added. Biochar, prepared from either poultry litter or pine chips and combusted/pyrolized at both 400 °C and 500 °C, was added at a rate of 20 $Mg.ha^{-1}$. Every two weeks pH, mineral N (NO_3^-, NH_4^+) and plant available phosphorus (PPP) was determined. Initially and after 14, 56 and 98 incubation days cation exchange capacity (CEC) and additional soil microbial parameters, such as phospholipid fatty acid analysis (PLFA) for the microbial community structure, microbial biomass (by the fumigation-extraction method) and enzyme activities were measured.

Due to the biochar amendments nutrient cycles in these loamy soils were affected. Depending on the charring temperature and the biomass feedstock, N dynamics differed significantly among the treatments. Higher charring temperatures slowed the rate of N mineralization down. In pine wood biochar amended soils even an immobilization of N was observed. PPP increased in poultry litter amended soils, however charring temperature increase the amount of PPP. Also microbial community structure, biomass and activity were affected by the different biochar amendments. These changes were linked to the changed nutrient dynamics.

We conclude that the addition of biochar to Flemish loamy soils has a tremendous effect on microbial community and nutrient dynamics. Especially N leaching and the accompanied environmental harm may be prevented by adding specific biochar types to these soils.

References:

Glaser, B., Lehmann, J., Zech, W., 2002. Ameliorating physical and chemical properties of highly weathered soils in the tropics with charcoal – a review. Biology and Fertility of Soils 35, 219-230.

Gundale, M.J., DeLuca, T.H., 2006. Temperature and source material influence ecological attributes of ponderosa pine and Douglas-fir charcoal. Forest Ecology and Management 231, 86-93.

Steiner, C., Das, K.C., Garcia, M., Förster, B., Zech, W., 2008. Charcoal and smoke extract stimulate the soil microbial community in a highly weathered xanthic Ferralsol. Pedobiologia 51, 359-366.

Keywords: Biochar, microbial community structure and activity, nutrient availability, soil fauna, microbial biomass, PLFA

Poster S3-P2

Death in soil or how microbial biomass contributes to soil organic matter genesis

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Soil microorganisms are not only catalysts for organic matter transformation in soils, but they also are a carbon source for refractory soil organic matter (SOM). This is indicated, for example, by NMR data showing a high contribution of biomass, in particular microbial biomass, to the chemical structures identified in SOM. In line with this, we recently showed that in a laboratory incubation experiment 40% of the C added as ^{13}C-labeled *Escherichia coli* remained in soil and was transformed to non-living SOM. To identify the processes of microbial biomass stabilization, we visualized the microbial biomass residues in soil samples from our laboratory incubation experiment by scanning electron microscopy (SEM). Only rarely intact cells were detected, which is in line with data on bacterial abundance in soil and its specific surface area. Broken cell envelopes were more abundant, but the most prominent feature were patchy fragments of 100 - 500 nm size covering the mineral surfaces. We found similar patches in SEM micrographs of groundwater-exposed in-situ microcosms. These microcosms were initially clean, then loaded with toluene and exposed to BTEX-contaminated groundwater. After exposure, the microcosms were densely populated. In addition to a large number and diversity of intact cells, empty and broken cell envelopes could be found as well as the same patchy fragments as in the soil samples. Therefore the patchy fragments in the microcosms definitely originated from the decay of microbial biomass. By analogy, we conclude that the patchy fragments in soil also are derived from microbial biomass, namely from disintegrated cell envelopes. This was confirmed by SEM micrographs of samples from a chronosequence in the forefield of the Damma glacier (Switzerland). Along this chronosequence, the number of patchy fragments as well as their coverage on the mineral surfaces increased. The microbial origin of the patchy fragments explains many properties of SOM including the low C/N ratio, the abundance of microbial-derived biomolecules. The spatial arrangement of the patchy fragments, the complex chemical composition and the recalcitrance of the cell envelope also explain how microbial biomass-derived carbon can be stabilized in soil.

Keywords: Soil organic matter, microbial biomass, cell wall fragments, scanning electron microscopy

Poster S3-P3

Agricultural modifications affect glycerol dialkyl glycerol tetraether (GDGT) membrane lipid concentration and distribution in the short term

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Branched and cyclic glycerol dialkyl glycerol tetraether (GDGT) membrane lipids are thought to be biosynthesized by anaerobic bacteria that were shown to occur ubiquitous in soils. GDGTs were thought to be slow reacting or even recalcitrant in terrestrial environments justifying their use as biomarkers and environmental indicators for mean annual air temperature and pH values in soils. These environmental conditions can be assessed using the methylation and cyclization of the molecules. A recent study showed that the mean residence time of GDGTs in soils is faster than expected and accounts for 17 years (Weijers et al. 2010).

Using a time series of soils after the change from permanent grassland without ploughing to an agricultural soil cropped with wheat and annually ploughed, we determined changes in GDGTs in soils during 4.5 growing seasons in surface (0-10 cm) and deep parts (10-20 cm) of the ploughed horizon. Additionally, the effect of elevated vs. ambient CO_2 concentration was investigated on the soils originating from the 'Mini-FACE' experiment in Stuttgart-Hohenheim (Germany).

After the conversion from grassland to cropland a significant change in GDGT concentrations was observed for most membrane lipids. Ploughing led to an enrichment of GDGTs in deeper parts of the ploughed layer, which is related to the lower oxygen content and thus a higher abundance of anaerobic bacteria. Methylation and cyclization ratios (MBT and CBT) increased as well as the ratio of branched vs. isoprenoid tetraethers (BIT) decreased after conversion. While CBT did not change furthermore after the first year, MBT and BIT decreased during the whole investigated period of 4.5 years.

Several minor changes in GDGTs were observed under elevated when compared to ambient CO_2 concentration including the MBT and CBT, which were slightly increased under elevated CO_2. The environmental parameters deriving from GDGT composition including pH and MAT did not change significantly, but MAT was slightly higher under elevated CO_2 in surface soil, which is due to a higher temperature in the vegetation cover that has been frequently described for such experiments.

The GDGT composition in time series indicated a fast and significant reaction on the agricultural management, whereas the effect of elevated CO_2 concentration was low.

References: Weijers J.W.H., Wiesenberg G.L.B., Bol R., Hopmans E.C., Pancost R.D., 2010. Carbon isotopic composition of branched tetraether membrane lipids in soils suggest a rapid turnover and a heterotrophic life style of their source organism(s). Biogeosciences Discussions 7, 3691-3734.

Keywords: GDGT, FACE

Poster S3-P4

Changes in ectomycorrhizal communities with stand ages at Japanese coastal pine forests

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Coastal areas are harsh environmental conditions being poor soil nutrients and water defect conditions. Because of salinity and dry resistances, Japanese black pine, *Pinus thunbergii*, is commonly planted along the coast in Japan. However, the pine has been declining by the damages of the pine wilt disease. For the rehabilitation of declining forests, root symbiotic fungi, ectomycorrhizal (EM) fungi might be an effective plant growth promoter. Although the species composition of EM fungi has been studied based mainly on the above-ground EM fruiting bodies and was suggested to be changed as tree ages, an imperfect EM fungus, *Cenococcum geophilum*, was suggested to dominate in local coastal pine forests. An advent of DNA analyses enables to unveil EM species below the ground, a few studies focused on the EM communities in coastal pine forests. To reveal the succession of EM communities in coastal pine forests, we examined EM roots collected at three different stand ages at a same location. We hypothesized that 1) *C. geophilum* dominated in all the stands, 2) the older tree ages, the more EM fungi involved in an EM assemblage, and 3) the EM assemblage was differed among the tree age classes.

A study site was located at a coastal pine forest in Mie prefecture. The site has a 800 m width along a coast line facing to the sea with a 20m distance. In the site, 3 stands from 3 different tree ages of either 5, 8 or 11 years old, were established for a soil sampling. Five soil samples, 3 cm in diameter and 30 cm depth, were collected at each the stand in July 2008 and were kept at 4 ºC. Pine roots taken from the soils were examined under a dissecting microscope. EM roots were further observed under a light microscope for the classification as morphotypes, and *Cenococcum geophilum* roots were identified based only on morphological traits. Each the morphotype was processed subsequently for DNA extractions, RFLP and sequence analyses focusing on the nuclear rDNA of the internal transcribed spacer (ITS) region to infer the taxonomic affiliation of EM fungi.

A total of 9312 pine roots ranging from 578 to 1263 roots were examined in each stand, and 91.2% to 100 % of them were found to be EM roots. For 8 and 11 year old stands, the number of *C. geophilum* EM roots were dominant accounting for 72 % and 56 %, respectively. The EM roots occurred the most frequently in 40 out of 45 soil samples. Pine EM roots were divided into 49 types based on both morphological and molecular discriminations, and DNA sequences indicated that EM fungi were members of Atheliaceae, Thelephoraceae, Pyronemataceae, *Rhizopogon*, *Suillus* and *Russula*. RFLP types detected were increased as tree ages; 16, 23 and 26 types for 5, 8 and 11 years old stands, respectively. EM assemblages and their abundances tended to be differed gradually from 5 through 8 to 11 years old. These results indicate that *C. geophilum* is a dominant mycobiont, and the increase in the EM fungal species as and the difference in EM assemblages among stand ages show a succession in EM fungal communities as tree ages in the coastal pines forest.

Keywords: Cenococcum geophilum, DNA sequences, internal transcribed spacer region, succession

Poster S3-P5

Destroying aggregates: When structure means conservation

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Aims: Aggregates are basic to the structure and metabolism of soils. Although several authors proposed that aggregates are important to protect carbon pools in the soil (2,3), discrepancies exist (8). One mechanism that can drive C out of soil is drying/rewetting events, but it is possible that aggregate structure could protect C from microbial release by rewetting events. We therefore tested the response of aggregates to drying/rewetting events in to test this possibility in soils from a California grassland with a Mediterranean climate (1).

Material and results: We isolated 4-to-9 mm diameter aggregates from the first 20 cm of a California grassland soil to analyze the respiration behavior under different rewetting regimes of intact vs. crushed aggregates (obtained by manual grinding). First, we checked the respiration of both samples upon *successive rewetting* events and second, we tested the respiration upon a rewetting event after different *drought* periods. In the first case, respiration was lower in intact aggregates than in crushed material but after three rewetting cycles, respiration rates became similar. In the second experiment, the respiration of intact aggregates was always lower than that of crushed aggregates.

Interestingly, using a modified SIR biomass assay (7), the biomass of crushed aggregates was consistently higher than that of intact aggregates. This could be explained by a higher access of microbes to carbon or to oxygen in crushed samples; in intact aggregates their inner regions could be partially anoxic. In order to determine this, we checked the potential nitrification rate of the samples. This slurries soil in an aerated solution of ammonium salts and sodium chlorate, which inhibits nitrite oxidation to nitrate (4). Potential nitrification rates were not affected by crushing the aggregates, probably indicating that: *a)* the microbial populations are not affected by the crushing procedure (at least nitrosifying and respiring bacteria) and *b)* since this assay destroyed the intact aggregates, and both the aggregates and the crushed material behave equally, the structure of aggregates could also explain the difference in respiration upon rewetting events. In order to confirm a possible effect of aggregate structure on nitrification rate, we tested it without destroying the aggregate using a concentrated ammonium solution and no shaking. In these conditions, aggregates showed a higher nitrification rate than the crushed samples.

When the respiration/biomass ratio after every rewetting experiment was determined, aggregates showed a higher productivity indicating that respiring populations consume carbon sources more efficiently. This happened more extensively in the successive rewetting experiments than in the drought assay. A possible explanation could be that the control of the metabolism by limiting concentrations of oxygen avoids the overconsumption of the available carbon sources.

Conclusion: The structure of aggregates favors the protection of carbon pools lowering its respiration upon rewetting events and being more conservative that of crushed samples.

References: 1. Austin, A. T., *et al*. 2004. Oecologia 141:221-235 ; 2. Balesdent, J., C. Chenu, and M. Balabane. 2000. Soil Till Res 53:215-230 ; 3. Beare, M. H., P. F. Hendrix, M. L. Cabrera, and D. C. Coleman. 1994. Soil Sci Soc Am J 58:787-795 ; 4. Belser, L. W. and E. L. Mays. 1980. Appl Environ Microbiol 39:505-510 ; 5. Birch, H. F. 1958. Nature 182:1172 ; 6. Fierer, N. and J. P. Schimel. 2002. Soil Biol Biochem 34:777-787 ;7. Fierer, N., J. P. Schimel, and P. A. Holden. 2003. Microb Ecol 45:63-71 ; 8. Goebel, M. O., S. K. Woche, and J. Bachmann. 2009. Biologia (Bratisl) 64:443-448

Keywords: soil aggregate, carbon cycle, rewetting events, drought, soil respiration, Mediterranean conditions

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Poster S3-P6

Distribution and status of sclerotia as microbial oriented SOC along transitional soil sequence in Mt. Chokai, northern Japan.

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Sclerotium grains, the resting structure of *Cenococcum geophilum* and related species, are black and spherical, mainly 1-2 mm in diameter with a characteristic hollow structure, and can be easily found in natural forest soils. Kumada & Hurst (1967) assumed that these grains are the source of the green fraction of P-type humic acid, so called “Pg”. According to Watanabe *et al*. (2001; 2007), elemental analysis conducted for sclerotium grains found in Japanese Andosols revealed that Al (1.4%) was detected as the dominant element following C (48%), O (30%), H (3.3%). The ^{27}Al MAS NMR and X-ray diffraction analyses determined the predominant state of Al contained in sclerotium as octahedral Al, which suggested the presence of Al-humus complex. Our previous studies on distribution of sclerotium grains in forest soils of Japan and Central Germany concluded that formation of sclerotium grains could be regulated by content of exchangeable Al and status of Al in soil, regardless of soil type. Furthermore, the ratio of colloidal Al (Al_p/Al_o ratio>0.5) could give the threshold of sclerotia formation in soils (Watanabe *et al*. 2002; 2004).

Since the maximum content of sclerotium grains is obtained as 3.4-5.4 g kg^{-1} in A horizons of Japanese Andosols and German Luvisol (Sakagami *et al*., 2004; Sakagami, 2010), we suggest that the contribution of sclerotium grains to forest soils cannot be ignored as one of the soil organic components (SOC). Moreover, from the fact that sclerotia content harmonize with the content of ergosterol, a biomarker of viable fungal biomass, in soils of Harz Mts., Germany (Watanabe *et al*., 2004), we expect to proceed further discussions on the accumulation state of soil humus and fungal metabolites in low pH forest soils.

The objective of this study is to contribute for the above discussions by conducting soil survey and analyses along a transitional soil sequence developed under *Quercus mongolica* and *Fagus crenata* in Mt. Chokai, Northern Japan.

Seven soil profiles were investigated on the western slope of Mt. Chokai (N 39°, 05’, 57’’, E 140°, 02’, 55’’, site elevation 550-1,100m). The annual mean temperature and total precipitation at the summit of Mt. Chokai (2,059m asl) are 0.5°C and 3,285mm, respectively. The parent materials of the soils were weathered Andesite associated with continental aeolian dust. Extremely high precipitation (approximately 3,000mm, mainly occupied by snowfall) and the non-andic mineralogical properties regulated the development of the investigated soils. Formation of sclerotia was observed in all soil profiles and the abundance of sclerotia was regulated by soil acidity (pH(KCl): 2.7-3.4 in A horizon), content of exchangeable Al (0.64-0.96 g kg^{-1} in A horizon) and intensity of leaching of colloidal Al and Fe. In consideration of analytical results on humus composition, we attempt to estimate the state of soil organic carbon in forest soils comprising sclerotium grains as an integrated microbial oriented SOC.

References: Kumada K and Hurst HM (1967) Green humic acid and its possible origin as a fungal metabolite. *Nature* **214**, 613-633.

Sakagami N (2010) Analysis on formation factor of sclerotia of *Cenococcum geophilum* in *Picea abies* forest, Harz Mts., Germany. *Geographical Review of Japan* 82, 136-147

Sakagami N *et al*. (2004) The relation between distribution of sclerotium grain and chemical properties in nonallophanic Andosols. *PEDOLOGIST* 48, 24-32.

Watanabe M *et al*. (2007) Characterization of major and trace elements in sclerotium grains. *European Journal of Soil Science* 58, 786-793.

Watanabe M *et al*. (2002) Distribution and development of sclerotium grain as influenced by aluminum status in volcanic ash soils. *Soil Science and Plant Nutrition* 48, 569-575.

Watanabe M *et al*. (2004) Morphology, chemical properties and distribution of sclerotium grains found in forest soils, Harz Mts., Germany. *Soil Science and Plant Nutrition* 50, 863-870.

Keywords: Cenococcum geophilum, forest soil, humus composition, sclerotium grain, SOC

Poster S3-P7

Effect of addition of organic inputs with contrasting resource quality on dynamics of soil organic matter in a tropical dryland agroecosystem

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Management of soil organic matter in tropical dryland agroecosystems is a great challenge and may be achieved through manipulation of the microbial community by varying organic inputs to soil. In India about 68% of total arable land is under rainfed dryland farming conditions. Addition of organic inputs rather than chemical fertilizer is advocated as they can not only enhance soil fertility but also can conserve soil moisture content. Resource quality of the organic inputs among other factors is the main driver of nutrient release through the process of decomposition. Reports on the effects of organic residues and fertilization on the dynamics, build-up and turnover of soil microbial biomass, the labile component of soil organic matter and also a sensitive index of soil fertility, are often conflicting. We evaluated the rate of decomposition of three organic inputs, having contrasting resource quality and their impact on soil microbial biomass dynamics in a dryland agroecosystem supporting rice-barley-summer fallow crop sequence. The treatments involved addition of equivalent amount of N (80 kgNha^{-1}) through three organic inputs: *Sesbania* shoot (*Sesbania aculeata* shoot, high-quality resource, C:N 16, lignin:N 3.2), wheat straw (low-quality resource, C:N 82, lignin:N 34.8) and *Sesbania* + wheat straw (high-and low-quality resources combined), besides chemical fertilizer (N:P:K:: Urea: SSP: MP) and control (no input). It is hypothesized that by combining high and low quality organic inputs the nutrient release can be regulated at a substantially higher level for a considerable period during the annual cycle, thereby improving crop productivity. Such response is expected to be particularly beneficial during the dry phase of the annual cycle when soil moisture and nutrient limitation may prevail in tropical dryland conditions.

The decomposition rates of various inputs were determined in field conditions by mass loss method. *Sesbania* (decay constant, k ¼ 0.028) decomposed much faster than wheat straw (k ¼ 0.0025); decomposition rate of *Sesbania* + wheat straw was twice as fast compared to wheat straw.

Soil microbial biomass C and N were determined 11 times at different growth stages of crop during a year by the Chloroform fumigation-extraction method. In both crops soil microbial biomass C and N decreased distinctly from seedling to grain-forming stages, and then increased to the maximum at crop maturity Soil microbial biomass was increased through rice and barley crop periods to summer fallow; however, in *Sesbania* shoot application a strong peak was obtained during rice crop period. The sharp increase in microbial biomass during early rice crop period, after the application of *Sesbania* (rich in labile C and N) could be due to active growth of r-strategist species growing on nutrient rich substrate. Subsequently during barley crop period, due to limited availability of nutrients, K-strategists probably out-compete r-strategists, leading to slow build up of biomass through summer fallow. Under nutrient poor conditions, the slow decomposition and persistence of wheat straw (rich in recalcitrant C) through the annual cycle may facilitate K-strategists over r-strategists for longer duration, slowly leading to substantial build up of microbial biomass through barley and summer fallow periods. In the combined input i.e. *Sesbania* + wheat straw (rich in labile C and N) treatment presumably both r- and K-strategists remain active for longer period, thereby maintaining higher microbial biomass through the annual cycle. We conclude that the form of C content of the inputs (labile or recalcitrant) plays more important role than the absolute amount in regulating the accumulation of soil microbial biomass. These findings may help in better understanding of soil organic matter dynamics and hence in management of the soil fertility in tropical dryland agroecosystems.

Keywords: Soil microbial biomass, organic inputs, tropical,agroecosystem

Poster S3-P8

Effects of cultivation practices on denitrification and its product ratios

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Denitrification is believed to be the major process responsible for N_2O production in soils. To determine how selected long-term cultivation and land-use practices affect basic denitrification properties and to deduce potential mitigation strategies, incubation studies with soil samples from long-term agricultural field experiments comparing tillage methods and rates of fertilization and liming were carried out. The soil's chemical properties (pH and organic carbon content) were compared to biological activities (O_2 consumption, CO_2 production, denitrification potential and product ratio $N_2O/(N_2+N_2O)$). Oxic and anoxic incubations were performed in the presence of ample amounts of NO_3^- and the acetylene blockage method was used to obtain potentials and product ratios. When most experimental conditions are standardized, phenotypic denitrification studies such as this can be used to screen for differences in microbial activities. As a result, differences in microbial (denitrifyer) communities can be linked to factors such as soil organic matter abundance or stability.

This study resulted in a clear inverse relationship between the denitrification product ratio and pH (R_2=0,86) for the fertilized and limed soils, whereas the denitrification product ratio was negatively correlated with the soil organic carbon content (R_2=0,57) as affected by tillage practices having only small variations in pH across treatments. Denitrification potential was also correlated to soil organic matter content (R_2=0,86) where minimum tillage soils had the highest soil organic carbon content and denitrification activity. Combining these results indicates that denitrification happened more efficiently (at a faster rate and with less N_2O production in relation to N_2) in the presence of higher soil organic carbon content. The relationship between pH and the product ratio as well as the relationship between organic carbon content and the product ratio were linear and seem to be inclusive of both soil types (sandy acidic and neutral loamy), indicating that the effects these soil properties have on microbial functions may be largely independent of soil type.

It is concluded that mitigation strategies that enhance denitrification efficiency (raise pH of acidic soils and enhance soil fertility through increased soil organic carbon content) will control nitrous oxide emissions while helping to close the nitrogen cycle and reduce leaching and eutrophication of waters.

Keywords: denitrification, SOM, pH, nitrous oxide, nitrogen cycle

Poster S3-P9

Efficiency of DSE fungal sclerotia as microbial cell carrier in forest soils

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Fungal sclerotia, the resting bodies mostly formed by ectomycorrhizal fungi are frequently found in forest soils and characterized by their hard, black, and spherical structure. Bacteria are detected in their porous internal structure of the sclerotium. It has been known that porous materials containing microbial cells have an advantage to maintain activities of useful microbes in soil. The objective of this study is to conduct phylogenetical examination of the microbial community inside the sclerotia and to evaluate the efficiency of sclerotia as microbial cell carrier.

In addition, fungal community of sclerotia was analyzed to investigate and isolate sclerotia-forming-fungi. Result from molecular phylogenetic analysis of the ITS 1 - 5.8S rDNA - ITS 2 gene regions and morphological characteristics indicated the existence of Dark Septate Endophytic fungi (DSE). Three isolates from Mycelium radicis atrovirens complex, comprised in DSE, preformed the initial stages of sclerotium formation on artificial media. Hence, it was considered that sclerotia-forming-fungi were DSE.

Bacterial communities inside of the fungal sclerotia by 16S rDNA gene clone library and culture method indicated different flora between sclerotia and soil. Bacterial community of sclerotia showed higher diversity compared to soil. On the contrary, bacterial flora isolated from single sclerotium differed from each other. Additionally, the bacterial community was composed by limited species of related genus.

The efficiency of sclerotia as microbial cell carrier was evaluated by the experiment on bacteria fixation in sclerotia comparing with charcoal, as a representative of utilized microbial carrier. The autoclave-treated sclerotium was immersed in a pure culture of the isolated bacteria to check the behavior of bacteria. The experiment using eight strains including Ralstnia pickettii, demonstrated that the maximum counts of viable cell found in sclerotium was 8.7×107 CFU g $^{-1}$. The experiment demonstrated that the maximum counts of migrated bacterial and migrating rate into sclerotium were proper to each bacterium. From the above results, we confirmed the function of sclerotia as microbial carrier in soil. However, the treatment of autoclave might have caused loss of nutrients and antibiotics generated by microbes in sclerotia, which allowed most of the applied bacteria to migrate inside the sclerotia.

Physical and chemical properties, structure characteristic, and water retention ability of sclerotia were examined with comparison of several utilized microbial carriers. It was confirmed that sclerotia were comprehensively excellent materials as microbial cell carrier.

Keywords: DSE sclerotia, microbial community, microbial cell carrier

Poster S3-P10

Enzyme assay for oxido-redutase activity measurement in soil and plant residue samples

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Phenol oxidases (laccase) and peroxidases (Lignin and manganese peroxidase) belonging to class oxido-reductase are the principal enzymes responsible for biodegradation of most recalcitrant compounds i.e. phenols via an oxidative process (Kandeler et al.1999). Although measurement of the enzymatic oxidation of phenols is an important measure of the soil microflora_capacity to degrade potentially recalcitrant organics, the proposed methods to perform this measurement are few and sometime questionable.

In this context, our study is focused on 1) comparing different methods of oxido-redutase activity measurement by using their relevant substrates and 2) to evaluate the effect of certain abiotic factors (temperature, pH) on enzyme activities measured by these methods which will enable us to find optimum conditions for oxido-redutase activity measurement in soil and plant residue along decomposition.

Activity of phenol oxidase and peroxidases were measured on soil, maize residue and incubated soil mixed with maize residue. Within this contrasted media, enzyme activities were determined by taking in account several factors including substrate concentration, temperature, pH and time of enzyme-substrate incubation. The kinetic parameters V_{max} and K_m (Michaelis and Menten, 1913) were studied regarding different substrates of Phenol oxidase and peroxidases. Substrates under these studies are Syringaldazine, 2,2 zinobis-3-ethylbenzothiazoline-6-sulfonic acid (ABTS), L-3,4-dihydroxyphenylalanine (L-DOPA, 3,3,5,5-tetramethylbenzidine (TMB), and pyrogallol. The results will be discussed in relation to soil ecological and enzymatic functions relative to biodegradation in soil.

References: Kandeler et al. 1999, Biology & Biochemistry 31:1171- 1179; Michaelis et al. 1913, Biochemische Zeitshrift 49: 334-336

Keywords: Lignin, enzyme, Oxido-reductase, substrate

Poster S3-P11

Hierarchy of biotic and abiotic controls on the degradation in soil of native and added organic matter

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The prediction of soil organic carbon stock is a main issue in the double context of climate change (Rustad et al., 2000) and fast evolution of cropping systems (Arrouays et al., 2002). To improve the modelling approaches of carbon dynamics, regulatory processes of soil organic matter decomposition have to be better known. The activity of soil microbial communities and their diversity play a key role in regulating organic carbon dynamics (Bradford et al., 2007; Cleveland et al., 2007), but research suggesting that abiotic processes (such as diffusion) are important regulators (Kemmitt et al., 2008). In other words, it is important to identify the regulatory mechanisms and their relative importance.

The aim of this study is to analyse and assess the relative importance of biotic and abiotic factors in the regulation of soil organic matter dynamics. Regarding biotic factors we will focus on size and structure of soil microbial populations, and concerning abiotic factors, on soil structure which determines substrate accessibility to microbial decomposers. We will use a soil from a long-term site that varies in micro scale physical structure and organic matter content (Essai de La Cage, Versailles, France).

In order to test the effect of the size and the structure of soil microbial population, sterile soils cores with a homogenized soil structure will be inoculated with different dilutions of the native population and incubated. The mineralization of organic matter will be compared with that of controls containing native soil population without dilution. On the other hand, to test the effect of the soil structure, soils cores with different structures (undisturbed, disagregated at the 5 mm scale (by sieving) and disagregated at the 50 µm scale (by agitation in water)) will be incubated and we will compare the mineralization of organic matter between these three structures.

^{13}C-labelled substrates (fructose and vanillin) will be used to stimulate the response of soil microorganisms. During the incubation, the CO_2 released will be measured by micro-GC and its isotopic signature will be determined using a GC-IRMS to differentiate the CO_2 evolved from the added substrates from that of the native soil organic matter.

It is hypothesised that the mineralization of added soluble substrates and soil organic matter may respond differently to the structure of the microbial community and to changes in accessibility via changes in soil structure.

References: Arrouays, D., Balesdent, J., Germon, J.C., Jayet, P.A., Soussana, J.F. et Stengel, P., 2002. Contribution à la lutte contre l'effet de serre. Stocker du carbone dans les sols agricoles de France ? *Expertise scientifique collective. Synthèse INRA, 32 p.*

Bradford, Tordoff G.M., Black H.I.J., Cook R., Eggers T., Garnett M.H., Grayston S.J., Hutcheson K.A., Ineson P., Newington J.E., Ostle N., Sleep D., Stott A., Jones T.H., 2007. Functional Ecology, 21, 690-697.

Cleveland C.C., Nemergut, D.R., Schmidt S.K., and Townsend A.R., 2007. Increases in soil respiration following labile carbon additions linked to rapid shifts in soil microbial community composition. Biogeochemistry , 82, 229–240.

Kemmitt, S.J., Lanyon, C.V., Waite, I.S., Wen, Q., Addiscott, T.M., Bird, N.R.A., OĐnnell, A.G., Brookes, P.C, 2008. Mineralization of native soil organic matter is not regulated by the size, activity or composition of the soil microbial biomass - a new perspective. Soil Biology & Biochemistry, 40: 61-73 .

Rustad, L.E., T.G. Huntington, and R.D. Boone, 2000. Controls on soil respiration: Implications for climate change. Biogeochemistry 48: 1- 6.

Keywords: Soil organic matter decomposition, Carbon dynamics, Soil structure, Soil microbial population

Poster S3-P12

Impacts of compost amendment and seasonal differences in soil moisture and temperature on microbial community in a Mediterranean soil

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Climate models predict higher air temperature and less frequent, but larger precipitation events. These events may impact the soil functions. Moreover, production of biosolid wastes such as compost is increasing and waste management becomes more crucial. The amendment of soils with composts is an alternative for improving soil fertility and also for reducing waste disposal costs. In the current Mediterranean context, fewer studies have focused on the interaction of seasonal shifts and organic amendments on soil microbial community. In this work, we studied the impacts of inputs of urban waste compost *in situ* on the activities of microbial communities under actual Mediterranean climate. The compost was added on October 2009 at the recommended dosage. Temperature, humidity of soils (control soil and soil with compost) and functional diversity of microbial community are monitoring along the year. The physiological profile of the community is determining by MicroResp analysis. The first results showed that compost amendment affected the activity of the soil microbial community. In addition, this change in the microbial function is also affected by seasonal temperature and precipitation.

Keywords: Microbial community, compost, seasonal variation

Poster S3-P13

Impacts of different N management regimes on nitrifier and denitrifier communities and N cycling in soil microenvironments

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Fundamental knowledge of the distribution and function of nitrifier and denitrifier communities within agricultural soils is vital to understanding soil N cycling and developing sustainable cropping practices. Real-time quantitative PCR assays, targeting part of the ammonia-monooxygenase (*amoA*), nitrous oxide reductase (*nosZ*), and 16S rRNA genes were coupled with ^{15}N pool dilution techniques to investigate the effects of long-term agricultural management practices on potential gross N mineralization and nitrification rates, as well as ammonia-oxidizing bacteria (AOB), denitrifier, and total bacterial community sizes within different soil microenvironments. Three soil microenvironments [coarse particulate organic matter (cPOM; >250 µm), microaggregate (53-250 µm), and silt-and-clay fraction (< 53 µm)] were physically isolated from soil samples collected across the cropping season from conventional, low-input, and organic maize-tomato systems (*Zea mays* L.- *Lycopersicum esculentum* L.). We found that, despite 13 years of different soil management and greater soil C and N content in the organic compared to the conventional and low-input systems, total bacterial communities within the whole soil were similar in size across the three systems (~5.15×10^{8} copies g^{-1} soil). However, *amoA* gene densities were ~2 times higher in the organic (1.75×10^{8} copies g^{-1} soil) than the other systems at the start of the season and *nosZ* gene abundances were ~2 times greater in the conventional (7.65×10^{7} copies g^{-1} soil) than in the other systems by the end of the season. Hence, we conclude that higher N inputs and soil N content do not necessarily foster larger AOB and denitrifier community sizes. Additionally, canonical correspondence analyses revealed that AOB and denitrifier abundances were decoupled from potential gross N mineralization and nitrification rates and from inorganic N concentrations. Finally, our results indicate that, overall, microaggregates support larger nitrifier, denitrifier, and total bacterial communities compared to the cPOM and silt-and-clay. These results suggest that soil microaggregates are microenvironments/habitats promote the growth of nitrifier and denitrifier communities, thereby serving as potential hotspots for N_2O losses.

Keywords: nitrifiers, denitrifiers, soil microenvironments, N transformation rates, cropping system

Poster S3-P14

Implications of land-use change and pasture-fertilization on soil microbial activities and communities in a mountain rainforest region of Southern Ecuador

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In the South Ecuadorian Andes, vast areas of the mountain rainforest have been converted to cattle-pastures for milk production by slash and burn practice. Frequently, these managed pastures were invaded by the fire-tolerant tropical bracken fern. When the bracken becomes dominant on the pasture sites the productivity decreases and the sites are abandoned. To assess the implications of land-use changes and pasture-fertilization on ecosystem functioning, a study was conducted in the area of the German research station Estación Científica San Francisco (ECSF) in Southern Ecuador. For comparison of the different land-use types three adjacent sites were selected at 2000 m asl.: a mountain rainforest site, an active pasture site dominated by the grass species *Setaria sphacelata* and an abandoned pasture site overgrown by bracken (*Pteridium arachnoideum*). To investigate the effect of the fertilization of pastures with urea and/or rock phosphate on soil microbial properties, a fertilization experiment was conducted *in situ* as well. Therefore, six replicate plots (5 x 5 m) of each treatment (*control, urea* (50 kg ha^{-1} a^{-1}), *rock phosphate* (10 kg ha^{-1} a^{-1}), *urea+rock phosphate*) were established in a 10-year-old managed pasture site. Samples from the organic layer (Oi and Oa) of the natural forest site as well as from the mineral soil of all three land-use sites and treatments (0-5, 5-10 and 10-20 cm) were taken to analyze biogeochemical properties (e.g. pH value, total C and N content). For soil microbial analysis, the amounts of microbial biomass (CFE-method), the microbial activity (basal respiration, net N mineralization (KCl-extraction); gross N mineralization (^{15}N dilution technique) rates) and the microbial community structure (PLFA-analysis) were determined.

17 years after pasture establishment, a threefold higher content of soil microbial biomass carbon (MBC) and nitrogen (MBN) as well as significantly lower C:N ratios were determined compared to the other land-use types. Furthermore, highest C and gross N mineralization rates were observed in 0-5 cm depth of the pasture soil. An actively inorganic N immobilization by the microbes indicated an easy availability of organic substrates partly due to the prolific fine-root system of the pasture grass. These differences in the microbial activity after land-use change from forest to pasture and from pasture to abandoned pasture were also associated with shifts in the soil microbial community structure (MCS). Results of a Redundancy Analysis revealed that MCS varied by land-use type and soil depth. After invasion of bracken the MCS shifted again towards the natural forest and a higher relative abundance of actinomycetes was associated with a higher acidity and a higher exchangeable Al-concentration.

In general, one year after the establishment of the fertilization experiment, higher microbial biomass and carbon mineralization rates were detected in all fertilized treatments compared to the *control*. Highest net N mineralization rates were observed in the plots fertilized with urea only, indicating a rapid microbial use of the amended organic nitrogen. In conclusion, the observed land-use change and pasture-fertilization had an impact of nutrient transfer and on ecosystem functioning in the mountain rainforest region.

Keywords: land-use change, pasture, fertilization, soil microbial community structure (PLFA), net and gross N mineralization rates

Poster S3-P15

Integrating the relationships among soil organic matter, aggregate structures, and the microbial community

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Nearly ideal conditions for soil aggregate formation and stabilization exist in the rhizosphere. In soils with a legacy of long-term exploration by roots, a hierarchical aggregate structure often develops. As fibrous roots grow, they exert pressures and locally dry the soil causing soil particles to be pushed and drawn together at the same time that exudates and rhizodeposits support a diverse microbial and faunal community. Roots and the hyphae of associated mycorrhizal fungi serve as a flexible latticework that enmeshes and stabilizes larger aggregates. Because root turnover often occurs within the inner space of soil aggregates, the decomposition process leads to the formation and stabilization of microaggregates within macroaggregates and development of an aggregate hierarchy. The resulting physical structure feeds back to impact decomposer access to substrates, air, water, and nutrients, thereby affecting decomposition and soil carbon cycling and sequestration. In our past work (Jastrow et al., 1998, Soil Biol. Biochem. 30:905-916), we used path analysis to demonstrate that the recovery of a stable macroaggregate structure in restored grassland was driven by the direct and indirect effects of roots and mycorrhizal hyphae, with lesser relative contributions from microbial biomass, soluble carbohydrates, and soil organic matter. More recently, we reported that this recovering grassland system has steadily accrued soil carbon for 30 years (Matamala et al., 2008, Ecol. Appl. 18:1470-1488). Here, we reverse conceptual focus to investigate the influence of aggregate structure on the soil microbial community and the accumulation of soil organic matter. With our original data, we use a new heuristic path model to explore (1) the integrated roles of macroaggregate structure as the habitat for soil microbes and as a mechanism for the physical protection of particulate organic matter and (2) the outcome of that interplay on the accrual of mineral-associated organic matter. We also use new data from this grassland chronosequence, including physically isolated soil fractions and phospholipid fatty acids, to examine the interrelationships among aggregate hierarchy, the microbial community, and the nature and spatial location of accumulated soil carbon.

Keywords: soil carbon accrual, soil aggregation, soil microbial community, physical protection, roots, mycorrhizal fungi, grassland

Poster S3-P16

Land-use change: effects on soil microbial C , N and P in aggregates in subtropical China

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Soil microbial C, N and P in soil aggregates as affected by land-use change were studied in the subtropical region of China.. The land-use sequence contained natural forest (control treatment), secondary forest, two plantations, citrus orchard and tea garden. Results showed that the contents of the microbial C, N and P in different size groups increased with increasing sizes of dry-sieved aggregates , except in tea plantation. The conversion of natural forest into other land-uses resulted in a decline in the amounts of soil microbial C. But the microbial N and P had minimal impact on different land use in this area.It is not clear in this site if the microbial biomass was sensitive to land use change.

Keywords: land use ; soil aggregates ; microbial biomass ; subtropics

Poster S3-P17

Link betwween microbial diversity and soil organic matter turn-over

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Numerous human activities essential to the well-being of modern society have a severe impact on soil biodiversity. The functional significance of these losses/modifications of biodiversity, in terms of the capacity of ecosystems to maintain the functions and services on which humanity depends, is now of pivotal importance. In this context, we investigated the link between microbial diversity and the turn-over of organic matter in soil, which is a major function for soil fertility, environment quality and global changes. To simulate an erosion of soil microbial diversity, microcosms of a soil previously sterilized by gamma irradiation have been inoculated with three different dilutions of a suspension of the same but non sterile soil. By this way, three series of microcosms representing a gradient of soil diversity have been obtained, with D1>D2>D3. After microbial communities have colonized and stabilized, microcosms have been amended with ^{13}C labelled wheat residues. Microcosms without wheat input were used as control. Decomposition of wheat residues and of indigenous organic matter have been assessed during 60 days by measuring $^{13}CO_2$ and $^{12}CO_2$ fluxes, respectively. Several organic families have also been followed with compound specific isotopic (^{13}C) analysis: lignins, sugars, lipids including PLFA. In parallel, dynamics of microbial diversity have been characterized by both DNA-fingerprinting and pyrosequencing techniques. Results show that intensity of the soil respiration as well as of the priming-effect induced by the addition of plant residues was strongly linked to microbial diversity, with the highest values observed where diversity is greatest. The stability of microbial communities was also dependent on diversity, the least diversified communities being more greatly affected by the addition of organic matter. These results illustrate the importance of considering the microbial diversity as a predictive variable of organic carbon storage/release in soils.

Keywords: Microbial diversity, soil, organic matter

Poster S3-P18

Litter and soil organic matter transformation during extreme drying/wetting

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As a consequence of climate change not only an increase of average annual temperature is likely to occur but also an accumulation of extreme meteorological events.

Shifts in summer rainfall patterns of Central Europe, such as extended summer-droughts followed by heavy rainfall events could change the soil organic matter (SOM) quantity, composition, microflora and thus turnover in temperate forest ecosystems.

Here, we performed a tracer experiment in a mountainous Norway spruce forest in south Germany to verify the influence of drying-as well as wetting events on SOM transformation and needle decomposition. At the experimental site original tree litter was diluted by ^{13}C and ^{15}N enriched spruce litter. On three manipulation plots we excluded summer troughfall in the year of 2009 and analysed the ^{13}C and ^{15}N signatures of the litter and in different soil pools in comparison to three control plots and three irrigated plots. By sampling after 8, 22 and 52 weeks and different soil depths it was possible to evaluate quality and quantity of SOM turnover during time and space. To date we analysed the ^{13}C and ^{15}N signatures of bulk soil, microbial biomass and in phospholipid fatty acids (PLFA).

Soil organic matter turnover is mainly controlled by the activity and composition of the microbial community. Since different microbial groups contain distinct PLFA patterns their analysis allows a differentiation between principal microbial groups such as gram-positive and gram-negative bacteria, fungi and protozoa.

According to rapid response on environmental changes like temperature and humidity the microbial biomass is a very sensitive proxy for identifying drying and wetting effects.

We assumed that drought stress will result in reduced litter and SOM turnover rates. Moreover we expected a switch of microbial community composition to more fungi.

Keywords: SOM turnover/ drought stress/ drying-wetting cycles/ forest soil/ microbial biomass

Poster S3-P19

Microbial communities and organic carbon turnover under alternating redox conditions in paddy soils

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Paddy soils are characterised by interchanging cycles of anaerobic and aerobic conditions. Such fluctuations alter the soil microbial activity. Temporary deficiency in oxygen creates conditions favourable to facultative or obligate anaerobic bacteria. This can cause the composition of the microbial community to change drastically but also the physiological responses of the present soil microbial community to shift. These alterations can strongly affect soil processes, in particular organic matter accumulation and mineralization.

We aimed at detecting potential rapid changes in the soil microbial community due to interchanging oxic and anoxic cycles. Such changes can help explaining the dynamics of CO_2 and dissolved organic carbon (DOC) production in paddy soils.

We choose two soils from a chronosequence of paddy soils in China. These soils have been subjected to anoxic conditions during the rice growing period and oxic conditions during harvest and growth of other crops since 700 and 2000 years. Therefore the present microbial community should be adapted and promptly responding to alternating redox conditions. Starting from oxic and anoxic conditions, the redox state of the soils was reversed every 3 weeks for 3 months in laboratory incubation experiments. At each sampling time, we determine phospholipids fatty acids (PLFA) contents and composition. We related the results to carbon mineralization, ^{14}C age of CO_2 and DOC production.

Production DOC was slightly higher under anoxic than under oxic conditions. In the 700 years old soil, mineralised carbon originates mainly from old carbon pools, and in both soils anoxic conditions favoured this trend. In the 700 years old soil, the first change in redox conditions resulted in a decrease in living biomass, being larger when the experiment started at oxic conditions. The fungal-to-bacteria ratio increased after each change in redox conditions, pointing at the bacterial community as the more sensitive component of the microbial communities. Gram-positive bacteria were most affected by changes from oxic to anoxic conditions. In both treatments, the living biomass promptly recovered when the initial redox conditions re-established. In the 2000 years old soil part of the living biomass was lost during the first 3 weeks of incubation, especially when the experiment started under oxic condition. The change in redox state had different effect on the entire microbial biomass, depending on the initial redox state: it increased from oxic to anoxic but slightly decreased from anoxic to oxic conditions. Again, the differences were due to changes in the bacterial component, with gram positive bacteria being lost upon shifts from oxic to anoxic conditions. The initial total living biomass re-established with the second change in redox state.

The larger carbon content, combined with the larger living microbial biomass could explain the larger DOC and CO_2 production of the 2000 years old soil. When starting from anoxic conditions, it showed the largest CO_2 and DOC production during the entire incubation experiment, despite the temporary reduction in living biomass upon changes in redox state. This suggests a better adaptation of the microbial community at the older sites, allowing for continuous activity even with changes in community composition.

The microbial communities, especially their bacterial components, seem to respond fast to changes in soil redox status. However, long periods of time seem to be necessary to achieve strong and lasting adaptation (resilience). Prompt response and adaptation mechanisms can strongly affect the role of soils as sources or sinks of carbon, as temporal and spatial changes in oxic and anoxic conditions are common to soils in various ecosystems and might increase with future changing climatic conditions.

Keywords: phospholipids fatty acids, oxic/anoxic conditions, CO_2, DOC, soil organic matter

Poster S3-P20

Microbial isotopic fractionations of carbon and nitrogen during soil organic matter decomposition

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The soil microbial biomass (SMB) is known to participate in key soil processes such as the decomposition of soil organic matter (SOM). However, its contribution to the isotopic composition of the SOM is not clear yet. Shifts in the ^{13}C and ^{15}N natural abundances of the SMB and SOM fractions (mineralised, water soluble and non extractable) were investigated by incubating an unamended arable soil for 6 months. Microbial communities were also studied using Fatty Acid Methyl Ester specific isotope analysis. The SMB was significantly ^{13}C and ^{15}N-enriched relative to other fractions throughout the incubation. However, significant isotopic variations with time were also observed due to the rapid consumption of relatively ^{13}C-enriched water soluble compounds. The increase in the difference in SMB and water soluble ^{15}N compositions as the water soluble C/N ratio decreased. This relationship indicated a shift from N assimilation to N dissimilation during the incubation. These changes also induced modifications of the microbial community structure. Once the system reached a steady-state (after 1 month), the isotopic trends appeared to corroborate those obtained in long term experiments in the field in that there was a constant microbial isotopic fractionation leading to a ^{13}C and ^{15}N enrichment of the SOM over the long-term. This work also suggests that caution must be exercised when interpreting short term incubation studies since perturbations associated with experimental set-up can have an important effect on C and N dynamics, microbial fractionation of ^{13}C and ^{15}N and microbial community structure (Lerch et al., 2010).

References: Lerch T.Z., Nunan N., Dignac M.F., Chenu C., Mariotti A. (2010) Variations in microbial isotopic fractionation during soil organic matter decomposition. *Biogeochemistry*

Keywords: ^{13}C, ^{15}N, Isotope Fractionation, Soil Organic Matter, Microbial community structure

Poster S3-P21

Multiscale modelling and emergent properties of microbial degradation of soil organic matter

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The effects of climate change on C transformations in soils are still largely unknown and a matter of much debate. Work carried out in the last few years suggests that the reason we do not understand what is going on, is because we are ignoring important microscopic aspects of soils, in particular their high level of heterogeneity at the particle and pore scale (caused by soil structure), which lead to a spatial disconnection between soil carbon, energy sources, and the organisms that are involved in carbon transformations. We aim to make significant progress in this area by modelling processes at the microscopic scale while simultaneously carrying out measurements to test the model at that scale, and by developing approaches to upscale from pore to core scales. The general aim of the MEPSOM project, which is presented here, is to understand and predict microbial transformations of carbon in the complex and structured environment of soils. Our modelling approaches of soil biogeochemical functioning will not be predicated on the premise of the classical black box approaches of soil biota and soil organic matter, but rather attempt to explicitly take into account that (i) soils are physico-chemical environments in which the biota reside in highly heterogeneous and structured media, (ii) soil biota and organic resources are sparsely distributed throughout the available pore space, and (iii) soil microbial communities are highly complex and are involved in multiple interactions. The project is fundamentally plurisciplinary and associates soil microbial ecologists, soil biophysicists, soil physicists with modellers of soil processes, either physical or ecological, with mathematicians. It is organized in four work packages in each of which experimental and modelling components are closely associated. The work packages are structured as follows: the first deals with the spatial organisation of the biological, physical and chemical components of soil at the microbial habitat scale, the second develops the modelling of the dynamic elements of the system (microbes, substrate diffusion, respiration) and the final two correspond to a progressive increase in the levels of biological and physical complexity of the system studied and by ensuring that the mathematical description accurately encapsulates functioning at each level. Analysed systems span from pure bacterial or fungal strains in sand microcosms to soil cores with their natural microbial population, with intermediates in complexity. From a modelling perspective the biological functions will be implemented in 3 different models describing the 3D environment of the soil. The first two are based on avoxelized description of the soil, one solving equations through EDP (µBio-3D), the second one through Laticce Bolzman procedures (BIO-TRT-LB), whereas the third model is a geometrical description of the pore space combined with algorithmic methods (MOSAIC II).

Keywords: microbial habitat, soil pore system, model, accessibility

Poster S3-P22

On the microbial biomass and dissolved organic substances dependence of soil respiration

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Our understanding of the controls of soil CO_2 emissions in Tropic of Cancer are limited by uncertainties due to rapid land use change and temporal variation in environmental conditions influenced by monsoon season. In order to better understand the limiting factors and substrate affecting soil CO_2 flux, we measured total organic carbon (TOC), microbial biomass carbon (MBC), microbial biomass nitrogen (MBN), dissolved organic carbon (DOC), and dissolved organic nitrogen (DON) from seven sites of four land use types (1 vegetable field, 3 uplands, 2 orchards, 1 pine forest) of subtropical soils at Zigui county, located in Three Gorges Reservoir Area, China. We also determined the ratio of MBC to TOC (microbial quotient, Q_t), MBC:MBN, DOC:DON as an indicator of soil organic matter quality or availability. Objectives were to (1) evaluate the separate and interactive relationship of TOC, MBC, MBN, DOC, and DON with soil CO_2 flux, in addition to the relationship obtained by usually used environmental variables (soil temperature and moisture), and (2) investigate the seasonal and annual CO_2 fluxes from different land uses.

The climate was warm and wet from April through September (the hot-humid season) and became cool and dry from October through March (the cool-dry season). Driven by the seasonality of precipitation, soil temperature, MBC, MBN, DOC and DON, CO_2 fluxes were significantly higher in the hot–humid season than in the cool-dry season. Annual CO_2 fluxes ranged from 5.4 to 9.5 Mg CO_2 ha^{-1} yr^{-1}. Vegetable field had the highest CO_2 emission, while pine forest had significantly lower CO_2 emission than cultivated land uses. Tilled orchard had significantly higher CO_2 emission than non-tilled orchard. CO_2 fluxes were significantly correlated with Q_t and MBC:MBN, while not being correlated with DOC:DON. Different quantities of MBC and MBN significantly regulated the CO_2 emission among different land uses, relatively weakly correlated with DOC, while not being correlated with DON. However, temporal fluctuations of CO_2 flux were significantly regulated by MBC, MBN, DOC and DON, in one model of variation, in all land uses. But, when all the variables were included in the multiple stepwise regression analysis, different trend of dominancy was observed for soil temperature (two sites), MBC (one site), MBN (one site), DOC (two sites) and DON (one site). Our results indicate that (1) there can be a significant shift of microbial biomass with land use change, which in turn, caused to shift in CO_2 flux, and (2) apart from the soil temperature, microbial biomass and dissolve organic substances must be considered in a warming future as these can explain a major part of temporal variation of soil CO_2 fluxes.

Keywords: Microbial biomass Carbon, Dissolved organic carbon, CO_2 flux, Microbial biomass nitrogen

Poster S3-P23

Physicochemical characteristics of sclerotia of Cenococcum species found from soils of three cool-alpine mountain areas

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Sclerotia of *Cenococcum* species tend to be particularly abundant near *Cenococcum* mycorrhiza, as spherical grains of 0.05~4 mm or more in diameter (Trappe, 1969). According to Watanabe *et al*. (2007), the ^{14}C ages of sclerotia from surface A and buried A horizons of *Fagus crenata* forest soil were ca. 100~200 yr. B.P. and ca. 300~1,200 yr BP, respectively. Moreover, the ^{14}C ages of sclerotia were older than those of humic acids and soil. From this fact, sclerotia were considered to be persistent for a long term as a structural organic component in soils. In this study, we obtained some quantitative information on physicochemical characteristics of sclerotia from three types of forest soils to understand of sclerotia as the nature of soil organic component.

Sclerotia used in this study were collected from surface soil in three sites. The first site (Harz) is Luvisol under *Picea abies* forest near Elend village (51°43'N, 10°43'E, 470m asl) in Harz mountains, Germany. The second site (Ontake) is Podsol under *Abies veitchii* and *Tsuga diversifolia* forest (35°55'N, 137°27'E, 2100m asl) in Mt. Ontake, central Japan. The site sight (Akita) is Andosol under *Fagus crenata* forest (39°47'N, 140°46'E, 620m asl) in Lake Tazawa plateau, northeastern Japan.

Sclerotia were directly separated from surface soils by wet sieving and hand sorting methods. The weight and the diameter were measured using an electric micro balance (AX26, Mettler Toledo) and a digital microscope (VH-7000, Keyence), respectively. 295, 328 and 196 grains of sclerotia from Harz, Ontake, and Akita were measured and bulk densities were calculated by their weight and volume. The contents of C, H, and N were determined by a dry combustion method (CHN analyzer, type MT-6, Yanaco Corp.). Physical persistence of sclerotia was examined using a simple load test equipment. 82, 45 and 55 grains from each site were tested. The ^{14}C ages of sclerotia were obtained by using accelerator mass spectrometry (AMS) measurements by 3 MV Tandem accelerator at IAA (Institute of Accelerator Analysis Ltd., Japan). Approximately 5 mg of sclerotia were applied for ^{14}C age measurement.

The mean diameters of sclerotia from Harz, Ontake, and Akita were 0.75±0.17, 0.76±0.20, and 0.53±0.10 mm, respectively. Sclerotia from Harz and Ontake showed similar size distribution. On the contrary, the bulk density of Ontake sclerotia agreed well with it of Akita. The maximum load of sclerotia was 1,730 g (Harz), 781 g (Ontake), and 1,136 g (Akita). Sclerotia in Harz revealed their hardness, and sclerotia in Ontake were friable. Commonly to three sites, the average of diameter lied close to the peak in the load data. From this result, it was suggested that the midrange sclerotia have a possibility to have the highest physical persistence in certain soil. Possible explanations of the regulating factor of the load are rate of internal hollow space, weathering, or decomposition by bacteria or other fungi during persisting term in soil. ^{14}C age of Harz, Ontake, and Akita sclerotia were modern, 360±30, 370±30 yr BP. This fact may gives an evidence for the hardness of Harz sclerotia.

Formation of sclerotia would be regulated by soil physicochemical properties and microbial activities. Simultaneously, sclerotia in soil are exposed to decomposition process. In some suitable region, sclerotial carbon has a potential to be equivalent to microbial carbon in soil (Sakagami, 2010). Sclerotia, which are formed by ectomycorrhizal fungi, can be a sink and/or a source of organic carbon in sub-alpine forest soil.

References: Sakagami N (2010) Analysis on formation factor of sclerotia of *Cenococcum geophilum* in *Picea abies* forest, Harz Mts., Germany. Geograph. Rev. Japan, 82, 136-147

Trappe JM (1969) Studies on *Cenococcum graniforme*. I. An efficient method for isolation from sclerotia. Can. J. Bot. 47, 1389−1390.

Watanabe M, Sato H, Matsuzaki H, Kobayashi T, Sakagami N, Maejima Y, Ohta H, Fujitake N, Hiradate S (2007) ^{14}C ages and δ^{13}C of sclerotium grains found in forest soils. Soil Sci. Plant Nutr. 53, 125−131.

Keywords: Cenococcum species, forest soil, organic carbon, sclerotia

Poster S3-P24

Plant competitive abilities for N as drivers of microbial growth and turnover in the rhizosphere

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The functional structure and activity of rhizosphere microorganisms depend on the quantity and quality of root exudates, which are plant specific and depend on nutrient availability. It is still unclear how plants with different competitive abilities alter microbial growth and turnover in the rhizosphere under nutrient limitation. Depending on C and N availability, an acceleration or even retardation of microbial activity can be expected in the rhizosphere of plants with high competitive abilities for N. Our study aimed to estimate the functional parameters of microbial growth kinetics characterizing the *in situ* response of the decomposer community to substrate quantity and availability. The application of the general ecological theory of an r- to K-selection continuum to soil microbiology (Prosser et al., 2007) was used for interpretation of experimental data. We hypothesized slower microbial growth rates in the rhizosphere of plants with smaller roots, because such plants release less exudates compared to those with a small shoot-to-root ratio. As C availability for microorganisms is mainly affected by root exudates we also expected that N limitation stronger restricts microbial growth in the rhizosphere of plants with smaller root mass.

These hypotheses were tested on two strawberry species: Fragaria vesca L. (native species) and Duchesnea indica (Andrews) Focke (an invasive plant in central Europe) growing in intra-specific and inter-specific competition at two contrasting N levels. Microbial biomass and the kinetic parameters of microbial growth in the rhizosphere were estimated by dynamics of CO_2 emission from the soil amended with glucose and nutrients. Specific growth rate (m) of soil microorganisms was estimated by fitting the parameters of the equation: $CO_2(t) = A + B \times \exp(m \times t)$, to the measured CO_2 production rate ($CO_2(t)$) after glucose addition, where A is the initial respiration rate uncoupled from ATP production, B the initial rate of the growing fraction of total respiration coupled with ATP generation and cell growth, and t time.

The growth strategies of rhizosphere microorganisms and different adaptation strategies of F. vesca and D. indica were linked only when N was limited. At low N level, the specific microbial growth rates were 2.4-fold slower under D. indica (0.09 h^{-1}), which is characterized by a smaller root biomass and lower N content in roots compared with F. vesca. The turnover time of actively growing microbial biomass was 6 h longer in the rhizosphere of D. indica than under F. vesca (10.7 versus 4.6 h, respectively). Thus, under N limitation, strong competition for N between plants and microorganisms decreased microbial growth rates and turnover in the rhizosphere. Under conditions of competition between both plant species at low N level, microbial growth rates were similar to those for D. indica growing on its own. This indicates that the plant species with stronger competitive abilities for N controls microbial community in the rhizosphere.

At high N availability the root biomass did not differ significantly between both plants. This resulted in similar microbial growth rates for intra- and inter-specific plant competition. Fine root proliferation and root exudation decrease at high N levels. Accordingly, N addition smoothed the differences in microbial growth independent of plant competitive abilities. We conclude that microbial growth in rhizosphere was affected by the competitive abilities of plant species only under N imitation.

References: Prosser, J.I., Bohannan, B.J.M., Curtis, T.P., Ellis, R.J., Firestone, M.K., Freckleton, R.P., Green, J.L., Green, L.E., Killham, K., Lennon, J.J., Osborn, A.M., Solan, M., van der Gast C.J., and Young J.P.W. 2007. The role of ecological theory in microbial ecology. Nature, 5: 384-392.

Keywords: Microbial community, Functional structure, K- and r-strategy, Plant - microbial interactions, Soil organic matter dynamics

Poster S3-P25

Rate of soil organic carbon mineralisation by monospecific bacterial population placed in specific soil pore size classes

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Microbial communities exist and are active in a complex 3-D physical framework which can cause a variety of micro-environments to develop that are more or less suitable for microbial growth, activity and survival. Soil structure is known to be a controlling factor in soil organic matter (SOM) dynamics. Soil organic carbon decomposition was shown to be pore size class dependent. Results of a previous study, in which we added labelled fructose in undisturbed soil cores and equilibrated them at a given matric potential in order to target specific pore size classes (291µm, 97µm, 2.9µm), have shown an higher fructose mineralisation in pore size classes between 9.6 µm and 291 µm and an higher SOM mineralisation between 0.9µm and 290µm. In addition those same results suggested existence of different microbial communities in different pore size classes. It may be therefore, that the differences in microbial community structure in the different pore size classes are the reason for the different decomposition rates. The aim of the present study was to determine the importance of soil pore size structure in soil organic C decomposition, independent of microbial community structure

This was achieved by using a sterilized and reinoculated soil, thus with a constant and known microbial community structure and measuring carbon mineralisation at different matric potentials. We worked with sieved (5mm) silty cultivated soil.

It has been sterilized by gamma ray exposition (70kGy). Samples were incubated at two matric potentials (-1kPa and -100kPa) targetting predominantly pores with maximal diameter of 291µm and 2.9µm. We inoculated each sterilized sample with mono-specific bacterial cultures isolated from fresh unsterilised samples of the same soil. Bacteriae gender used are *Arthrobacter* (1.82 E+7 CFU)*, Rhodococcus* (1.57 E+7 CFU), *Erwinia* (1.9 E +7 CFU), *Cellulomonas* (2.9 e+8 CFU), Pseudomonas (1 E+7 CFU), *Cocobacille* (6.4 E+8), *Bacillus* (1.5 E+7). Samples were incubated at 20°C in the dark during 130 days. Carbon mineralisation was monitored by gas chromatography. In order to be sure that the mono-specific bacterial community inoculated were predominant in our samples, we established soil microbial profiles by Denaturating Gradient Gel Electrophoresis (DGGE). Profiles of mono-specific bacterial cultures are established at the beginning of the experiment and compared to those established with samples inoculated at the end of the incubation.

Sterilization by gamma ray killed most of the soil microbial biomass. We hypothesise that the observed flush of mineralisation at the beginning of the incubation corresponds to consumption of dead biomass by the re-inoculated bacteria. We decided thus to consider the existence of two pools of available carbon: one represented by dead microbial biomass and the other one represented by soil organic carbon (SOC). We used a simple first order kinetic model with two pools in order to compare the rates of soil organic carbon mineralisation . First results, concerning *Arthrobacter, Rhodococcus*, *Pseudomonas*, show a strong effect of bacterial type on soil organic carbon mineralisation.

References: DS. Treves,1 B. Xia,1 J. Zhou,2 J.M. Tiedje1 A Two-Species Test of the Hypothesis That Spatial Isolation Influences Microbial Diversity in Soil.

Keywords: sterilised soil, poral scale, matric potential, SOC mineralisation

Poster S3-P26

Relationships between nutrient cycling and microbial communities in arable soils: Does organic matter quality matter?

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Understanding carbon (C) and nitrogen (N) cycling in arable soils is a challenge to establish sustainable agricultural production. These biogeochemical processes are largely mediated by the soil microbial communities and thus their quantitative prediction must encompass this biological component. Mineral fertilizer and organic amendments are applied to arable soils to meet plant nutrient demand during the growing season. These soil management practices are known to change the chemical, biological and physical properties of soils. However, less is known how different past organic matter quality inputs affect the relationships between nutrient cycling and soil microbial communities. We will present results from a recent study carried out on the Ultuna Long-Term Soil Organic Matter Experiment (Uppsala, Sweden) where we have studied the link between nutrient cycling and microbial community structure. The experiment started in 1956 on a post-glacial clay loam soil. Since then, soils have been treated with different N-fertilizers (80 kg N ha^{-1} year^{-1}), different organic amendments (Green manure, Farmyard manure, Peat, Sawdust, Straw, Sewage Sludge; 8 Mg ha^{-1} ash free organic matter biennial), or combinations of N-fertilizers and organic amendments. In the laboratory, incubations were carried out to determine the C and N dynamics by measuring the CO_2 evolved and by using the ^{15}N isotope dilution technique. The microbial community structure and potential catabolic diversity of the soils were assessed using the Phospholipid Fatty Acid (PLFA) profiling method and community level physiological profiles (CLPP) by means of the MicroResp^{TM} method, respectively. In addition, the amount of the microbial biomass was determined by the fumigation-extraction method. Rates of C mineralization in relation to total organic C in soils amended with peat, peat and nitrogen or sewage sludge were significantly lower than in other soil treatments. These peat and sewage sludge amended soils also exhibited the highest differences in terms of PLFA and CLPP profiles among all soil treatments. In general, we found that there was a significant relationship between the microbial community structures and the catabolic profiles. The importance of the quality of past organic amendments in shaping the relationship between the soil organic matter decomposition and the soil microbial communities will be discussed.

Keywords: Long-term field experiments, soil organic matter, Microbial communities, PLFA, functional profiling

Poster S3-P27

Rhizosphere priming effects: soil organic matter turnover in hotspots of microbial activity

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Up to now it is tacitly accepted that the decomposition and turnover of soil organic matter (SOM) is mainly controlled by abiotic environmental factors such as soil temperature and moisture. This contribution shows that biotic factors controlling microbial activity e.g. substrate availability, overshadows the effects of abiotic factors. High substrate availability that is common in such hotspots of microbial activity as rhizosphere induces priming effect leading to changes of SOM decomposition. In the most studies the acceleration of SOM decomposition was observed in the rooted soil. Despite very small spatial extension of the hotspots and their very short life time of few days only, the estimated intensity of turnover in such hotspots is at least one order of magnitude higher than in the bulk soil. This is connected with some properties of microorganisms in the rhizosphere, especially: 1) the increase of specific growth rates of microorganisms, 2) shift to r strategists, 3) increase of mineralization potential, etc. The conclusion is that biotic interactions and substrate availability should be incorporated in models of C and N dynamics, and that microbial biomass should regarded not only as a C pool but also as an active driver of C and N turnover.

Keywords: Microbial activity, Hotspots, Rhizosphere, Root C, Soil organic matter turnover, Enzyme activities, ^{14}C, ^{13}C, ^{15}N, Substrate availability, C sequestration

Poster S3-P28

Soil carbon and microbial population evolution after the application of two types of urban sludge in the Mediterranean climate.

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Introduction and objectives: Urban sludge from wastewater treatment plants is commonly used for agricultural purposes in developed countries. A common idea in agricultural policy is that soil acts as a carbon sink after application of sewage sludge. However, mineralisation is the more effective process (4). Since few field experiments have been carried out in Mediterranean climates, the aim of this work is to assess the evolution of organic carbon and its relationship with bacterial communities under these conditions.

Materials and Methods: Three blocks of 8 plots (≈25 m^2) were randomly distributed in a homogeneous area in an experimental farm belonging to the Institute for Crop and Food Research (IMIDRA). Each block is sufficiently separated from the others in order to avoid any possible effect on the other blocks. We used two types of sewage sludge in a single application at a high dose (160 ton/ha), each with three replicates. A monitoring programme was designed with different intensities depending on the parameter to be analysed: soil, groundwater or microbiological aspects. Soil carbon was analyzed after 2 years of monitoring: total organic carbon and soluble carbon **(ISRIC 2004)** (1) and isolating organic carbon in three different fractions (6). Soil respiration was measured *in situ* using a Licor Li-8000 IR analyzer. At the end of the experiment, the structural stability index was measured using dry sieved macroaggregates (5). Microbial populations were analyzed by DNA sequencing of 16S rDNA minilibraries obtained by PCR using soil DNA. Sequences were analyzed by comparison against RPD database. C substrate consumption was analyzed using standard protocols and Microresp (2).

Results: After two years of monitoring, significant differences were found in total and soluble carbon, mainly in the surface horizons (0-20 cm). During the first year, there was an increase in the content of soluble and total carbon although in the second year these values decreased to almost the initial content. Regarding the different fractions of the soil carbon, labile pool 1 (mainly hydrocarbons) had a net increase after one and two years, especially in plots treated with anaerobic sludge. Labile pool 2 remained fairly stable throughout the whole period except in the plots treated with anaerobic sludge. Recalcitrant fraction showed an increase in the first year, although these values returned to near the initial values after the second year, except in the case of plots with anaerobic sludge.

Anaerobic sludge shows a substantially different behaviour if compared with aerobic sludge. This fact has important implications in terms of the carbon cycle: anaerobic sludge has a lower mineralization rate and therefore its incorporation into the soil is higher. Two years after the application, soil aggregates had increased in amount, size and stability. These data seem to be related to trends in soil microbial populations where bacterial counts increased in both soils compared to a blank soil but being lower in anaerobic-treated plots. Nevertheless, using a modified SIR biomass assay (3), the biomass of anaerobic plots was higher than that of aerobic or control soils. The molecular analysis of bacterial communities showed clear differences among plots that were substantiated in metabolic analyses of the different soils.

Conclusions: The type of wastewater sludge added to crop soil influences the amount and type of remaining carbon in this soil under mediterranean conditions. Also, addition of wastewater sludge changes soil microbiota in terms of community composition and biochemical activities.

References: 1. ISRIC. Procedures for soil analysis. 2002. International Soil Reference and Information Center-FAO-UN, Wageningen, The Netherlands ; 2. Campbell, C. D., S. J. Chapman, C. M. Cameron, M. S. Davidson, and J. M. Potts. 2003. Appl. Environ. Microbiol. 69:3593-3599 ; 3. Fierer, N., J. P. Schimel, and P. A. Holden. 2003. Soil Biol. Biochem. 35:167-176 ; 4. Lal, R. 2004. Nutrient Cycling in Agroecosystems 70:103-116 ; 5. Le Bissonnais, Y. 1996. European Journal of Soil Science 47:425-437 ; 6. Rovira, P. and V. R. Vallejo. 2007. Soil Biol. Biochem. 39:202-215.

Keywords: Carbon cycle, Mediterranean climate, soil aggregate, soil respiration, wastewater sludge, MicroResp, bacterial populations, soil metabolism.

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Poster S3-P29

Soil Microbial Communities: Precursors and Mediators of Humification in Forest Soils

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Microbial communities are critical controllers of the conversion of plant detritus to humic materials and/or CO_2. Since microbial communities can differ in body chemistry and metabolic capacities across ecosystems, we hypothesize that soil microbial community composition influences rates and products of humification. The purpose of this research is twofold. First, we are examining how microbial composition affects the amount of C humified and the stability of the products due to differences in the macromolecular composition of microbial bodies and metabolic products. Second, we are looking at how the metabolic capacity of the microbial community regulates the amount of C humifed and the stability of SOM products. This study uses ^{13}C-labeled microbial cells (whole killed + EPS) to monitor the uptake of microbial ^{13}C into the living microbial biomass and to delineate controls of C partitioning between CO_2 and humic materials. Our field incubation follows the fate of ^{13}C-labeled cells added to soils in a tropical forest (Luquillo Experimental Forest and LTER, PR) and in a temperate conifer forest (Blodgett Forest Research Station, CA). Soil ^{13}C substrate groups (Gram positive, Gram negative, Actinomycetes, Fungi) were reciprocally applied to each soil to compare the effect of the microbial metabolic capacity in two very different forests. We are tracking the fate of ^{13}C microbial litter for 3 years by measuring total recovery, utilization by indigenous microbial communities and incorporation into their biomarker components, and ultimately humification products (density fractionation). A laboratory incubation also follows the flow of C from the ^{13}C-labeled bodies as it is partitioned into CO_2 or humified C in soils from the Luquillo LTER, the Blodgett Research forest, and a CA coastal redwood forest. To understand the role of climate as it controls microbial community function and carbon cycling, each soil type has been incubated under native and non-native climatic regimes in a full factorial design. Carbon flow is being followed over 1 year by analyzing ^{13}C in total carbon, microbial biomass (phospholipid fatty acid analysis), CO_2, and humification products (density fractionation) to analyze the movement of ^{13}C into light, occluded and mineral associated humic fractions. Results show that microbial ^{13}C moved differentially in the tropical vs temperate soils. Movement of ^{13}C was significantly more rapid through the wet tropical forest soils than the temperate forest soils. Differences in microbial communities affect the uptake of microbial C into living biomass and interacted with climate conditions to control the partitioning of C to CO_2 versus organic components.

Keywords: PLFA, microbial bodies, C stabilization, climate, edaphic characteristics, tropical forests, temperate forests

Poster S3-P30

The effect of litter quality and mineral nitrogen on microbial functioning, residue decomposition and soil organic matter accumulation

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The accumulation of soil organic matter (SOM) is important for sustaining soil fertility while improving soil structure and increasing soil water-holding capacity[1]. To increase SOM content, one can amend soils with organic residues. The decision support system for organic residues (OR) divides OR into four quality classes based on the content of lignin, polyphenol and N, which are considered to be the most influential biotic factors controlling decomposition of OR[2]. However, the underlying mechanisms that regulate the magnitude, stability and duration of SOM increases following OR amendments are still poorly understood. Traditionally, it was thought that complex carbon compounds, such as lignin, were preferentially stabilized as soil organic carbon (SOC) by avoiding microbial decomposition[3]. A direct link was thus drawn between SOC quantity and quality and the quality of the OR applied. For example, low quality OR, characterized by high lignin and low N concentrations were thought to contribute more to the stable SOM than OR with high N and low lignin concentrations. This concept for SOM stabilization is currently used in SOC models[4]. Recent studies have shown, however, that microbial polysaccharides and cellular constituents (proteins, amino acids, peptides, chitin) have a longer residence time in soil than lignin, possibly due to preferential stabilization in fine soil fractions by organo-mineral interactions[5,6,7]. These studies suggest that carbon first passes through the microbial pool before being stabilized as SOM. Through the integration of microbial methods designed to target key physiological aspects of the microbial community, this study aims to elucidate the link between organic residue quality, N amendments, and the function of microbial communities in SOM stabilization.

We hypothesized that the quantity and quality of SOM would be a function of residue lability and the growth yield efficiency of the decomposer community. Soil samples were collected from a long-term field site in Embu, Kenya. The soil is a red, clayey Humic Nitisol dominated by Kaolinite. The following residue treatments, with and without the addition of mineral N (100 mg N kg^{-1} soil), were applied to 200 g soil at a rate of 3.65 g C kg^{-1} soil and incubated at 25°C for 180 days in a microcosm experiment: 1) Tithonia diversifolia leaves, 2) stems, 3) leaves + stems, 4) Zea mays, and 5) a no-input control. For each residue treatment, the concentration of lignin, hemicellulose, polyphenol, cellulose, nitrogen and glucose were measured as residue quality indicators. Furthermore, a glucose treatment was added to the incubation to test the effect of a very labile C source. Microbial community function was assessed through analysis of microbial growth yield efficiency (GYE) and respiration at five time points along the decomposition continuum. In the future, these analyses will be complimented by phospholipid fatty acid analysis, extracellular enzyme activity (α-glucosidase, β-glucosidase, cellobiohydrolase, xylanase, and L-leucine aminopeptidase), and the measurement of SOM quantity and quality at each time point.

During the initial stages of decomposition (15 days), the addition of mineral N concomitantly increased respiration and decreased GYE. In contrast, cellulose abundance was found to decrease respiration and increase GYE. Lignin, on the other hand, had no significant effect on respiration but decreased GYE when residues were applied in combination with mineral N. These results suggest that cellulose and mineral N amendment are more influential biotic factors controlling the stabilization of OR derived SOC compared to lignin. In conclusion, our results can help to improve existing SOC models and to develop alternative management practices that will maximize the quantity and stability of SOC, especially in highly weathered, infertile soils in sub-Saharan Africa.

References: [1] Craswell, E. and Lefroy, R. 2001. The role and function of organic matter in tropical soils. Nutrient Cycling in Agroecosystems 61: 7-18 ; [2] Palm, C.A., Gachengo, C.N., Delve, R.J., Cadisch, G., Giller, K.E. 2001. Organic inputs for soil fertility management in tropical agroecosystems: application of an organic resource database. Agriculture Ecosystems & Environment. 83: 27–42 ; [3] Stevenson, F. 1994 Humus Chemistry: Genesis, Composition, Reactions. John Wiley & Sons, New York. 496 p ; [4] Parton, W.J., D.S. Schimel, C.V. Cole, and D.S. Ojima. 1987. Analysis of factors controlling soil organic matter levels in Great Plains grasslands. Soil Science Society of America Journal 51:1173-1179 ; [5] Kiem, R., and I. Kogel-Knabner. 2003. Contribution of lignin and polysaccharides to the refractory carbon pool in C-depleted arable soils. Soil Biology & Biochemistry 35:101-118 ; [6] Gleixner, G., N. Poirier, R. Bol, and J. Balesdent. 2002. Molecular dynamics of organic matter in a cultivated soil. Organic Geochemistry 33:357-366 ; [7] Dignac, M.F., H. Bahri, C. Rumpel, D.P. Rasse, G. Bardoux, J. Balesdent, C. Girardin, C. Chenu, and A. Mariotti. 2005. Carbon-13 natural abundance as a tool to study the dynamics of lignin monomers in soil: an appraisal at the Closeaux experimental field (France). Geoderma 128:3-17.

Keywords: Soil organic matter; Organic residues; Extracellular enzyme activity, Growth Yield Efficiency; Phospholipid Fatty Acid Analysis; Incubation

Poster S3-P31

The influence of manure quality on some microbial populations and soluble organic carbon in soil

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Water soluble organic carbon (WSOC) accounts only for a small portion of the total organic carbon in soil. Nevertheless WSOC is considered the most mobile and reactive organic carbon fraction, thereby can control a number of physical, chemical and biological processes in both aquatic and terrestrial environments. An option for improving soil physical, chemical and biological properties and carbon sequestration is by increasing OC input through recycling of crop residues and organic manures. The objective of this study was to determine the influence of manure quality on some microbial populations and different forms of soluble OC in soil. A soil was sampled from the top 20-cm layer of an agricultural land in Hamadan, in northwest of Iran, which has a semiarid climate. The soil was treated with mild (d < 2 mm) poultry, cow and sheep manures (PM, CM and ShM), at a rate of 20 g kg^{-1} (dry weight basis) and incubated in field capacity and lab temperature conditions. After 1, 20, 60 and 120 days of incubation a portion of each soil were taken for analysis. Bacterial and fungal populations (BP and FP), water soluble OC (WSOC) and hot water soluble OC (HWSOC) were determined and statistically analyzed. Soil BP increased in all treatments in 1st day of incubation. It decreased continuously in CM and ShM treatments during soil incubation. However soil BP and also FP in PM treatment increased significantly in 20 days of incubation and decreased after that. Soil FP increased in CM and ShM treatments in 60 and 120 days of incubation respectively. Manure application increased soil WSOC and HWSOC significantly. However soil WSOC and HWSOC were relatively lower in PM treatment compared to CM and ShM treatments in 1st day of soil incubation. The decrease rates of soil WSOC and HWSOC in CM and ShM treatments compared to that in PM treatment were relatively higher in 20 days and 60 days of soil incubation respectively, may be related to the higher soil FP in PM treatment in 20 days of soil incubation. Finally soil WSOC and HWSOC in all treatments reached to those in control soil after 120 days of soil incubation.

References: Barbara, S., Fabrizio, A., 2009. Biodegradability of soil water soluble organic carbon extracted from seven different soils. J. Environ. Sci. 21: 641–646.

Cambardella, C.A., Elliott, E.T. 1992. Particulate organic matter changes across a grassland cultivation sequence. Soil Sci. Soc. Am. J. 56: 777–783.

Jones, D. L., Willen, V. B., 2006. Experimental evaluation of methods to quantify dissolved organic nitrogen (DON) and dissolved organic carbon (DOC) in soil. Soil Biol. Biochem, 38: 991–999.

Saggar, S., McIntosh, P.D., Hedley, C.B., Knicker, H., 1999. Changes in soil microbial biomass, metabolic quotient and organic matter turnover under Hieracium (*H. pilosella* L.). Biol. Fert. Soil. 30:232–238.

Schulz, E., Korschens, M., 1998. Characterization of the decomposable part of soil organic matter (SOM) and transformation processes by hot water extraction. Eurasian Soil Sci. 31:809–813.

Keywords: Manure quality, Soil microbial populations, Water soluble organic carbon, Soil incubation.

Poster S3-P32

The role of microbial diversity for the degradation of simple carbon substrates

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In order to gain insight into the relationship between microbial diversity and organic matter decomposition, we analysed the kinetics of degradation of different simple substrates in soil microcosms of reduced diversity. We studied three soils of very close geographical location, but with different land use. We achieved diversity reduction by a heat stress, resulting in a respiration boost signifying respiration of dead bacterial cells or newly available soil organic matter. In order to let the soils return to identical microbial biomass, we left the soils to stabilize until basal respiration of the stressed and unstressed soil pairs had returned to identical levels. Respiration was measured by online CO_2 / O_2 monitoring of soil subsamples. For several substrates (glucose, arginine, proline), the maximum respiration rate was higher in stressed soils compared to unstressed soils, and was also reached earlier. For few soils and substrates (para-aminobenzoic acid, chitin), stressed soils showed a longer lag time and slower maximum respiration rate. We hypothesize that the observed increase in respiration of simply degradable substrates is due to selection for r strategists during community regrowth after stress. In contrast, the number of species able to degrade more difficult substrates such as p-aminohydroxybenzoic acid or chitin might have been reduced during the heat stress. With respect to soil use, we note that grassland soil gives higher maximum respiration rates for several but not all substrates, when compared to forest soil and soil from an agricultural field.

Keywords: microbial diversity, substrate respiration kinetics, land use

Poster S3-P33

The soil organo-mineral interface composition as controlling factor for the microbial habitat

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The biogeochemical interfaces of soils are a dynamic and hierarchically organized system of various organic and inorganic constituents and organisms, the spatial structure of which defines a large, complex and heterogeneous interface. The formation of soil interfaces is controlled by the type of particle surfaces present and the assemblage of organic matter and mineral particles. Major solid phase constituents of soils are rock fragments, minerals like quartz, carbonates, clay minerals and the (hydr)oxides of iron, manganese and aluminium. Carbonaceous materials including charred organic carbon of biogenic origin (biochar) and, of course, the soil organic matter (SOM) are a second major ingredient of soils. These components are of different provenience, complexity and molecular size. Their arrangement during pedogenesis results in the spatial and temporal development of complex biogeochemical interfaces in soils.

The formation of interfaces is studied in batch incubation experiments with inoculated artificial soils consisting of model compounds. Thus eight artificial soil materials with increasing complexity of interfaces were created. The experiment used clay minerals, iron and aluminium oxides and charcoal as major model components controlling the formation of interfaces because they exhibit high surface area and microporosity. Soil interface characteristics are analyzed in relation to microbial community structure that developed after 6 months of incubation.. Already after 6 months of incubation, the different artificial soil materials show a large difference in C stabilization, although the amount of C substrate added as manure was similar for all soils. Microbial communities were followed by molecular fingerprints of ribosomal RNA gene fragments amplified from DNA directly extracted from soil samples taken at different time points. In the batch experiments, the different artificial soils were investigated by means of cultivation independent methods to evaluate the effects of clay minerals, iron oxides and charcoal on the bacterial and fungal community composition. Samples were taken at day 1, 9, 31 and 90. Soil-like bacterial communities' patterns could be already observed even at 9 days after inoculation. The bacterial communities reassembled in the two soils containing charcoal were found to be strikingly different from the other soils. Cluster analysis of DGGE profiles showed that separate clusters were always formed for those samples with charcoal. Effects of montmorillonite, illite and iron oxides on microbial communities could also clearly be observed at day 90. Bacterial communities of samples with montmorillonite differed from those of the corresponding samples with illite. Separated clusters for samples with iron oxides were also formed in betaproteobacterial and actinobacterial communities, but no clear difference was observed between ferrihydrite and aluminium hydroxide.

The results suggest that the minerals present during formation of biogeochemical interfaces, determine stabilization and quality of organic matter. Already after 6 months of incubation the artificial soils exhibited different properties like aggregation in relation to their composition. Major effects are observed for artificial soils formed in the presence of montmorillonite, ferrihydrite and charcoal. These differences in the organo-mineral interface formed are associated with specific microbial community structures. The presence of charcoal and different mineral composition had a clear effect on the development of the microbial community after only 3 months of incubation.

Keywords: microbial habitat, organo-mineral associations, interface, iron oxide, clay mineral, biochar

Poster S3-P34

Complex conductivity response to active phenanthrene biodegradation in soil

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The contamination of the subsurface soil by anthropogenic sources (waste, chemicals, fuel, etc.) represents a serious problem endangering both human health and the environment. Geochemical and microbiological studies demonstrated that indigenous microorganisms and microbial activity play a role in altering the physicochemical properties of hydrocarbon-contaminated sediments in different ways (Abdel Aal et al., 2006). Several laboratory studies have demonstrated the utility of geophysical methods (notably spectral induced polarization -SIP) for the investigation of microbial-induced changes in porous geologic media (Davis et al. 2006).

The objectives were to develop SIP to monitor biodegradation of organic contaminants, first in laboratory conditions then in situ (lysimeters of the GISFI experimental station, www.gisfi.fr). Three experiments were conducted in laboratory conditions. In the first one we measured the effect of bacterial growth and biofilm formation in liquid medium enriched in phenanthrene (PHE) on SIP. Results (significant correlations between phase shift decrease and biofilm quantity) suggest that complex conductivity measurements, specifically phase shift, were a useful indicator of bacterial biofilm formation inside the overall signal of microbial activity. Two column experiments were then conducted: -with phenanthrene spiked sand to compare two PAH-degrading bacterial strains, and -with soils contaminated or not by PAHs. A real time geophysical monitoring (SIP) was coupled with specific aspects of biodegradation (PAH analysis, microbial numbers). Results in sand columns confirmed the usefulness of SIP to monitor microbial degradation on phenanthrene-spiked medium. However, assays with soil columns contaminated or not by PAHs have nuanced the previous conclusion. Indeed, signal of microbial activity of degradation in soils were measured by SIP but it was masked by the overall signal of microbial activity. Thus, further studies are needed to improve the accuracy of measures and distinguish the different signals.

References:

Abdel Aal, G. Z., L. D. Slater, and E. A. Atekwana (2006), Induced-polarization measurements on unconsolidated sediments from a site of active hydrocarbon biodegradation, Geophysics, 71(2), H13-H24.

Davis, C. A., E. Atekwana, E. Atekwana, L. D. Slater, S. Rossbach, and M. R. Mormile (2006), Microbial growth and biofilm formation in geologic media is detected with complex conductivity measurements, Geophysical Research Letters, 33(18).

Keywords: complex conductivity; pahs; microbial activity

"Café des sciences": **Phil Sollins and Ingrid Kögel-Knabner :** ***Modeling SOM Dynamics: Pools or Particles?***

SOM stabilization and destabilization: mechanisms and model

Phillip Sollins

Mechanisms of soil organic matter stabilization and stabilization are becoming better understood. More specifically, sequential density fractionation has yielded a mix of directly useable information, some interesting and testable hypotheses, and several mysteries. Perhaps most mysterious is how so many soil particles can show an increase in calculated ^{14}C MRT with increasing density (across a range of densities from the lightest to about 2.5 g cm^{-3}) along with an increase in ^{15}N concentration and a decrease in C:N.

The problem is that the simplest explanation for the increasingly old ^{14}C dates is microbial degradation of the more labile organics, leaving behind the more recalcitrant forms. The increase in ^{15}N concentration, however, is most readily explained by continual reprocessing of the organics. The two patterns seem incompatible: it is unlikely that the organics can be processed by microbes without first desorbing from the mineral surfaces. But if this happens, then why are the sorbed organics not constantly diluted by ^{14}C-rich forms, thus lowering the measured ^{14}C MRT? Also mysterious are the densest particles, mainly primary minerals, which yield the oldest ^{14}C MRTs but quite low and highly variable ^{15}N concentrations.

Here I first propose a simple explanation for the above observations. Then, given at least a tentative explanation for these phenomena, I then develop a set of goals and assumptions that can form the basis for the first model of SOM dynamics that takes into account what is known and suspected about mechanisms of SOM stabilization and destabilization.

Keywords: SOM Stabilization and Destabilization Mechanisms, Model

Session 4 – TROPHIC NETWORKS AND ORGANIC MATTER DYNAMICS

Oral presentations – Session 4

Keynote lecture

Trophic interactions and soil organic matter dynamics

Richard D. Bardgett

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Trophic interactions, which involve the consumption of one organism by another, are a fundamental component of all ecosystems. In terrestrial ecosystems, most terrestrial plant biomass is either consumed by herbivores as live material, or it enters the dead organic matter pool, where it supports complex detritus-based food webs that determine the balance between carbon mineralization and sequestration. Moreover, herbivores themselves can alter the amount and quality of organic matter entering the dead organic matter pool, with far reaching consequences for the turnover and storage of carbon in soil. In this talk, I will illustrate the potential for trophic interactions to influence soil organic matter dynamics through two general routes: aboveground muti-trophic interactions, involving herbivores and their predators, which result in changes in plant community composition and productivity, and hence the input of carbon to soil; and, multi-trophic interactions within the detritus-based food web, which determine the decomposition of organic matter and hence the loss of carbon from soil. Finally, I will consider recent advances in our understanding of how plant-plant interactions, and especially changes in plant diversity, can influence soil microbial communities and the storage of carbon in soil.

Keywords: Trophic interactions and soil organic matter dynamics

Accelerated organic matter decomposition as a result of earthworms effect on soil microbial community

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Decomposition of organic matter in soil is microbially mediated. Since microbial functioning in soil is restricted by the lack of available nutrients and energy sources the most part of microbial community in soil remains dormant. The earthworms can activate soil microorganisms 1) directly changing the structure of soil microbial community; or 2) indirectly by the disturbance of soil structure which increases the availability of organic matter. The activation of soil microorganisms can strongly change the turnover of native soil organic matter (SOM), i.e. can cause priming effects (PE). The effects of earthworms on mineralization of SOM and plant residues during PE induced by the input of available organic substances remains unclear. Our study aimed to evaluate how the microbial community modified by earthworms alters the decomposition of SOM and ^{14}C-cellulose added to soil. Two-factorial experiment to assess the interactive effects of 1) earthworms *Aporrectodea caliginosa* and of 2) ^{14}C-uniformly labeled cellulose on soil organic matter mineralization was carried out during 30 days incubation. The following parameters were determined: 1) dynamics of CO_2 evolution; 2) $^{14}CO_2$ originated from the added cellulose; 3) microbial biomass C and ^{14}C by fumigation-extraction; 4) specific growth rates of microorganisms by the kinetics of substrate induced respiration and 5) activities of extracellular enzymes (β-glucosidase, chitinase, cellobiogidrolase and xylanase) with fluorogenically labeled substrates. The experimental design allowed us to distinguish the contribution of different microbial communities to priming-effects, i.e. soil microbial community activated by cellulose; earthworms and their own microbial community; soil microbial community changed by earthworms.

Maximal intensity of CO_2 and $^{14}CO_2$ efflux as well as of enzyme activities was observed between 5th and 15th days after cellulose application. Contribution of earthworms to total soil respiration (calculated as difference between CO_2 efflux from soil with and without earthworms) amounted up to 60%. Earthworms accelerated SOM decomposition for 50% while cellulose mineralization was accelerated by *A. caliginosa* for 15.8 % as compared to soil without earthworms. Increased activity of enzymes which release monomer units from polymeric chains (β-glucosidase for 32 % and chitinase for 19 %) was observed in the presence of earthworms in soil. However, strong decrease in activity of cellulolytic enzymes: xylanase (for 25 %) and especially of cellobiogidrolase (for 87 % !) was caused by *A. caliginosa* in 15 days after cellulose addition. The maximal specific growth rates of soil microorganisms were for 20 - 30 % lower in soil with application of earthworms as compared with worms-free soil.

No significant effects of earthworms on total microbial biomass C were observed. However, the changes in microbial growth kinetics as well as in enzyme activities prove the shift in microbial community structure to domination of slow growing K-strategists caused by earthworms. We conclude that earthworms strongly control soil microbial populations resulting in accelerated decomposition of both SOM and plant residues.

Keywords: Earthworms, Microbial community, Piming effect, Enzyme activities, Cellulose, Microbial growth strategies, Soil organic matter decomposition

Endogeic earthworms modify bacterial functional communities and affect the balance between priming effect and crop residues mineralization in a tropical agricultural soil.

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Priming effect is defined as a stimulation of the mineralization of soil organic matter due to fresh organic matter supply. This process is likely based on a competition between different microorganisms for the access to the "fresh" organic carbon and depends on the availability of soil nutrients. This poorly studied process can have important consequences on the fate of soil organic matter and on the management of residues or amendments in agricultural soils. The understanding of this process is thus of particular significance in southern countries where soil fertility is essentially based on the management of organic matter.

Earthworms are ecosystem engineers known to affect the dynamics of soil organic matter. Geophagous endogeic earthworms ingest large amounts of soil and assimilate a part of organic matter it contains. During gut transit, microorganisms are transported to new substrates and their activity is stimulated by (i) the production of limited amounts of readily-assimilable organic matter (earthworm mucus), and (ii) the possible presence of fresh organic residues in ingested soil. The objective of our study is to see (i) whether earthworms impact on the priming effect intensity when a fresh residue is added to the soil, and (ii) whether this impact is linked to a stimulation/inhibition of bacterial taxa.

To achieve this goal, a tropical soil from Madagascar was incubated in the laboratory, amended with a ^{13}C highly enriched, finely ground wheat residue, in the presence or absence of a peregrine endogeic tropical earthworm, *Pontoscolex corethrurus*. Emissions of $^{12}CO_2$ (respiration from the soil) and $^{13}CO_2$ (respiration from the residues) were followed during 24 days. The coupling between DNA-SIP (Stable Isotope Probing – separation between ^{12}C and ^{13}C labelled bacteria) and 16sRNA gene pyrosequencing (both on ^{12}C and ^{13}C labelled bacteria) on samples with or without earthworms was realized. Results showed that the activity of earthworms led to a stimulation of the mineralization of wheat residues, increased priming effect intensity and modified its dynamics. Several bacterial phylogenetic groups stimulated by earthworms were identified, some of taxa feeding on fresh residues and others on soil organic carbon.

Keywords: Organic matter, Pontoscolex corethrurus, Bacteroidetes, DNA-SIP, pyrosequencing, Madagascar

Posters – Session 4

Poster S4-P1

A comparison of the size and structure of the microbial and free-living nematode communities between organically and conventionally managed soils

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Research from long-term field trials suggests organic agriculture is characterised by a more diverse and abundant soil biota. A survey of organically and conventionally cultivated soils was undertaken in order to compare the size and structure of the microbial and free-living nematode community, and how both of these relate to more commonly determined soil physico-chemical variables. Soils of similar texture and supporting the same crop (leek, *Allium porrum*) were selected, and were sampled in early spring to minimise the over-riding effects of recent ploughing and fertilisation operations. Soil organic carbon was significantly higher in organic fields and resulted in a significantly lower bulk density.

Soil free-living nematodes have been recognised as useful indicators of soil conditions, being ubiquitous, abundant and present at several trophic levels in the soil food web. The abundance of nematodes was significantly greater in organic fields and was correlated with organic carbon; however the composition of the nematode community did not reflect important differences in management. A residual effect of compost addition in organic fields was suggested by a generally greater Channel Index, indicating a more fungal-mediated decomposition pathway.

Microbial biomass C was determined using the fumigation-extraction method and gave altogether low but also variable values, and was not significantly greater in organic fields. The structure of the microbial community was investigated using phospholipid fatty acid (PLFA) profiling, a technique that allows the quantification of the relative contributions of the main microbial groups. Organically managed fields were differentiated from their conventional counterparts through the higher concentration of most microbial biomarkers, although this was mainly due to the influence of organic carbon content in the soils. The ratio of bacterial to fungal biomarkers did not agree with the nematode community indicators of the relative importance of fungal and bacterial decomposition pathways.

Despite intentional sampling to reduce differences in soil texture between fields, a significantly lower clay content was found for the organic fields sampled, which also resulted in a lower pH, and is likely to have had a strong influence on the nature of the soil biotic communities.

Keywords: organic agriculture, microbial community structure, nematodes, PLFAs

Poster S4-P2

Measuring $^{13}CO_2$ uptake by soil microorganisms

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The sequestration of CO_2 via biological sinks in the environment is a matter of great scientific importance and therefore interest. The contribution of CO_2 uptake via soil dwelling chemoautotrophic bacteria may be either a negligible anomaly or its impacts on the carbon cycle and soil organic matter is greatly underestimated. In this study a custom built incubation chamber was used to cultivate a mixed soil microbial community in an attempt to prepare a methodology whereupon soil chemoautotrophy may be investigated. The internal atmospheric CO_2 concentrations were tracked and used to estimate the mass of CO_2 uptake. It was found after careful background corrections that 27.26 mg CO_2 kg^{-1} dry soil was removed from the chamber atmosphere over a 16 hour period. Comparisons were made to photosynthetic controls such as grass and soil algae whereupon it was observed that the chemoautotrophic fraction sequestered 0.6% of the uptake capacity of the soil algae. Using isotopic $^{13}CO_2$ and GCMS-IRMS it was also possible to extract and identify several labeled lipids after a short incubation time, hence confirming the CO_2 harvesting potential of the microcosm. Analysis of the lipid content determined that some compounds achieved a maximum ^{13}C enrichment of 91%. The extraction of DNA from soil samples was then subjected to DNA-SIP to isolate the organism responsible for CO_2 sequestration, followed by DGGE to identify the species to the genus level. The study has conclusively shown that chemoautotrophic conditions were manifested within the soil microcosm and successful isotopic enrichment of soil organic matter has been achieved. The method development approach has provided the means to produce and extract ^{13}C-labelled material on-demand while also demonstrating the capabilities of the incubation chamber.

Keywords: carbon uptake, soil microorganisms, soil organic matter, lipids, enrichment, DNA-SIP.

Poster S4-P3

The timing of browsing by large herbivores in naturally regenerating birch forest influences indirect feedbacks on soil respiration

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The understanding of plant-soil carbon fluxes, and the variables and processes that drive and constrain them, is a key current research interest in soil ecology. Browsing is ubiquitous in forest ecosystems and has been shown to have substantial effects on processes that control ecosystem functioning, by altering the quantity and quality of organic matter, plant carbon dynamics, fine root turnover and the flow of exudates from the roots. Soil respiration is driven by belowground carbon allocation by plants and allocation differs with season. Recent research demonstrates that belowground allocation is far greater during the late season (August) than in the early season (June). We hypothesized that the effects of browsing on naturally regenerating *Betula pubescens* will influence belowground microbial communities and therefore soil respiration, and that the timing of browsing will influence this response.

The HIBECO experiment in the Scottish Highlands was established in August 2000 to study above ground effects of the timing of browsing. 66% of new growth is clipped to simulate browsing during budburst (B), late summer (LS) and dormancy (D). This study began sampling in-situ CO_2 flux and soil properties after 8 years of simulated browsing. We measured soil microbial biomass and community composition (as PLFA), soil organic matter content, total soil carbon and nitrogen, nutrient availability and nitrogen mineralisation.

Long term browsing treatments have negatively affected sapling growth, most severely impacting the LS treatment. However the results of the CO_2 flux sampling showed a positive feedback on soil respiration for the LS clip during the autumn sampling in both 2008 and 2009, but not for B or D clips. It is remarkable and unique that we could detect a significant response of respiration against the background variation of this heather dominated system when compared to other browsed/unbrowsed studies.

Preliminary analysis of soil properties suggests that there was no increase in microbial biomass, which was supported by PLFA analysis. However a decrease in the bacterial to fungal ratio of PLFA concentrations for LS treatments indicates an increase in the relative importance of the fungal-based energy channel to the bacterial-based energy channel. Additionally analysis of the diversity of microbial PLFA concentrations suggests a shift in the microbial community structure, with a reduction of microbial diversity in LS treatments. This may indicate promotion of microflora that, for example have lower carbon use efficiency and could explain observed rates of soil respiration. We also observed increased inorganic nitrogen availability and potential rates of mineralisation in spring suggesting that there is an effect of the LS treatment on soil processes throughout a growing season.

We have demonstrated that the timing of browsing to be crucial when considering multitrophic interactions on forest carbon cycling, which has wider implications for forest carbon management.

References: Ayres E., Heath J., Possell M., Black H.I.J., Kerstiens G. & Bardgett R.D. (2004) Tree physiological responses to above-ground herbivory directly modify below-ground processes of soil carbon and nitrogen cycling. *Ecology Letters*, 7, 469-479

Bardgett R.D. & Wardle D.A. (2003) Herbivore-mediated linkages between aboveground and belowground communities *Ecology*, 84, 2258-2268

Högberg M.N., Briones M.J.I., Keel S.G., Metcalfe D.B., Campbell C., Midwood A.J., Thornton B., Hurry V., Linder S., Näsholm T., Högberg P. (2010) Quantification of effects of season and nitrogen supply on tree below-ground carbon transfer to ectomycorrhizal fungi and other soil organisms in a boreal pine forest. *New Phytologist*, In Press

Staddon P.L. (2004) Carbon isotopes in functional soil ecology. *Trends in Ecology & Evolution*, 19, 148-154

Wardle D.A., Yeates G.W., Williamson W. & Bonner K.I. (2003)The response of a three trophic level soil food web to the identity and diversity of plant species and functional groups. *OIKOS*, 102, 45-56.

Keywords: Carbon Cycling, Browsing, Microbial Community Structure, Soil respiration

Session 5 – IMPACT OF CHANGING ENVIRONMENTAL CONTROLS ON SOM DYNAMICS

Oral presentations – Session 5

Keynote lecture

Soil organic carbon turnover in a changing world

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Global changes in climate and atmospheric chemistry will influence soil carbon cycling in myriad ways. This presentation will consider these myriad pathways of influence, how they are represented in current ecosystem models, and considerations for a research agenda to improve predictions of soil response to global change factors.

Our understanding of how soil organic matter is stabilized informs how we think about and model vulnerabilty to environmental change. In many disciplines, conceptions of SOC cycling and its expression in mathematical models rest heavily on the concept of recalcitrance – that some organic structures are intrinsically inert. However, a wide array of research, using isotopic, spectroscopic, and molecular marker tools finds little evidence that selective preservation of plant derived material or of resynthesis products determines the long residence time of organic carbon in soil. Even the decomposition rates of fire-derived organic material depend on the soil environment, and it can degrade more quickly than other pools of organic matter in some soils. Thus, intrinsic chemical recalcitrance can no longer be considered a dominant control for long-term organic matter preservation.

Much more likely is that rates of carbon cycling are determined by the *interaction* of the organic matter and the soil environment including microorganisms, mineralogy, climate, and so on. This does not mean compound chemistry is not important, rather it means it is not important for creating a universal recalcitrance but is very important for determining the potential for stabilization (e.g., tendency to form stable bonds with mineral interfaces) and of the requirements for decomposition (e.g., oxygen requirements to degrade lignin). This understanding is well expressed in recent papers on, for example, physical stabilization, organic carbon-mineral interactions, and the role of microbial by- products in stabilization.

The next step, then, is to consider how these pathways of stabilization affect vulnerability to global change. Changes in plant productivity and root depth alter the input of high energy substrates to the subsoil, which has been shown to be important for priming decomposition of subsoil organic matter. Molecular tools show that nitrogen deposition alters microbial communities, the enzymes expressed, and the byproducts produced. Perhaps least well understood is how predicted changes in soil temperature and moisture will interact with physical and mineralogical modes of stabilization, and thus the vulnerability of very old or deep soil organic matter.

Without the foundational principle that chemical composition defines the rate of decomposition, many tenets of old models are not supported, for example regarding decomposition response to change in temperature or plant species composition. At the same time, the demands on models have expanded to include interest in long time spans and the whole soil profile. Given these new demands and new results, current models may not be adequate. There is a need to develop numerical models that include the pathways and mechanisms that are (1) important for stabilization and destabilization and (2) likely to be affected by global change. These models need to be able to be run globally and yet be testable in point mode against observations.

Much progress could be made in the near term to improve soil carbon models by, for example, improving representations of oxygen diffusion and limitation, root carbon inputs, isotopic tracers, and making depth- or transport-related processes explicit. In other areas, new research is needed to translate recent findings into new parameters, for example, to replace texture with parameters for reactive mineral surface area to represent organo-mineral interaction. Likewise, solubility and other properties of molecular moieties should be investigated to create parameterizations that may better predict response to future change. Furthermore, much is not known a structural level, for example, about the interaction of warming with altered moisture regimes, the importance of priming by new plant inputs, or the resolution at which microbial genomics and gene expression must be represented. For these and other knowledge gaps, a new generation of soil experiments are needed to generate understanding of long-term, whole-profile processes that will govern SOC dynamics in a dynamic world.

Keywords: Prediction, models, feedbacks, Climate change and global change, soil organic carbon

Soil C dynamics and its temperature sensitivity along management-induced SOM gradient: Nature of Q10-substrate quality relationship

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Better understanding of SOM stabilization and destabilization process, in particular, its sensitivity to warming is critical to improve currently-used SOM models. Soil incubation literature suggests that temperature sensitivity of soil C degradation (Q_{10}) is linked to substrate quality (e.g., recalcitrance) in accord with Arrhenius kinetic theory. However, it is unclear which substrate quality indices are adequate and to what extent substrate quality controls Q_{10} among field soils. Here, we compared SOM dynamics using four volcanic-ash soils of the same mineralogy but with contrasting SOM levels to elucidate the factors controlling Q_{10}. Laboratory incubation (30 day) was done at 15, 25, and 35oC. Microbial biomass was measured before and after the incubations. Measures of substrate quality included structural information of C (by ^{13}C-NMR) in bulk soil and lower-density fractions. One soil was from a soybean/wheat rotation plot under no-tillage and annual leaf-manure addition for the last three decades and contained 15% TOC (0-5 cm) and 8% TOC (5-20 cm depth), representing a maxima (NT). Two other soils were tilled, received no manure, and contained 5.1% and 4.2% TOC (Till-1, 2). The last soil was kept bare for the last five years and had 3.8% C (Bare), representing a minimum C level for this soil type at surface environment.

With 4-fold increase in TOC from Bare soil to NT soil, microbial biomass C and substrate quality indicies (soil C:N, respiration potential, C-normalized respiration potential, and OC in low-density fraction) linearly increased. In contrast, Q_{10} of the respiration had non-linear response. Despite 3-fold change in TOC from NT to Till-1, these OM-rich samples had surprisingly constant Q_{10} of 2.2-2.3 while the other OM-poor soils (Till-2, Bare) had the Q_{10} of 2.9-3.0. The variation in Q_{10} had no correlation with above-mentioned substrate quality indicies or aromaticity (aromatic-C/O-alkyl-C ratio) of bulk soil C. However, the soils with significantly higher Q_{10} (Till-2, Bare) had (i) higher C:N and aromaticity in low-density fraction (< 1.6 g/cc) which consists of plant detritus, and (ii) lower respiration rate per microbial biomass C, compared to the OM-rich, low Q_{10} soils. These results suggest that (i) the low-density fraction represents most accessible and thus active C pool and (ii) aromaticity of the fraction is a useful measure of substrate quality, controlling both the status of microbial population and Q_{10} of respiration. Our results imply non-linear nature of O_{10}-SOM relationship. OM degradation in low-density fraction beyond a certain level likely leads to strong increase in Q_{10} while OM accretion above the level has little impact. The validity of the non-linear relationship to other soils needs to be tested in future work.

Keywords: management effect, substrate quality, density fractionation, ^{13}C-NMR, non-linear response, SOM accretion gradient

Changes in forest soil organic matter pools after a decade of elevated CO_2 and O_3 fumigation

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The impact of rising atmospheric carbon dioxide (CO_2) may be mitigated, in part, by enhanced rates of net primary production and greater C storage in plant biomass and soil organic matter. However, C sequestration in soils may be offset by other environmental changes such as increasing tropospheric ozone (O_3) or vary based on species-specific responses to elevated CO_2. To understand how projected increases in atmospheric CO_2 and O_3 alter the formation of soil organic matter (SOM), we used physical fractionation to characterize soil C and N pools at the Rhinelander Free Air CO_2–O_3 Enrichment (FACE) experiment. Tracer amounts of $^{15}NH_4^+$ were applied to the forest floor of developing *Populus tremuloides*, *P. tremuloides-Betula papyrifera* and *P. tremuloides-Acer saccharum* communities during exposure to factorial CO_2 and O_3 treatments, and the isotope was traced into SOM particle size fractions over four years. The CO_2 used for CO_2 enrichment was strongly depleted in ^{13}C and was used to study C dynamics in SOM based the ^{13}C signature of SOM fractions. Over time, elevated atmospheric CO_2 induced a steady increase in both the C and N stocks of coarse particulate organic matter (cPOM) and a decrease in the C and N stocks of mineral-associated organic matter (MAOM), relative to ambient CO_2. Elevated CO_2 caused a 28% increase in the ^{15}N recovered in the cPOM; however, as main effects, neither CO_2 nor O_3 significantly altered the amount of ^{15}N recovered in SOM fractions. Under elevated CO_2, new C significantly increased in cPOM and fine POM (fPOM) over the duration of our study, while old C significantly decreased in fPOM and MAOM. Overall, in the bulk soil, old C stocks decreased while new C stocks increased, resulting in no net change in soil C storage under elevated CO_2. Together, these data suggest that elevated CO_2 has altered SOM cycling at this site to favor accumulation of C and N in less stable pools, with more rapid C and N turnover in MAOM. Elevated O_3 had the opposite effect on cPOM, significantly reducing the N stocks by 15% and significantly increasing the C:N ratio by 7%. Our results demonstrate that CO_2 can enhance SOM turnover and potentially limit long-term C sequestration in terrestrial ecosystems.

Keywords: soil C sequestration, soil nitrogen, physical fractionation, ^{15}N, stable isotope, elevated O_3, elevated CO_2, FACE experiment, POM

Soil organic and inorganic C dynamics under two contrasting rewetting frequencies: an annual experiment in ^{14}C-labelled mesocosms

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IPCC models predict atmospheric mean temperature to increase as well as a modification of the global hydrologic cycles. Reductions of rainfall events have been already observed in tropical, subtropical and Mediterranean regions (IPCC 2007), predicting even more drought periods in the future for those areas. These changeable environmental conditions may involve profound effects on soil organic C dynamics in arid and semiarid regions, where microbial degradation is often limited by moisture. Moreover, increased drought could also affect soil inorganic C pool (which accounts for 1/3 of the global C stored in soils), but its much lower turnover normally makes it difficult to ascertain. Although impacts of temperature and water regime on SOM have been extensively measured in the short term, the long-term effects of rainfall event reduction and their interactions with soil depth are yet poorly understood. This study aimed to test the influence of these effects on the annual CO_2 efflux (soil microbial respiration) and on the evolution of the different soil organic C fractions, quantifying at the same time their relation with the inorganic C pool.

In this experiment, we field-incubated a soil obtained from a Mediterranean agricultural plot (2.4 % C_{ORG}, 38.1 % $CaCO_3$) into a set of PVC columns (12-cm diameter, 18-cm height) filled with sandy loam mineral subsoil (0.1 % C_{ORG}, 0 % $CaCO_3$). Each PVC column contained a homogeneous 4-cm layer (560 g) of the agricultural soil, which had been previously sieved (2 mm) and mixed with 0.235 g of ^{14}C-labelled wheat straw. Soil layers were placed at two different depths (0-4 or 10-14 cm, one per column), and PVC columns were buried and subjected to two different rewetting frequencies throughout one-year incubation period. Half of the columns (IRG) were subjected to continuous drying-rewetting cycles (35-45 days each), whereas the other half part (DRO columns) received only 1/3 of the irrigation events. Total and ^{14}C-labelled CO_2 effluxes from the agricultural soil layers were determined daily during the incubation period (alkali traps and scintillation). Destructive samplings were performed four times along the year, in which a set of columns (3 per experimental condition) were removed, without reposition, for determining the C dynamics of the agricultural soil layers. Soil subsamples were finely ground and analyzed for total and ^{14}C-labelled organic (C_{ORG}) and inorganic carbon (C_{INORG}), following a new protocol for the quantification of labelled C in both C_{ORG} and C_{INORG} substrates. Extractable (EOC) and microbial organic C (total and ^{14}C) were also estimated, using the fumigation-extraction procedure.

Preliminary results indicate that DRO soil layers reduced their annual loss of C-CO_2 around 30-35 % (for both depths), whereas ^{14}C-CO_2 respiration (from the labelled fresh straw) decreased around 25 % compared with their IRG counterparts. However, the CO_2 flushes (i.e. the microbial respiration peaks associated with soil rewetting) were considerably higher in DRO soil layers, thus partially counteracting their longer drought (= low-respiration) periods. Indeed, towards the end of the incubation, DRO soil respiration was equivalent to that from the IRG layers. Total and ^{14}C-labelled EOC showed a different evolution along the incubation period, and their dynamics were also determined by soil depth and irrigation frequency. Neither EOC nor the amount of microbial C were related to CO_2 effluxes. Although no signs of C_{INORG} evolution were observed, labelled C derived from straw respiration entered rapidly into the soil inorganic C pool (around 40 µg ^{14}C/g C-CO_3 just after the first rewetting). Moreover, inorganic ^{14}C evolution appeared to be faster than expected and was significantly affected by rewetting frequency and soil depth, suggesting the presence of a small fraction of inorganic C sensitive to CO_2 flushes.

Keywords: Rewetting frequency, soil depth, mesocosm experiment, ^{14}C-labelling, microbial respiration, CO_2 flush, SOC dynamics, extractable C, inorganic C

Soil organic matter responses to chronic nitrogen additions in a temperate forest

Kate Lajtha

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The Chronic Nitrogen Addition Experiment at Harvard Forest in central Massacusetts, USA was established in 1988 to investigate the effects of increasing anthropogenic atmospheric N deposition on forests in the eastern United States. Located in an old red pine plantation and a mixed hardwood forest, the treated plots have received 50 and 150 kg N ha^{-1} yr^{-1} as NH_4NO_3 in six equal monthly applications during the growing season each year since the start of the experiment. Additionally, the control and low N treatments were given a single pulse label of $^{15}NO_3$ and $^{15}NH_4$ in 1991 and 1992. Regular measurements have been made over the past 20 years to assess woody biomass production and mortality, foliar chemistry, litter fall, and soil N dynamics. Less frequent measurements of soil C pools, soil respiration, fine root dynamics, and microbial biomass and community structure have been made. For the 20th anniversary, an intensive sampling campaign was carried out in fall 2008 with a focus on evaluating how the long-term N additions have impacted ecosystem C storage and N dynamics. Our primary objective was to assess the amount of C and N stored in wood, foliage, litter, roots, and soil (to a depth of ~50 cm). We also wanted to examine the fate of N by comparing patterns of ^{15}N recovery to those observed previously. An additional objective was to further examine how chronic N additions impact microbial biomass, activity and community structure. Results indicate that chronic N additions over the past 20 years have increased forest floor mass and soil organic matter across the soil profile; decreased microbial biomass, especially the fungal component; and altered microbial community composition (i.e., significantly lower fungal:bacterial biomass ratios in the N amended plots). N15 tracer recoveries in soils and forest floors were much higher than in tree biomass, ranging from 49 to 101% of additions across forest types and N addition rates. Stoichiometric analyses of these recoveries suggest that N additions are contributing to soil C accumulation to a greater extent than to biomass accumulation in these forests.

Keywords: Nitrogen deposition; carbon storage; soil organic matter

Interaction of carbonates and fresh organic matter in macroaggregate dynamics and organic matter stabilization in carbonate-rich Mediterranean soils

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The presence of carbonates in many soils in semi-arid land can influence aggregates dynamics and soil organic matter stabilization (Baldock & Skjemstad, 2000; Bronick & Lal, 2005). The effect of carbonates on aggregation and organic matter stabilization has been however mostly studied in non-calcareous soils amended with carbonates (Muneer and Oades, 1989; Grünewald et al., 2006), which also implies altering the original soil properties such as pH, microbial activity and organic matter turnover. Our objective was to study the effect of naturally-occurring carbonates on soil aggregation and its influence on organic matter stabilization in carbonated soils. We hypothesized that, as a source of calcium, carbonates would enhance microaggregation and organic matter protection within microaggregates, resulting also in an increased amount of water-stable macroaggregates. That for, the fraction < 250 µm of a carbonated Typic Calcixerept and a non-carbonated Typic Haploxerept from the Mediterranean semi-arid Ebro Valley in NE Spain were incubated with and without maize straw addition. The two soils were similar in organic matter content, clay mineralogy and had undergone equal agricultural management for the last two decades. Incubated samples from both soils were fractionated at days 21, 42, 63, 84 and 105, to isolate macroaggregates (Magg), microaggregates (magg) and the silt+clay (s+c) fraction. Macroaggregates and maggs were furhter dispersed to isolate coarse POM (c-POM), magg within Magg (mMagg), the intra-Magg and intra-magg silt+clay fractions (M(s+c) and m(s+c)), and intra and inter-magg particulate organic matter (intra-mPOM and inter-mPOM, Six et al. (2002)). All fractions were analyzed for organic C content. As expected, the mass percentages of Magg and mMagg were greater in the carbonated soil than in the non-carbonated soil, when maize straw was not added. Maize straw addition in the carbonated soil resulted in greater stable Magg than straw addition in the non-carbonated soil and the effect of carbonates alone (with no straw added). Moreover, the amount of Magg in the carbonated soil with straw addition was almost constant all along the incubation period, while Magg recovered without straw addition was greater at day 21 and decreased thereafter. These results indicate that an interaction between carbonates and fresh organic matter, resulting in enhanced macroaggregation, exists in the carbonated soil. The percentage of mMagg was greater and constant all along the incubation in the carbonated soil compared to the non-carbonated soil. No effect of straw addition was observed in this percentage in any of the two soils. Therefore, carbonates, rather than fresh organic matter addition, promote water-stable magg formation in carbonate-rich soils. The organic C concentration of Magg and mMagg was lower in the carbonated soil than in the non-carbonated soil, and remained almost constant in time, regardless of straw addition. In the non-carbonated soil, organic C content in these fractions increased until day 84 and decreased at day 105, with no effect of straw addition. The total organic C stock in the Magg fraction was similar in the carbonated soil and the non-carbonated soil, and increased with maize straw addition in the two soils, but its distribution in the different fractions within Magg differed between the two soils. In the carbonated soil, it was mainly stored in the mMagg fraction, while in the non-carbonated soil it was mainly found in the cPOM fraction. Data suggest that the presence of carbonates in the soil did not stimulate organic C accumulation within macroaggregates; however, organic C was stabilized by different mechanisms in the two soils. We conclude that the presence of carbonates and its interaction with fresh organic matter promotes soil macroaggregation and favours a longer turnover of organic C by protection within mMagg rather than in labile forms (i.e. cPOM).

References: Baldock, J.A., Skjemstad, J.O., 2000. Role of the soil matrix and minerals in protecting natural organic materials against biological attack. Organic Geochemistry 31, 697-710 ; Bronick, C.J., Lal, R., 2005. Soil structure and management: a review. Geoderma 124, 3-22 ; Grünewald, G., Kaiser, K., Jahn, R., Guggenberger, G., 2006. Organic matter stabilization in young calcareous soils as revealed by density fractionation and analysis of lignin-derived constituents. Organic Geochemistry 37, 1573-1589 ; Muneer, M., Oades, J.M., 1989. The role of Ca-organic interactions in soil aggregate stability.I. Laboratory studies with 14C-glucose, $CaCO_3$ and $CaSO_4.2H_20$. Australian Journal of Soil Research 27, 389-399 ; Six, J., Callewaert, P., Lenders, S., De Gryze, S., Morris, S.J., Gregorich, E.G., Paul, E.A., Paustian, K. 2002.Measuring and Understanding Carbon Storge in Afforested Soils by Physical Fractionation. Soil Science Society of America Journal 66, 1981-1987.

Keywords: Mediterranean soils, semi-arid land, carbonates, organic matter

Depressing decompostion of organic amendments in soil facilitated by oxyhydrate coating

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Chemical protection via binding to ferric oxyhydrates had been recognized as an key process of organic matter accumulation in rice paddies in China's soils. In this study, we further tested the hypothesis if ferric coating could facilitate the C protection from decomposition using aerobic lab incubation and landfill observation of oxyhydrate-coated organic amendments. The organic amendments used were sewage sludge, pig manure, straw pellets and granualated organic fertilizer. These material were air-dried, ground to pass a 60 mesh sieve, and coated with Fe(OH)3 by spraying the colloid at 0.2 mol L^{-1}. After granualation in moist condition, the amendment pellets (3mm in diameter) were aged in room temperature for 2 weeks. Lab incubation was done using 5 g of amendment in a sealed bottle of 125mL caped with two tuflon tube. The decomposition of organic amendments under incubation was measured with the CO_2 production in the bottle in 3 days interval. The field observation of decomposition of the amendments was performed using about 300g in a nylon bag with grid size of 300 mesh, and buried at 5cm depth of a rice paddy in moist condition. The decompostion was measured with the changes in C concentration and weight after 30days of lay-out. The results showed that ferric oxide coating treatment significantly depressed C mineralization of organic materials at a single time interval of aerobic incubation as the cumulative production of CO_2 from decomposition of organic amendment materials was significantly reduced for the early incubation period of 23 days, from 1.93, 5.3, 5.3 and 0.79 g CO_2-C kg^{-1} (OC) to 0.12, 1.53, 1.47 and 0.50g CO_2-C kg^{-1} (OC) for amendments from rice straw pellets, pig manure, sewage sludge and organic fertilizer respectively, being most intense for rice straw. Under the field burial condition, however, the residue organic carbon in the decomposed material from rice straw, pig manure and sewage sludge, after decomposition 30, 60 and 90 days was distinctively high with treatment of oxyhydrate coating as compared to without coating though not significant for organic fertilizer. The depressing extent of OC decomposition rate of all types of organic amendments during the whole 90 days under field burial was estimated to reduce with oxyhydrate coating at over 30%, with biggest for rice straw pellets. Both experiments of aerobic lab incubation and field burial indicated a distinct effect of oxyhydrate coating on depressing the C mineralization, thus, stabilizing organic matter amended in the soils. This present study again supported our previous finding of chemical protection of SOM in rice paddies, which would play an key role in SOM accumulation under good managements..

References:

Cheng W, Yagi K, Akiyama H, et al. An empirical model of soil chemical properties that regulate methane production in Japanese rice paddy soils[J]. *Journal of Environ. Qual.*, 2007, 36: 1920-1925.

Furukawa Y, Inubushi K. Effect of application of Fe materials on methane and nitrous oxide emissions from two types of paddy soils[J]. *Soil Sci. Plant Nutr.*, 2004, 50: 917-924.

Furukawa Y, Inubushi K. Feasible suppression technique of methane emission from paddy soil by Fe amendment[J]. *Nutr. Cycl. Agroecosys.*, 2002, 64: 193-201.

Huang B, Yu K W, Gambrell R P. Effects of ferric iron reduction and regeneration on nitrous oxide and methane emissions in a rice soil[J]. *Chemosphere*, 2009, 74: 481-486.

Jäckel U, Russo S, Schnell S. Enhanced Fe reduction by Fe supplement: a strategy to reduce methane emission from paddies[J]. *Soil Biol. Biochem.*, 2005, 37: 2150-2154.

Watanabe A, Kimura M. Influence of chemical properties of soils on methane emission from rice paddies[J]. *Commun. Soil Sci. Plant Anal.*, 1999, 30: 2449-2463.

Keywords: organic matter stabilization; oxyhydrate coating; aerobic C mineralization; organic amendments; rice paddy

Characterizing organomineral complexes in surface and subsurface horizons of an acid loamy soil using sequential density fractionation

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One of the major difficulties in understanding and predicting soil organic matter (SOM) dynamics originates from the comprehension of interaction mechanisms between SOM and minerals surfaces (Kögel-Knabner et al. 2008). Recently, Kleber et al. (2007) suggested a conceptual model of organomineral association, in which sorption of SOM at the molecular scale would be organized in three distinct zones with specific organic compounds and turnover times.

Our objectives were (i) to quantify organomineral complexes in surface and subsurface soil organic carbon (SOC) pools, and (ii) to characterize the structure and the mechanisms of these associations in surface and subsurface SOC pools.

The soil studied was an acid loamy soil (Vermic Haplumbrepts) sampled under natural pine (*Pinus pinaster*) forest (Arrouays et al. 1992). Soil samples were taken from surface (0-30 cm, 50 mgC.g^{-1} of soil) and subsurface (30-50 cm, 30 mgC.g^{-1} of soil) horizons. SOC pools and organomineral complexes were isolated using a sequential density fractionation method (Basile-Doelsch et al., 2007). Organomineral complexes were characterized by XRD, ^{13}C-RMN, δ^{13}C and SEM imaging.

We measured that the amount of SOC firmly associated with the mineral phase was equivalent for surface and subsurface horizons (i.e. 10 mgC.g^{-1} of soil). Our results showed that, whatever the horizon, organomineral complexes formed by chlorite and kaolinite, could stabilize up to 200 mgC.g^{-1}. Isotopic characterization showed a d^{13}C enrichment with increasing density of organomineral association (+ 1,7‰ in surface and + 0,9‰ in subsurface horizons). We hypothesized that the observed δ^{13}C enrichment was the result of the influence of microbial residues in interaction processes. At a nanometric scale (SEM observations), the mechanisms that control organomineral complexes organization seemed to be similar whatever the density fraction.

We concluded that, in the studied soil, processes that link firmly organic matters to minerals are likely controlled by the same mechanisms in surface and in deep soil. However, in the deeper horizon, relative amount of SOC stabilized by organomineral complexation is greater than in surface horizon.

References: Arrouays, D., Baize, D.& Hardy, M. 1992. Les sols de touyas issus d'alluvions anciennes des gaves pyrénéens : Varacrisols. Intégration au Référentiel Pédologique. Science du sol, 157, 227-247.

Basile-Doelsch, I., Amundson, R., Stone, W.E.E., Borschneck, D., Bottero, J.Y., Moustier, S., Masin, F. & Colin, F. 2007a. Mineral control of carbon pools in a volcanic soil horizon. Geoderma, 137, 477-489.

Kleber M., Sollins P., Sutton R. 2007. A conceptual model of organo-mineral interactions in soils: self-assembly of molecular fragments into multilayered structures on mineral surfaces. Biogeochemistery 85:9-24.

Kögel-Knabner I., Guggenberger G., Kleber M., Kandeler K., Kalbitz K., Scheu S., Eusterhues K, Leinweber P., 2008. Organo-mineral association in temperate soils : integrating biology, mineralogy and organic matter chemistery. J Plant Nutr Soil Sci 171:61-82.

Keywords: Organic carbon stabilization, carbon storage, deeper horizon, temperate soil

Scaling from density fractions up to the pedon: Organic matter chemistry across sequential density fractions from two contrasting Oxisol soil depth profiles

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Changes in the chemical composition of organic matter (OM) across sequentially denser mineral fractions were examined for two contrasting Oxisol soil depth profiles. We used a sequential density fractionation technique[1] to examine C and N content and stable isotope composition (^{15}N, ^{13}C),^{14}C, mineral specific surface area, and oxalate-extractable Fe, Al and Si of sequentially deeper and denser soil fractions. For each depth sample, we collected six 10 cm soil cores--two from each of three soil profile walls in the pit. Four density fractions per soil depth for 7 depths (a depth to 10 cm for the first two mineral samples, then in 20 cm intervals thereafter) were examined up to 1.2 m within the soil profile. The overall soil depth profiles revealed a trend of both decreasing C/N values and C content, a soil depth profile pattern observed across a wide range of soil types. Our results suggest that more microbially processed materials accumulated with depth across both profiles. The C/N ratio, C content and ^{15}N, ^{13}C enrichment patterns across each of the density fractions yielded similar trends. Strong differences in SSA between the different soils, across depth and with denser soil fractions was observed, although the trends varied. However, the mean residence time (MRT) of carbon within each the various density fractions changed comparatively little with depth for both soil types, while the bulk soil C MRT increased. Our results suggest that increasingly microbially processed and older soil organic matter accumulated both at depth and on denser mineral particles. However bulk organic matter chemistry depth trends were found to be driven mostly by shifts in the proportion of the various soil density fractions rather than by depth-driven alterations of the organic matter within a given particle density fraction.

References: [1]Sollins, P. Kramer, M. G., Swanston, C., Lajtha, K., Filley, T., Aufdenkampe, A. K., Wagai, R., Bowden, R. D. Sequential density fractionation across soils of contrasting mineralogy: evidence for both microbial-and mineral-controlled soil organic matter stabilization. Biogeochemistry, 2009. 96(1): p. 209-231.

Keywords: SOM stabilization, organic mineral interactions, soil depth profile, sequential density fracitonation, stable isotopes

Posters – Session 5

Poster S5-P1

Assessing the vulnerability of the stable soil organic matter pool to inputs of fresh organic matter: evidence of a positive priming effect

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Soil organic matter is a huge carbon stock. A fraction of soil organic carbon, named stable carbon pool, has residence times longer than centuries and its vulnerability to land use or climatic changes is virtually unknown. Long term bare fallows offer a unique opportunity to isolate the stable organic pool of soils and study its properties. We investigated the vulnerability of the stable C pool to fresh organic matter (FOM) inputs by comparing the dynamics of C mineralization of a long term bare fallow soil with an adjacent arable soil. We amended or not the soil samples with two different ^{13}C-labelled fresh organic matter (straw or cellulose) at two different levels (0.5 and 5gC-FOM kg^{-1}). We always detected a positive priming effect indicating that under our conditions the mineralization might be easily accelerated by the presence of FOM. We observed that the priming effect was higher for the stable soil organic carbon from the long term bare fallow compared to the total organic carbon the arable soil. Our results suggest that the stable pool of soil organic matter may not be considered as inert or passive because changes in land use and/or biomass production might change the intensity of priming effect on the stable pool of soil organic matter.

Keywords: Stable soil organic matter, Bare fallow, priming effect, ^{13}C, Mineralization, Global change

Poster S5-P2

CO_2 emissions with different soil organic pools and temperature sensitivity

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The CO_2 fluxes from soils of different land use types are still highly uncertain. Surface soil organic carbon (SOC) pools and turnover time are particularly sensitive to site variables and land use change. Under field conditions, the net effect of land use change on soil organic carbon dynamics often remains unclear because many soil properties, which can interact and counterbalance, are influenced at the same time. In order to evaluate the differences of soil-to-atmospheric CO_2 emission among four different land use types, we made a laboratory investigation to quantify the relative importance of SOC pools influenced by land use change. Soil samples were collected from four different land use types at Heshengqiao ecological research site, Xianning, Hubei, China and were incubated in the laboratory under a range of moisture (air-dry to nearly saturated) and temperature conditions (5-45 °C). The data from the incubation study were fitted to a three-pool first-order model that separated mineralizable soil organic carbon into active (C_a), slow (C_s) and resistant (C_r) carbon pools.

The results showed that the C_a pool comprised 1.2–3.5% of SOC with a mean residence time (MRT) of 49-65 days, and the C_s pool comprised 25.3–60% of SOC with a MRT of 2-27 yr. While the C_r pool accounted for 36.5–73.9% of SOC in four land use types. The woodland had highest C_r pool and lowest C_a pool, which indicates it to be more stable than other land use types. Significant differences in soil CO_2 fluxes were observed among the four land use types, following the order of paddy > upland> orchard (O)～woodland. CO_2 emissions increased ($r^2 = 0.273\text{-}0.544$, $P < 0.0001$) with increasing temperature (up to 40 °C), with emissions reduced at the lowest and highest soil moisture contents. The Q_{10} values (from 5 °C to 45 °C, at 60% of WHC) of 1.9 ± 0.2, 2.2 ± 0.3, 2.3 ± 0.3, and 3.2 ± 0.5 were observed for paddy, orchard, woodland and upland, respectively, and decreased with decreasing moisture content when soil water content was less than its optimum value, but an opposite trend was shown when soil retained water at contents higher than the optimum water content. We concluded that SOC from different land uses had different temperature sensitivity, leading to different proportion of SOC pools, which in turn derived the different rates of soil carbon dioxide emission to atmosphere.

References:

Keywords: CO_2 emissions, Soil temperature, Soil moisture, Soil organic carbon pools, Q10

Poster S5-P3

Content and composition of soil humic substances after addition of vermicompost residues

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The most important economic activities in the surroundings of Pelotas, a city in southern Brazil, are the agribusinesses and cattle farming. Both activities generate organic wastes, which can be used in agriculture as fertilizer and/or soil conditioners, after their stabilization through vermicomposting. The molecular and chemical characteristics of the resulting humic substances (HS) vary according to the type of composted waste (Castilhos et al., 2008). The addition of vermicomposts to the soil in agricultural crops has been a common practice in the region however its effect on the soil organic matter (SOM) is still unknown. Hence, the aim of this study was to assess changes in soil HS, regarding humic acid (HA) and fulvic acid (FA) distribution and their chemical composition, after soil incubation with vermicompost from different wastes. The experiment was conducted in laboratory at the Federal University of Pelotas, and the experimental units consisted of one kg of soil (red yellow Ultisol, 0-20 cm) packed in plastic bags. Besides the control treatment (soil without vermicompost addition), the following treatments with vermicompost addition were evaluated: cattle manure (CM), sheep manure (SM), sludge parboiled rice (PR), pure vermicomposted and in mixtures (1:1,w/w): CM + PR, PR + SM, CM + WF (waste food), SM + WF, SM + FR (fruit residues), CM + FR. Vermicomposts doses added to the soil were calculated in order to provide the same nitrogen content (135 mg kg-1) in all treatments. The experimental design was completely randomized design with three replications. During the incubation period (180 days), humidity was maintained at 18%, corresponding to 80% of the water retained at 0.3 bar tension and soil was revolved and aerated weekly.

After incubation, total organic carbon (TOC) in soil samples was quantified by Walkley-Black method, with external heat. The chemical fractionation of SOM was performed according to the procedure recommended by Dick et al. (1998) and C content in the acid extract (CNH), soluble humic substances (CSHS) and fulvic acid (CFA) were quantified after wet combustion with potassium dichromate 1.25 mol L-1 in acidic medium at 60 ° C for 4h by determining the absorbance at 580nm. The C content in the form of humic acid (HA), in the form of humin (HU) were obtained by difference: CHA= CSHs - CFA, and CHU= TOC – (CNH + CSHs), respectively. In purified samples of HA and FA elemental composition was determined by dry combustion (Perkin Elmer, 2400) and oxygen content was calculated by difference, after correction of values for an ash-free basis. Samples of HA and FA was analyzed by Fourier transform infrared spectroscopy (FTIR) in KBr pellets (Shimadzu 830FTIR) in the ratio sample: KBr of 1:100. The infrared spectra were interpreted according to Dick et al (2003). SOM quality was investigated by laser induced fluorescence (LIF) and a humification index was determined (Milori et al., 2006).TOC levels increased in all treatments with vermicomposts, due to the increase of FA and HU fractions. HA levels tended to remain constant along the incubation. The consequent decrease of the HA/FA ratio and also the decrease of soil humification index determined by LIF indicates the incorporation of less humifed SOM within 180 days. In general, HA presented greater contents of C, H and N than FA, which in turn showed higher values for the atomic ratios H/C and O/C and (O + N)/C. Infrared spectra of HA and FA from soil with vermicompost addition showed similar pattern to that of the control HS, indicating that the amounts of vermicomposts added and the incubation period caused few changes in the molecular composition of humic substances in soil.

References: Castilhos et al., Rev. Bras. Ci. Solo, 32: 2669-2675, 2008; Dick et al., Rev. Bras. Ci. Solo, v.22, 603-611, 1998. Dick et al., Rev. Bras. Ci. Solo, 27: 29-39, 2003; Milori et al., Soil Sci. Soc. Am. J. 70 : 57-63, 2006;

Keywords: organic wastes, humification, humic acid, fulvic acid

Poster S5-P4

Carbon stock of a Brazilian subtropical Albaqualf soil under long-term different management systems

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In paddy soils, due to poor drainage and flooding during rice cultivation, the dynamics of soil organic matter (SOM) is distinguished from oxidized soils, both in the products formed, as in more slow decomposition rate. Furthermore, the low temperatures of subtropical climate in southern region of Brazil also reduce SOM decomposition rate. Therefore, the SOM stock depends on the characteristics of soil and climate region, vegetation and soil management system. In well drainage tropical and subtropical soils conservationist soil management systems, e.g. no-tillage (NT), have proved to promote an increase of C stocks at surface layers (Bayer et al., 2002). So far, little scientific information is available in lowland soils regarding quantity of soil organic matter distribution in soil physical compartments and SOM stabilyzing mechanisms. This study aimed to evaluate in a long-term experiment (21 years), the effect of soil management systems on the carbon stock and on the SOM stabilyzing mechanisms in an Albaqualf soil cultivated with irrigated rice in southern Brazil.

Soil samples were collected (four replication) at depths from 0 to 0.025; 0.025-0.05; 0.05-0.10 and 0.10-0.20 m under four soil management systems: traditional system (TS) - one years rice, conventional tillage + two years fallow; continuous rice, conventional tillage (CT), succession ryegrass and rice, no tillage (NT) and soil under native vegetation (NV). Physical fractionation was performed by the densimetric method (politungstate solution, ρ =2 g cm^{-3}) (Conceição et al, 2008), resulting in free light fraction (FLF), occluded light fraction (OLF) and heavy fraction (HF). Total carbon content in whole soil (TOC) and carbon content in physical fractions were determined by dry combustion. Carbon stocks were calculated by equivalent soil mass using soil density in each layer (Bamberg et al,2009) and the soil under natural vegetation (NV) as a reference (Sisti et al., 2004).

Compared to NV, the TOC stocks were preserved in no tillage system and reduced in both systems with conventional tillage in the surface layers (0 to 0.025 and 0.025 to 0.05 m). The NT system, preserved the carbon stocks of the FLF in the upper layers of soil, compared to the systems with conventional tillage (TS and CT). OLF was not sensitive to the different management systems used, suggesting low efficiency of the physical protection of SOM by occlusion in aggregates, due to the poor drainage condition. The stability of SOM in this soil is mainly due to the heavy fraction.

The TOC was correlated with mean weight diameter of soil aggregates (MWD) only in NV and NT systems. In conventional tillage systems (TS and CT) total soil carbon and carbon content of FLF and HF were not correlated with MWD suggesting that SOM has little contributing to the stabilization of soil aggregates in these systems. The revolving of soil causes breakdown of aggregates reducing physical protection and exposing organic matter to decomposition. Moreover, in systems where the soil is not cultivated (SN) or is cultivated under no revolving (NT) there was a correlation between the MWD and the carbon content of FLF (r = 0.76) and HF (r = 0.72). OLF carbon content was not correlated with mean weight diameter of soil aggregates in any management systems, supporting the low efficiency of the occlusion as a mechanism for stabilization of SOM in lowland soils.

References: Bayer et al., Plant and Soil, 238, 133-140, 2002
Bamberg et al., Rev. Bras. Cienc. Solo, 33, p. 1079-1086. 2009
Conceicao et al., Rev. Bras. Ci. Solo, 32, 541-549, 2008.
Sisti et al., Soil Till. Res. 76, p.39-58, 2004

Keywords: stabilyzing mechanisms

Poster S5-P5

Chemical and microbial controls on the temperature sensitivity of heterotrophic soil respiration

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The temperature sensitivity of heterotrophic respiration Rh is an important determinant for the feedback of terrestrial carbon pools to warming.

Present thinking emphasizes that inherent substrate quality may be an important control on Rh. However, substrate quality is experimentally difficult to separate from biochemical availability because both are closely connected to the enzymatic machinery. Here, rates of chemical oxidation of soil organic matter are explored by measuring heat flux and activation energy Ea during controlled burning and used as an indicator of substrate quality. They were compared to Ea of microbial respiration. Enzymes reduced mean Ea from 136 to 83 kJ mol^{-1} and thereby increased the rate of CO_2 production by a factor of 1.5 E+7 at room temperature as compared to the non-catalyzed reaction. The temperature dependencies of microbial and chemical oxidation were not related to each other, suggesting weak, if any, control of chemical degradability on the temperature sensitivity of Rh. Rather, and based on first principles of temperature control on decomposition, high microbial Ea is likely caused by differences in substrate use efficiency SUE that i) declined with temperature and ii) was affected by substrate nitrogen content and pH. Thus, measuring Rh gives only partial answer to the question of temperature sensitivity of organic matter decomposition.

Keywords: temperature, substrate quality, respiration, CUE

Poster S5-P6

Destabilization of decadal soil carbon

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Soil carbon stocks are likely to be affected by global environmental changes, yet these changes are difficult to observe due to the slow cycling of most soil organic matter. The carbon isotope label in the soils of the Free Atmosphere CO_2 Enrichment (FACE) experiments provide a unique opportunity to examine the dynamics of soil carbon cycling on decadal timescales. Soils from FACE experimental ecosystems are depleted in both ^{13}C and ^{14}C due to decade-long addition of fossil-derived CO_2, making young (FACE-labeled C, < 10 y) and old (pre-FACE fumigation, >10 y) soil carbon easily distinguished by their carbon isotope signatures.

We conducted short and long-term incubations with soils from two temperate forest FACE sites (Duke FACE and Aspen FACE) to examine the effects of global changes such as warming, nitrogen fertilization, and priming on the age of carbon respired. Natural abundance ^{14}C and FACE-derived ^{13}C and ^{14}C of respired CO_2 and bulk soil C allows us to determine the response of both fast and slow (decadal) cycling carbon to global change drivers.

Upon warming, CO_2 flux rates increased along with the ^{14}C content of respiration in both CO_2 control and enriched soils. Using the atmospheric ^{14}C history, we determined that the mean age of carbon respired from CO_2 control soils from both sites increased by 2 years with +10ºC of warming. The greater contribution of older, bomb-derived ^{14}C is likely due to more rapid exhaustion of the fastest cycling C under warming treatments.

However, when we partitioned respiration into < 10 y and > 10 y flux using FACE-derived ^{13}C and ^{14}C, we observe no difference in their response to temperature. Total fluxes were higher in the warmed soils relative to the control temperature throughout the 1 y incubation. While the flux of > 10 y carbon increased with warming, the proportion of flux coming from the >10 y pool did not change with warming. Over the incubation period, the temperature effect on fluxes declined, likely because the substrate for respiration became limiting.

To investigate the role of substrate, we added ANU sucrose (distinct in ^{13}C and ^{14}C from SOC) at the early and late phase of incubation. While we observed a priming effect (increased SOM decomposition) at both stages of incubation, a change in the ^{14}C of source pool was only apparent late in incubation. After 8 months of incubation, sucrose addition promoted an increased flux of > 10 y C.

The CO_2 and nitrogen fertilization treatments had no statistically significant effect on fluxes or age of respired CO_2. Despite the differences in soil type, climate, and forest type of the two sites, warming increased decomposition of decades-old soil C (proportional to fluxes of younger C). Substrate availability interacted with warming, and priming responses are depends on the quantity and quality of soil carbon present.

Keywords: warming, decadal pool, priming, C-14, C-13, incubation, isotope label

Poster S5-P7

Different response of silicate fertilizer having electron acceptors on methane emission in rice paddy soil under green manuring

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Green manure cultivation in rice paddy soil during the fallow season has been strongly recommended to improve soil properties. However, green manuring may impact green house gas emission, like methane, (hereafter, CH_4) under the flooded rice cultivation system and thus, chemical amendments containing electron acceptors like iron (Fe) can be one of the most practicable mitigation strategy in reducing CH_4 emissions in irrigated rice (*Oryza sativa* L.) field, which is amended with green manure. We investigated the effect of iron slag silicate fertilizer (hereafter, silicate fertilizer), in green manure amended paddy soil by amendment of aboveground biomass of Chinese milk vetch (hereafter, vetch) at rates 0, 10, 20 and 40 Mg ha^{-1} on fresh weight basis before application of silicate fertilizer at rates 0 and 2.3 Mg ha^{-1} Silicate fertilization was effective to reduce seasonal CH_4 flux at about 14.5 % and increased rice yield at 15.7%, than the control(non-silicate fertilized plot). However, CH_4 production was increased dramatically by silicate fertilization in vetch-applied soil particularly at the initial rice growing stage, which was probably due to the enhanced methanogenic activity as product of the silicate's liming effect. Conclusively, silicate fertilization is not effective to reduce CH_4 production under highly green manure amended rice paddy soil, requiring proper control and management.

References: Adhya, T.K., Rath, A.K., Gupta, P.K., Rao, V.R., Das, S.N., Parida, K.M., Parashar, D.C., Sethunathan, S., 1994. Methane emission from flooded rice fields under irrigated conditions. Biol Fertil Soils 18, 245–248.

Keywords: methane, rice paddy soil, silicate fertilizer, electron acceptor, Chinese milk vetch

Poster S5-P8

Drought consequences on the stabilization of soil organic matter in grassland ecosystem

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Global change is likely to increase the drought periods which could alter global patterns of SOM production and decomposition. Drought may have significant consequences on the stabilization of SOM, originating from both aboveground and belowground plant biomass. However, drought is a complex phenomenon and the interactions between plants and soil are poorly understood.

In this work, we combined field studies with laboratory experiments to investigate the impact of drought on different plant compartments involved in SOM sequestration. We focused on three common grassland species (*Lolium perenne*, *Festuca arundinacea* and *Dactylis glomerata*) found to constitute grasslands of the temperate climate. We investigated drought impact on plant biochemistry, soil microbial biomass and their enzyme activities in the rhizosphere. Drought effects on above ground plant biomass (leaf litter) decomposition were also investigated under field conditions along with decomposition and stabilization of belowground biomass (root litter) in different soil horizons by considering abiotic factors like temperature and moisture contents.

Laboratory experiments showed that exposure to drought stimulated root growth at the expense of shoots when cultivated as monocultures. While for their mixture, we recorded lower root-to-shoot ratios. The changes in the plant root biomass were highly correlated to the microbial biomass carbon which resulted in higher enzyme activities in the rhizosphere due to drought stress. Extracellular enzyme (involved in C and N cycles) activities in the rhizosphere were sensitive to drought and drought induced changes in root litter production altered substrate availability and hence the activity of the enzymes. Under field conditions, drought altered the plant biochemistry by increasing lignin contents in plant shoot which resulted in decreased decomposition of this drought affected plant litter in soil when exposed to optimal conditions. At the soil surface drought reduced the decomposition of leaf litter of grassland species. After 7 months of litter exposure in litterbags, the decomposition of leaf litter with contrasting quality was similar at optimum moisture conditions, while under drought stress, low quality litter was less degraded compared to high quality litter. In the mineral soils, abiotic factors like moisture contents and temperature seemed to have no impact on decomposition of plant root litter and its stabilization in different SOM pools.

We concluded that altered moisture regimes had significant effect on plant biochemistry and ecophysiology. Contrasting moisture and temperature conditions affected more strongly to the decomposition and stabilization of aboveground plant biomass compared to the belowground biomass. The extent of C sequestration of aerial plant biomass due to drought stress was mainly controlled by their initial chemical composition.

Keywords: Drought; soil organic matter stabilization; grassland ecosystem; extracellular enzyme activity; plant biochemistry

Poster S5-P9

Drought stress affects partitioning of ^{15}N between soil N pools of SOM fractions, microbial biomass and inorganic N in a Rendzic Leptosol

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In Central Europe, prolonged summer droughts are expected to occur as a result of changes in climate resulting in reduced soil water availability, which may lead to changes in soil processes such as microbial nitrogen (N) mineralization-immobilization turnover (Borken and Matzner, 2009; Compton and Boone, 2002), which in turn may negatively affect partitioning and stabilization of soil N.

To elucidate the effects of drought stress on N partitioning between different soil N pools, we conducted a ^{15}N tracing experiment under controlled conditions. Containers were filled with a soil classified as Rendzic Leptosol and planted with one-year-old beech trees and cultivated during two subsequent vegetation periods in phytotrons under defined climatic conditions. When leaves were fully developed half of the containers were exposed to drought stress. ^{15}N label was applied at the end of July 2007 by addition of 50 mg ^{15}N as $K^{15}NO_3$ and $(^{15}NH_4)_2SO_4$ (1:1) in 300 ml H_2O per container. Immediately after label application (0 d) and additionally after 24 and 410 d the top 0-10 cm soil layer of each container was sampled. By combining physical soil fractionation and chemical soil extraction we followed the partitioning of ^{15}N in the soil organic N (SON) pools of different soil fractions, e.g. light fraction (LF) and organo-mineral fractions as well as in the extractable soil N pools including microbial biomass (MB), ammonium, nitrate and dissolved organic N (DON). 64% of total SON was stored in the clay sized fraction which thus represents the fraction with the largest SON pool, followed by the fine silt fraction and the LF, each with 13% of total SON. Whereas total SON pool sizes of the soil fractions were not influenced by drought treatment, pool sizes of soil MB-N and DON were significantly reduced by drought. The SON pool of the clay sized fraction acted as the main sink for added ^{15}N, followed by the LF. Regarding the extractable soil N pools recovery of ^{15}N was highest in the soil MB. 410 d after label application, ^{15}N concentrations decreased significantly in the SON pools of LF as well as in the coarse and fine clay fraction due to drought treatment compared to the control soil. ^{15}N concentrations of soil MB-N and DON pools were also strongly related to soil water contents and decreased significantly with reduced water contents.

From our results we conclude that the decreasing ^{15}N concentrations in the different SON pools in the drought treated soil are mainly attributed to a reduction of soil microbial mineralization-immobilization turnover, leading to a decoupling of soil N cycling and stabilization. With regard to climate change and probable prolonged summer droughts leading to decreased soil water contents we deduce from the results presented here that N stabilization processes may be inhibited by drought stress, as MB activity strongly depends on water supply. Especially SON pools of LF and fine organo-mineral fractions, representing the fractions with highest contents of active microbes and microbial residues, are supposed to be negatively affected by a decrease in microbial immobilization.

References: Borken, W., Matzner, E., 2009. Reappraisal of drying and wetting effects on C and N mineralization and fluxes in soils. Global Change Biology 15, 808–824

Compton, J.E., Boone, R.D., 2002. Soil nitrogen transformations and the role of light fraction organic matter in forest soils. Soil Biology & Biochemistry 34, 933-943

Keywords: Nitrogen stabilization; Physical fractionation; ^{15}N labelling; Soil water content; Microbial turnover; Phytotron

Poster S5-P10

Dynamics of dissolved organic N in soil investigated by ^{15}N isotope tracing

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Dissolved Organic Nitrogen (DON) plays a key role in the soil N cycle. Foremost, formation of DON represents a pivotal step in the process of N mineralisation, consequently affecting nutrient availability in natural and agricultural soils. In addition, DON can be taken up by plants and leaching of DON from ecosystems is more substantial than often assumed. Numerous devices and sampling procedures have been used to estimate its size, varying from *in situ* collection of soil (rhizosphere) solution to extraction of dried soil with salt solutions. Recent evidence from marine ecology suggests that DON has relatively low turnover rates (age ~ 4000 years). This suggestion could imply that existing devices and sampling procedures collect a recalcitrant pool of organic N rather than a fraction actively involved in N cycling. Consequently, present methods underestimate the fate of DON in soils.

Since the amount, characteristics, and probably also its fate strongly depend on the sampling procedure, we selected three different methods and tested them on their ability to determine the dynamics of DON in soils. These include the determination of DON in 1) soil solution collected by centrifugation, 2) a 0.01M $CaCl_2$ extract of field moist soil or 3) a 0.01M $CaCl_2$ extract of dried soil. Since extraction releases also organic N from lysed microbial cells and desorbed organic matter, we used the abbreviation Extractable Organic N (EON) to distinguish the last two pools from DON. We added ^{15}N-labelled ryegrass (exp. 1) and radish residues (exp. 2) to a loamy sandy soil to create a temporarily increase in DON, to stimulate microbial activity, and to test whether the source and dynamics of the three pools differ. We quantified the bio-available fraction of DON and tested whether the flow of N through DON was associated with the production of inorganic N using ^{15}N tracing.

Sampling procedures significantly affected the amount, but not the dynamics and origin of the three DON and EON pools. Both increased upon crop amendment and returned to its background concentrations within 10 to 30 days. The fraction of DON originating from the crop residue slightly decreased over 138 days and was not different for three methods. Field moist extraction of a loamy sandy soil with 0.01M $CaCl_2$ gave a reliable estimate of the concentration of *in situ* dissolved organic N. In contrast, extraction of dried soil increased the amount of DON. The agreement in dynamics, ^{15}N enrichment and C-to-N ratio's indicate that DON and EON have a similar role in N mineralisation. Our results also suggest that they make a minor contribution to N mineralisation; changes in the bio-available fraction and the turnover rate of DON were not associated with changes in the net N mineralisation rate. This implies that all three sampling techniques collect recalcitrant and less bioavailable DON rather than a pool actively involved in N mineralisation.

These findings emphasize the need for innovative sampling methods for rapid cycling DON. They also show the usefulness of ^{15}N isotope tracing to follow the dynamics of labile organic N pools in soil. Since EON pools are often used to predict N mineralisation in soil, with highly variable results, knowledge of their dynamics may give mechanistic underpinned criteria to differentiate between high and less potential soil tests.

Keywords: dissolved organic Nitrogen; mineralisation; availability; crop; isotope tracing

Poster S5-P11

Effects of pig slurries application on soil organic carbon in the Guadalentin Valley, Murcia SE Spain

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In order to increase food production for growing human population, chemical fertilizers are usually applied to agricultural lands, and humans have negative influences on soil organic matter potential and soil properties. Therefore, to provide conservation and sustainability of agricultural land, use of organic fertilizers in the soil has become an important research topic.

The aim of this study is to determine the effects of pig slurries applications on soil organic carbon (SOC) in Guadalentin Valley, Murcia, SE Spain. We applied 3 different dosages on two different areas: D_1 (170 kg N/ha), D_2 (340 kg N/ha) and D_3 (540 kg N/ha); unfertilized plots (D_0) served as controls. A total of 103 soil samples were collected at two different levels, 0-30 cm and 30-60 cm. The results showed that soils from the first study area are basic, with high content in calcium carbonate, silty loam texture and generally non saline, cation exchangeable capacity (CEC) is approximately 6 cmol/kg , soil organic carbon (SOC) content 12 g kg^{-1} before pig slurry applications and 11 g kg^{-1} after pig slurry applications. Soils from the second study area are basic, with very high content in calcium carbonate, silty loam texture and generally non saline, CEC is approximately 11 $cmolkg^{-1}$, and SOC content in soil 13 g kg^{-1} before pig slurry applications and 8 g kg^{-1} after pig slurry applications.

In conclusion, soil properties showed that pig slurries applications are effecting SOC, so SOC changed with pig slurries application depending on soil characteristics. D_0 (Control) and D_1 (170 kg N/ha) applications increased SOC; however D_2 (340 kg N/ha) and D_3 (540 kg N/ha) dosages decreased SOC, C/N ratio is also decreased with all dosages of pig slurry applications. The benefits from the use of pig slurry application will depend on how and where are used, therefore management of pig slurry is very important for carbon balance and environmental quality.

Keywords: Soil Organic Carbon, Pig slurry, Different Dosages

Poster S5-P12

Effect of Chinese Milk Vetch (Astragalus sinicus L.) as a Green Manure on Rice Productivity and Methane Emission in Paddy Soil

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This field study was undertaken to investigate the optimum recycling rate of the above ground biomass of Chinese milk vetch (*Astragalus sinicus L.* hereafter, vetch) to improve rice productivity and decrease seasonal methane (CH_4) flux in mono-rice cultivation system. The above ground part of vetch was applied in paddy field at rates 0, 10, 20 and 40 Mg ha^{-1} on fresh weight basis to investigate its effect on rice (*Oryza sativa*) productivity and CH_4 emission flux and was compared with the typical standard NPK chemical fertilization ($N\text{-}P_2O_5\text{-}K_2O=90\text{-}45\text{-}58$ kg ha^{-1}). Rice productivity increased significantly with increasing vetch application, and more interestingly, similar grain yield was obtained between vetch application at 10 Mg ha^{-1} as green manure and NPK fertilization. Methane emission rates, which were measured by closed-chamber method, increased significantly ($p < 0.05$) with increasing application levels of vetch, and seasonal CH_4 fluxes exceeded to that in NPK fertilization at over 10 Mg ha^{-1} vetch application. Our findings revealed that 10 Mg ha^{-1} vetch application as green manure amendment can be an effective application level of sustaining rice productivity without increasing CH_4 emission compared to NPK fertilization in Korean mono-rice cultivation systems.

References: Ali, M.A., Lee, C.H., Lee, Y.B., Kim, P.J., 2009. Silicate fertilization in no-tillage rice farming for mitigation of methane emission and increasing rice productivity. Agriculture, Ecosystems and Environment 132, 16–22.

Keywords: Chinese milk vetch (Astragalus sinicus L.), rice, methane, paddy soil, green manure

Poster S5-P13

Effect of Intermittent Drainage on Methane and Nitrous Oxide Emissions on Paddy Rice Fields

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Given the higher methane (CH_4) and nitrous oxide (N_2O) emissions from the agriculture sector, mainly by paddy rice cultivation, leading to global climate change, there is an urgent need to improve its soil management. This study was undertaken to determine the effect of intermittent drainage compared to continuous flooding (conventional water regime) on CH_4 and N_2O emissions with NPK (typical fertilizer application) and NPK+Straw fertilizations. Methane and N_2O rates were collected twice a week using a closed chamber method. Straw addition to NPK fertilization enhanced 93.4 and 148.3% of seasonal CH_4 and N_2O fluxes, respectively with respect to the NPK treatment (321.7 kg CH_4 ha^{-1}; 0.64 kg N_2O ha^{-1}) under continuous flooding. While it is true that intermittent irrigation can likely increase N_2O emission in paddy rice field, as we observed that N_20 seasonal flux was increased by 28.1-42.9% in the NPK and NPK+Straw treatments in this study, CH_4 flux was effectively decreased by 48.3-56.5%, resulting to a lower GWP at 49.9-58.3% in both treatments than that of continuous flooding (7.60 Mg CO_2 ha^{-1}, NPK; 14.55 Mg CO_2 ha^{-1}, NPK+Straw). Rice yield was higher by 10.8-13.6% with combined NPK+Straw application (6,276-6,312 Mg ha^{-1}) compared to NPK fertilization alone (5,525-5,694 Mg ha^{-1}) both in the intermittently drained and continuously flooded fields. More importantly, rice yield under intermittent drainage did not show much difference to that of continuous flooding. Conclusively, intermittent drainage even in an organic-matter amended (straw) paddy rice fields can be a very effective soil management strategy to mitigate the emissions of greenhouse gases like CH_4 and N_2O emissions and increase rice productivity in a temperate paddy rice field like Korea.

References: Xiong ZQ, Xing GX, Zhu ZL (2007) Nitrous oxide and methane emissions as affected by water, soil and nitrogen. Pedosphere 17(2): 146-155

Keywords: methane, nitrous oxide, emission, intermittent drainage, global warming potential

Poster S5-P14

Effect of nitrogen supply on rhizosphere priming effect in a grassland ecosystem

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Decomposition of soil organic carbon (SOC) is the main process which controls the release of CO_2 into the atmosphere from the terrestrial systems. Interaction of living roots with SOC is very important as it can accelerate the CO_2 respiration from SOC. Importance of this interaction is increasingly being recognized particularly in forest ecosystems where sources of CO_2 fluxes are relatively easy to distinguish. But complex nature of grassland rhizosphere makes it difficult to study and distinguish the respiration fluxes in intact plants.

To study rhizosphere processes under grasses, we have set up a continuous 13-C depleted air labelling system where ambient air is completely decarbonised and then mixed with 13-C depleted CO_2 of fossil origin at concentration of 400±20 ppm. This 13-C depleted air is then conducted to a mesocosm where monocultures of grasses are established. This labelling system is in operation for more than one year now.

The question being studied is whether supply of nitrogen may be used as a tool to increase the SOC accumulation in the soils. We assume: more we supply the nitrogen to a planted soil, less will be the priming effect due to dominance of carbon-storing microbial community and thus more will be the carbon stabilized in the soil and vice versa. To test this hypothesis we established *Lolium perenne* (Lp) pots with contrasted supplies of nitrogen i.e. 120 Kgha^{-1}a^{-1} for treatment 'high N' and 70 Kgha^{-1}a^{-1} for treatment 'low N'. Natural supply of nitrogen was ensured in another treatment 'Leg+Gram' where a mixture of *Lp* and *Trifolium repens (Tr)* was grown while control of *Tr* 'Leg' was included as another treatment in the experiment. All these treatments were compared with unplanted controls.

We took monthly measures of pot respiration. First measure was taken at the end of 4th month of experiment. For a respiration measure, intact plants were taken out from labelling system, put in PVC tubes, sealed for 24 hours along with 200 ml of 1M NaOH to capture the CO_2. Δ 13-C allowed us to separate this flux into SOC derived and FOC derived.

In all the four treatments, mineralization of SOC was significantly greater (up to 423%) than that in unplanted controls. All the treatments produced a priming effect 'PE' (acceleration of SOC mineralization in response to fresh organic carbon 'FOC' supply). On the whole, rhizosphere PE by both 'high N' and 'low N' treatment wasn't statistically different while being statistically inferior to that produced by 'Leg+Gram' or 'Leg'. This is explained by relatively less rhizodeposition by them as compared to 'Leg' or 'Leg+Gram'. On cumulative basis, 'Leg' mineralised greatest amount of SOC which was 279% of that by unplanted controls. This SOC mineralising capacity of 'Leg' in spite of greater amount of N in its rhizosphere is explained by its greater rhizodeposition. It added 309±40.2 mg/pot of fine particulate organic matter (POMf : ≥50 µ) to already existing 150±36.46 mg/pot as compared to 142.5±43.59 mg/pot and 123.2±13.17 mg/pot added by 'Leg+Gram' and 'high N' or 'low N' respectively. But if it is assumed that entire plant biomass is directly related to primed carbon and rhizosphere PE is represented in soil C primed per unit of labelled carbon respired (specific SOC mineralization) then it is the 'Leg' that mineralises least amount of carbon i.e. 0.29±0.02 units of SOC mineralized for each unit of FOC). While 'high N' and 'Leg+Gram' have the same specific SOC mineralization i.e. 0.48±0.03 and 0.41±0.03 respectively. Interestingly, 'low N' has the highest specific SOC mineralization i.e. 0.60±0.05.

Our study shows the potential of different grasses to accelerate the SOC decomposition. We see that supply of nitrogen either through mineral or natural source can reduce SOC mineralization par unit FOC thus favouring soil organic matter stabilisation. Moreover 'Leg' alone has lowest specific SOC mineralization thus indicating it's relatively potential to store C. On the basis of these results, we can say that the mixture of gramineae with leguminous species can ensure organic matter stabilization to the same extent but free of cost as compared to high N supplied gramineae alone.

Keywords: Rhizosphere priming effect, N supply, 13-C labelling, respiration flux, organic matter stabilisation

Poster S5-P15

Effect of soil drying on FT-IR spectroscopic analysis: a methodological study in Luxembourg

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Optimum soil quality is a goal to be achieved in agriculture and forestry and in order to maintain a sustainable equilibrium of ecosystems. The evaluation of various parameters influencing the soil's structure, fertility or even its chemical, physical or biological properties, like for instance soil organic matter, often relies on time-consuming and cost-intensive labwork. Fourier Transform Infrared (FT-IR) spectroscopy, however, has highly contributed to rapidly and cost-effectively assess these different parameters. Especially the mid-infrared (MIR) range (4000-400cm^{-1}) has proven to be an effective tool to predict soil properties. Additionally, MIR spectroscopy represents a qualitative analysis and renders spectral interpretation less complex by easily attributing peaks to organic or mineral compounds on the spectrum. Our research focuses on characterizing various soil compounds (water-extractable organic matter and lipids) through MIR spectral analysis. The present study specifically investigates the effect of various drying conditions on soils by Fourier Transform infrared spectroscopy in attenuated total reflectance (ATR) mode.

The OL and A horizons of five representative soils of Luxembourg were collected: a Stagnic cambisol (Humic, Dystric), a Haplic Acrisol (Arenic), a Stagnic Albeluvisol (Dystric, Siltic), a Cambic Leptosol (Calcaric) and a Haplic Cambisol (Eutric). Field-moist soil samples were directly sieved in a 2mm mesh and conditioned in accordance with the different drying procedures realized during this study, namely freeze-drying, oven-drying (25, 40, 80 and 105°C) and air-drying (20°C). The spectral analyses were performed after incorporation of KBr pellets on a Bruker Hyperion 2000 (Bruker Optik Gmbh, Ettlingen, Germany) Fourier Transform-Infrared Spectrometer (FT-IR) in Attenuated Total Reflectance mode (ATR). For each pellet, three spectra were recorded at different locations, in order to evaluate the reproducibility of the method.

Additional conventional soil analyses were realized: pH (H_2O, KCl, $CaCl_2$), exchange capacity (Cohex) and related exchangeable cations, particle size analysis and CHNS elemental analysis, including the distinction between total and organic carbon contents, by means of acidic pretreatment of samples (HCl 2N).

The outcome of this study shall define an optimal drying procedure for soil organic matter analysis coupled with infrared spectrometry. Indeed, traces of water in soil samples are known to produce broad bands around 3500cm^{-1}, which may mask relevant peaks related to soil. The expected results would show a significant attenuation or even an absence of the water band, depending on the pretreatment applied. In addition, this work will also be focused on the impact of the drying procedure on the spectral bands attributable to soil organic matter, possibly due to SOM degradation. Furthermore, the results from the preferred method should be reproducible independently from the type of soil chosen.

Keywords: SOM, degradation, FT-IR analysis, MIR, drying procedures

Poster S5-P16

Effects of grazing managements on soil physical fraction organic carbon and soil biological properties

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Little is known about the influence of grazing management on soil organic C (SOC), biological and biochemical properties, especially in Zagros Mountains where experienced heavy grazing for a long time. The objective of this study was to evaluate the effect of grazing management and slope aspect on soil organic C, total N, SOC physical fractions and biological properties of soils. The experiment was conducted in paired catchments with relatively same characteristics, such as lithology, soils and vegetations, but different grazing managements in Zagros mountains of western Iran, Hamedan province. Mean annual precipitation and temperature are 304 mm and 5.9 °C, respectively. Calcixerepts and Calcixerolls were dominated soil great groups and soil textures were clay and clay loam with 32 to 52 % clays. The main vegetation types were *Astragallus* sp., *Stipa barbata*, *Acantholimon* sp., *Gundelia* sp. and *Centurea* sp. There was not any control on grazing rate and duration in severely grazed catchment (representative catchment), while in adjacent catchment (grazing controlled catchment), grazing rate and duration have been controlled based on rangeland capacity for five years. Also, there were some fenced plots in grazing controlled catchment that were not grazed for five years (Non-grazing plots). Soils were sampled from 0-10 cm in 5 replicates from north and south face aspects of different grazing managements. Soils were physically fractionated to sand and silt plus clay sizes. SOC and total N were measured in bulk soil and size fractions. Excited respiration, microbial biomass C (MBC) and bacterial and fungal population were analyzed as well. Results showed that SOC was significantly higher in non-grazed plots, while in the grazing controlled region, total N showed the highest value. Sand size fraction OC, was significantly greater in controlled and non-grazed plots, with 1.10 and 1.13 %, respectively. Other researcher_studies showed more vegetation cover, surface litter and NPP in grazing controlled catchment. The least amounts of OC were found in silt plus clay fraction. As expected, C/N values were greater in sand size fraction (13.7±6.5), due to the large amount of fresh and uncomplexed OC in this fraction. Low values of C/N (7.5±1.4) were observed in silt plus clay fraction, suggesting more decomposed nature of SOC. The highest value of excited respiration and MBC (0.80 mg C-CO_2/gr soil and 494.0 µgr C/gr soil, respectively) and Bacterial and fungal population (2.18×10^7 and 4.2×10^5 N/gr soil) were observed in controlled grazing regions, indicating more microbial activity due to fresh OC additions to soils. The least amounts of measured parameters were observed in severely grazed region, indicating severely biochemical and biological degradation due to heavy grazing. All measured parameters were significantly higher in north-face slopes. Overall, controlled grazing management in the short time has significantly provoked the status of OC and microbial activity. More studies are needed to evaluate the quality and structure of SOC in different management systems of the region.

Keywords: Grazing management, Slope aspect, Soil organic C, Soil OC physical fractions, biological properties

Poster S5-P17

Effects of redox conditions on the adsorption of dissolved organic matter to soil minerals and differently aged paddy soils

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Current knowledge on dissolved organic matter (DOM) in soils is based mainly on observations and experiments in aerobic environments. Adsorption to soil minerals is an important mechanism of DOM retention and stabilization against microbial decay under oxic conditions. Under anoxic conditions where hydrous iron oxides, the potential main adsorbents of DOM, possibly dissolve, the importance of adsorption seems questionable. Therefore, we studied the adsorption of DOM to selected soil minerals and to mineral soils under oxic and anoxic conditions.
In detail, we tested the following hypotheses:

Minerals and soils adsorb less DOM under anoxic conditions than under oxic ones.

The reduced adsorption under anoxic conditions is result of the smaller adsorption to hydrous Fe oxides whereas adsorption to clay minerals and Al hydroxides is not sensitive to changes in redox conditions

DOM adsorption will increase with the number of redox cycles, thus time of soil formation, due to increasing contents of poorly crystalline Fe oxides. This will, however, cause a stronger sensitivity to redox changes as poor crystalline Fe oxides are more reactive.

Aromatic compounds, being preferentially adsorbed under oxic conditions, will be less strongly adsorbed under anoxic conditions.

We chose paddy soils as models because their periodically and regular exposure to changing redox cycles, with anoxic conditions during the rice growing period and oxic conditions during harvest and growth of other crops. Soils of a unique chronosequence of paddy soils (50, 300, 700 and 2000 years) in China were studied in direct comparison to non-paddy soils of the same age. In additions, selected soil minerals (goethite, ferrihydrite, amorphous Al hydroxide, hydrobiotite, nontronite and ripodolite), differing in their response to changes in redox conditions, were studied in order to indentify those mineral constituents responsible for redox-induced changes in DOM adsorption to the test soils. The DOM for the adsorption was extracted from composted rice straw as a surrogate for DOM percolating in paddy soils. Batch adsorption experiments were carried out with DOM pre-incubated to give oxic and anoxic conditions and maintaining these redox conditions during the whole procedure.
The redox potential resulting from anoxic pre-incubation was about 100 mV, thus in the range of Fe reduction. Besides of dissolved organic carbon (DOC), we determined changes in the composition of DOM by the specific UV absorbance. We also analyzed main cations, anions and redox-sensitive elements to give a comprehensive picture of the effects of changing redox conditions on the dynamics of organic C, N, P, S, Fe and Al.
First results indicated indeed less adsorption of DOM to Fe oxides under anoxic than under oxic conditions, with a more pronounced effect for ferrihydrite than for goethite. Maximum adsorption of DOM was more than 50% larger under oxic than under anoxic conditions. The effect was less pronounced but still detectable for clay minerals such as hydrobiotite, nontronite, and ripodolite. The specific UV absorbance of DOM contact with minerals was 20-50% stronger under anoxic than under oxic conditions. These changes in DOM composition indicated that preferential adsorption of aromatic compounds might be limited to aerated soils.

We conclude that adsorption, although less strong than under oxic conditions, is an important mechanism of DOM retention also under anoxic conditions. Decreasing amounts of adsorbed DOM and changes in its composition might result in a less effective sorptive stabilization against microbial decay under anoxic than under oxic conditions.

Keywords: Adsorption, DOM, Paddy soil, minerals

Poster S5-P18

Effects of soil additives such as clay minerals, activated carbon and iron oxides on SOC stability and configuration in three different soils

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Soil organic carbon (SOC) is one of the largest terrestrial C pools worldwide. Thus processes and factors involved in SOC dynamic and stability are highly important in the context of climate change. Management of soils that increases C stability and thus reduces SOC mineralization could contribute to C sequestration and thus mitigate the effects of climate change. Against this background, incubation and sorption experiments were performed to identify factors and processes that are controlling the SOC dynamics and configuration in three different agricultural soils. During the incubation studies 10 different additives as for example clay minerals, activated carbon or iron oxides were added to the soil samples and the CO_2 evolution was measured over time as indicator for the SOC stability. Also, the substrate induced respiration (SIR) method was used to characterize the SOC stability in presence of easily available carbon as glucose. To estimate additive effects on SOC configuration the incubated soil samples were used for sorption experiments with the hydrophobic compound 17a-Ethinylestradiol (EE2). Changes of EE2 sorption to soil samples were used as an indicator for different SOC confirmation caused by the different additives. Although the experiments are still running, the SIR demonstrated that especially the addition of iron oxides could reduces SOC mineralization in all soil samples.

Keywords: iron oxides, clay minerals, SIR

Poster S5-P19

Effects of valorization of olive mill wastewaters by soil spreading and co-composting with industrial Organic wastes in semiarid Mediterranean soil

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In Mediterranean countries, large amounts of olive mill wastewaters (OMW) are produced by traditional and industrial olive mills at a limited time period (usually from October to December). Olive oil mill wastewater contains a high organic load, substantial amounts of plant nutrients and may represent a low cost source of water. Thus, the use of OMW for soil fertigation is a valuable option for its disposal, provided that its impact on soil chemical and physical properties is established. Investigations were performed on the influence of OMW after five years of application on several chemical and physical properties of a soil from a semi-arid Mediterranean region (Tunisia).

As a consequence of long-term irrigation with OMW, the organic C content increased in treated soils. In the topsoil, organic matter content increased from 0.2 % in the control soil (TC) to 0.28, 0.49 and 0.62 % after 5 years of OMW application in T1 (50 $m^3.ha^{-1}$), T2 (100 $m^3.ha^{-1}$) and T3 (200 $m^3.ha^{-1}$), respectively. K concentrations were significantly greater in soil receiving OMW than control soil for all treatments. The higher contents were recorded in T2 and T3 with respectively 800 and 700 ppm in upper horizon.

The application of OMW caused a decrease in the saturated hydraulic conductivity at depths of 0–20, 20–40 and 40-60 cm. Suspended solids including organic matter in OMW may have filled up some of the soil voids causing a decrease in soil hydraulic conductivity.

The statistical analysis confirmed the significance of the differences between sites. The decrease in infiltration rate after 5 years of OMW application compared with the control can be explained by a reduction of the porosity. Besides, the penetration resistance test showed that OMW caused soil compaction mainly in T3 with higher OMW dose.

On the other hand, the use OMW for composting was studied by the addition of this liquid waste to a mixture of olive husks, poultry manure and confectionery wastewaters. The composting process was compared with that of another pile of similar composition, but without olive mill wastewaters. The olive mill wastewaters addition produced compost with higher organic matter concentrations and higher electrical conductivity, and a stabilized and humified organic matter lower than the compost produced without olive mill wastewater. The olive mill wastewater compost application to soil did not injure plants, producing a similar plant yield to both compost without olive mill wastewater and manure. The olive mill wastewater compost application to soil also improved the chemical and physicochemical properties of the soil mainly fertilizing elements such as calcium, magnesium, nitrogen, potassium and phosphorus. Compared to soil amended by manure, that amended by both composts showed the more important potato yield production reaching 46 and 47 t/ha. After these experiments, it can be concluded that composting is a suitable alternative for the recycling of OMW. The OMW compost obtained had higher organic matter (OM) content, higher EC values and a stabilized and humified OM lower than that of the compost produced without OMW. The OMW compost application to soil did not lead to phytotoxic effects on plants, producing plant yields similar to those of compost without OMW and more than the manure. The levels of the other macronutrients, Ca and Mg, were also higher in soil amended with both composts, mainly with OMW compost than in non amended control soil. After cropping, a decrease of OM, N and macro-nutrients was recorded due to OM mineralization and plant uptake.

This study showed clearly the beneficial role of OMW application of increase soil fertility and in the environmental safety.

Keywords: Keywords: Olive mill wastewaters, spreading, composting, semiarid soil, organic matter, potassium; porosity; compaction; infiltration

Poster S5-P20

Enzyme activity profiling in treated wastewater irrigated agricultural soils along soil profiles

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Treated wastewater (TWW) is an important source for irrigation water in arid and semiarid regions and already serves as an important water source in Jordan, the Palestinian Territories and Israel. Reclaimed water still contains organic matter (OM) and various compounds that may effect microbial activity and soil quality (Feigin et al. 1991). Natural soil organic carbon (SOC) may be altered by interactions between these compounds and the soil microorganisms. This study evaluates the effects of TWW irrigation on the quality, dynamics and microbial transformations of natural SOC. Priming effects (PE) and SOC mineralization were determined to estimate the influence of TWW irrigation on SOC along soil profiles of agricultural soils in Israel and the Westbank.

The used soil material derived from three different sampling sites allocated in Israel and The Palestinian Authority. Soil samples were taken always from TWW irrigated sites and control fields from 6 different depths (0-10, 10-20, 20-30, 30-50, 50-70, 70-100 cm).

Soil carbon content and microbiological parameters (microbial biomass, microbial activities and enzyme activities) were investigated. In several sites, subsoils (50-160 cm) from TWW irrigated plots were depleted in soil organic matter with the largest differences occurring in sites with the longest TWW irrigation history. Laboratory incubation experiments with additions of ^{14}C-labelled compounds to the soils showed that microbial activity in freshwater irrigated soils was much more stimulated by sugars or amino acids than in TWW irrigated soils. The lack of such priming effects (Hamer and Marschner 2005a, Hamer and Marschner 2005b) in the TWW irrigated soils indicates that here the microorganisms are already operating at their optimal metabolic activity due to the continuous substrate inputs with soluble organic compounds from the TWW. The fact that PE are triggered continuously due to TWW irrigation may result in a decrease of SOC over long term irrigation. Already now this could be detected at some agricultural fields by SOC measurements (Jüschke 2009). Therefore attention has to be drawn especially on the carbon content and quality of the used TWW for irrigation purposes.

References: Feigin, A., I. Ravina and J. Shalhevet (1991). Irrigation with treated sewage effluent. Springer-Verlag, Berlin. p. 224.

Hamer, U. and B. Marschner (2005a). Priming effects in soils after combined and repeated substrate additions. Geoderma **128** (1-2), 38-51.

Hamer, U. and B. Marschner (2005b). Priming effects in different soil types after addition of fructose, alanine, oxalic acid or catechol. Soil Biolology and Biochemistry **37** (3), 445-454.

Jüschke, E. (2009). Effluent Irrigation and Agricultural Soils: Effects on the Dynamics of Organic Carbon and Microbial Activity in Agricultural Soils in Israel Verlag Dr. Kovač, Hamburg. p. 336.

Keywords: TWW irrigation; soil organic matter, priming effects, enzyme activity

Poster S5-P21

Estimation of organic carbon loss potential in a climosequence in Golestan Privence, Northern Iran

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Soil organic matter (SOM) can be divided into labile or rapidly decomposed, and stable or slowly decomposed fractions. The most labile components of SOM include cellular contents such as carbohydrates, amino acids, peptides, amino sugars and lipids. Soil carbon oxidized by neutral $KMnO_4$, or permanganate-oxidizable carbon (POC), has been used as index of labile C by several workers, although the nature of organic C (OC) oxidized has not been well elucidated. The development of sustainable agricultural systems requires techniques that accurately monitor changes in the amount, nature and breakdown rate of soil organic matter and can compare the rate of breakdown of different plant or animal residues under different management systems. The study area a climosequence (Udic-Xeric-Ardic regimes) with loess parent material in Golestan province, Iran. Samples from 7 different soil orders with pasture land use (Mollisols, Inceptisols, Aridisols and Entisols) were collected at (0-20 cm) depth. Permanganate-oxidizable carbon (POC) an index of soil labile carbon, was used to show soil potential loss of organic carbon. This index shows the maximum loss of OC in a given soil. Maximum loss of OC for each soil was estimated through POC and bulk density (BD). The potential loss of OC were estimated between 1930634 and 69180986 g ha^{-1} Carbon. The lowest organic C loss was related to Entisols because of containing the lowest OC, and maximum potential loss of OC has been detected in Mollisols mainly due to having a lot of fresh organic tissue in mollic epipedon. In addition, the total amount of OC which were oxidised by $KMnO_4$ ranged from 14.41 to 59.43% of the total carbon. The effect of soil texture on soil permanganate oxidizable C (POC) was examined, clay + silt/OC, silt/OC and clay/OC accounts for 73%, 75% and 63%, respectively, of the variability in soil POC($P < 0.05$). And also soil permanganate oxidizable C (POC) of 7 soil sample were regressed with their total C contents and were found to be highly correlated ($R^2 = 0.964$, $P < 0.01$). Stable organic constituents in the soil include humic substances and other organic macromolecules that are intrinsically resistant against microbial attack, or that are physically protected by adsorption on mineral surfaces or entrapment within clay and mineral aggregates.

References: Anderson, D.W., Paul, E.A., 1984. Organo-mineral complexes and their study by radiocarbon dating. Soil Science Society of America Journal 48, 298–301; Baldock, J.A., Skjemstad, J.O., 2000. Role of the mineral matrix and minerals in protecting natural organic materials against decomposition. Organic Geochemistry 31, 697–710; Blair,G. J., R.D. B. Lefroy, and L. Lisle. 1995. Soil carbon fractions based on their degree of oxidation, and the development of a carbon management index for agricultural systems. Aust. J. Agric. Res. 46:1459–1466; Bouyoucos, G.J., 1962. Hydrometer method improved for making particle size analyses of soils. Agron. J. 54, 464–465; Brander, G., D. Pugh, and R. Bywater. 1982. Veterinary Applied Pharmacology and Therapeutics. Bailliere and Tindall, London; Brasher, B. R,. D. P. Franzmeier, V. Valassis, and S. E. Davidson. 1966. Use of Saran resin to coat natural soil clods for Bulk-density water retention measurements. Soil Sci. 101:108; Cotton, F.A., and G. Wilkinson. 1965. Advanced Inorganic Chemistry. 4th ed. InterScience Publishers, John Wiley and Sons, New York. p. 839±840; Jenny, H. 1941. Factors of Soil Formation: A System of Quantitative Pedology. McGraw Hill, New York, USA. 281 pages; Lal, R., 2001. Soils and the greenhouse effect. Soil Science Society of America Special Publication 57, 1–8; Lal, R., J. M. Kimble, E. Levine and B. A. Stewart. 1995. Soils and Global Change (Advances in Soil Science). Published by CRC Press. 440 pages; Lefroy, R. D. B., G. J. Blair, and W. M. Strog. 1993. Changes in soil organic matter with cropping as measured by organic carbon fractions and 13C natural isotope abundance. Plant and Soil. 155/ 156: 399-402; Loginow, W., W. Wisniewski, S.S. Gonet, and B. Ciescinska. 1987. Fractionation of organic carbon based on susceptibility to oxidation. Polish J. Soil Sci. 20:47-52; Paustian,K., Six, J., Elliott, E.T.,Hunt,H.W., 2000.Management options for reducing CO2 emissions from agricultural soils. Biogeochemistry 48 (1), 147–163; SAS Software. 1999 . SAS Institute. version 8. Cary, NC, USA; Schlesinger, W.H., 1991. Biogeochemistry; An Analysis of Global Change. Academic Press, San Diego; Skoog, D.A., and D.M. West. 1969. Applications of oxidation- reduction reagents to volumetric organic analysis. Chapter 21, Fundamentals of Analytical Chemistry. 2nd edn. Holt, Rinehart and Winston, New York; Soil Survey Staff. 2006. Keys to Soil Taxonomy, 10th ed. U. S. Department of Agriculture. ; Sollins, P., Homann, P., Caldwell, B.A., 1996. Stabilization and destabilization of soil organic matter: mechanisms and controls. Geoderma 74, 65–105; Stanford, G. 1978. Evaluation of ammonium release by alkaline permanganate extraction as an index of soil nitrogen availability. Soil Sci. 126:244-253; Swift, L.W. 1939. A System of Chemical Analysis (Qualitative and Quantitative) for the Common Elements. Prentice-Hall, New York. p. 53-63; Tirol-Padre, A. and J. K. Ladha. 2004. Assessing the reliability of permanganate oxidizable carbon as an index of soil labile carbon. Soil Sci. Soc. Am. J. 68: 969-978; Walkley, A., and I.A. Black. 1947. Determination of organic matter in the soil by chromic acid digestion. Soil Sci. 63:251-264; Weil, R.R., Islam, K.R., Stine, M.A., Gruver, J.B,. Samson-Liebig, S.E., 2003. Estimating active carbon for soil quality assessment: A simplified method for laboratory and Field use. American Journal of Alternative Agriculture 18; West, T.O., Post, W.M., 2002. Soil organic carbon sequestration rates by tillage and crop rotation: a global data analysis. Soil Science Society of America Journal 66, 1930–1946.

Keywords: Organic carbon loss potential, Permanganate-oxidizable carbon (POC), Climosequence, Golestan province, Iran.

Poster S5-P22

Five years impact of different grassland management strategies on soil carbon change studied at the observatory for Environmental Research at Lusignan

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Grassland management affects soil organic carbon (SOC) contents and a variety of management options have been proposed to sequester carbon in grasslands. Carbon sequestration in grasslands can be determined directly by measuring changes in soil organic carbon and indirectly by measuring the net C fluxes. The impacts of different harvesting techniques (grazing vs mowing) on biogeochemical cycles and SOM storage has rarely been addressed. We compared soil carbon pools (total soil carbon, carbon stock, microbial biomass C) and bulk density in grasslands which have been subjected to different harvesting techniques for five years. These sites are a part of observatory for Environmental Research at Lusignan (France). Our main objective was to evaluate the effects of management on SOM stocks and composition. Our conceptual approach included physical separation of SOM fractions. Additionally, we determined the lignin contents and composition by CuO-oxidation. Non-cellulose neutral carbohydrate was analyzed after TFA hydrolysis. Our results showed that soil carbon stock was about 21% and 17 % greater under grazing compared with mowing at 0-10 and 10-30cm respectively five years after the start of the treatments and no difference was found between two systems below these depths. Soil bulk density was greater under mowing than under grazing being significantly different at 0-10cm ($p = 0.009$) and 30-60cm ($p = 0.017$) and no difference was found at intermediate depth. Difference was obtained for the microbial biomass C contents when normalized for OC contents. The results of lignin and sugars will allow to assess if SOM quality changed due to the treatments. Our results suggested that grazed pastures can lead to higher SOM storage which is consistent with the higher input of low quality litter in this system compared to mowed pastures (Sanaullah et al., 2010).

Keywords: Grassland management, SOM, Carbon stock, Lignin, Carbohydrates

Poster S5-P23

Heterotrophic Microbial Decomposition of Soil Ancient Carbon in Norway Arctic

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High latitude region including the Arctic has largest reservoir of soil organic carbon including ancient (older) carbon in the Earth. Since the high latitude region would be significantly influenced with environmental change under global warming, fragile of soil carbon pool should be investigated. Here we measured radiocarbon of microbial phospholipids and soil organic matter, soil respired CO_2 to evaluate of future global warming feedbacks from the decomposition of ancient organic carbon pool which accumulated in the geological times.

Keywords: Radiocarbon, Ancient carbon pool, Heterotroph, Norway Arctic, Carbon cycling

Poster S5-P24

How is soil moisture influencing C incorporation and storage in soils for bulk C and at a molecular level?

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Soil moisture influences several soil properties like e.g. pH, oxygen availability and C storage. Especially water-logged and peaty soils can be characterized by large amounts of organic C and provide opportunity for improved preservation of total organic matter and at a molecular level like e.g. for lipids including alkanes and fatty acids. However, long term effects of different soil moisture on identical soils are investigated seldom and therefore it remains unknown, if even low differences in soil moisture (10-30 %) might have an effect on C incorporation and preservation in soils.

A long term field experiment on drained vs. undrained grassland plots from the Rowden plots (North Wyke Research, Okehampton, UK) provides the unique opportunity for studying long term influences of different soil moisture on biodiversity of plants and soil C storage. After establishment of drainage the plants community changed within several decades from predominant species adopted to wet conditions like *Juncus effusus* towards predominant grasses that are more tolerant to lower soil moisture like *Lolium perenne*. Due to the lower soil moisture in the drained plots, C_{org} and extractable lipid contents decreased throughout the soil profile by ~20 %. However, it remains unknown, if this change in drained vs. undrained plots is related to a modified plant biomass input due to changing plant community or an improved degradation of organic matter in drained plots.

To investigate these effects in detail, we carried out laboratory experiments, where identical plants (*Lolium perenne* and *Juncus effuses*) are kept under controlled conditions at two different soil moisture levels, which were adjusted daily to 70% and 100% of WHC, respectively. Short and medium term responses of plants and C incorporation in soil are followed by combining lipid and C_{org} analyses with the ^{14}C pulse labeling technique. The ^{14}C label is determined several times after the labeling in plants and soils for bulk C_{org} and at a molecular level (for total extractable lipids, fatty acids and alkanes). High soil moisture resulted in an improved growth of biomass, which was 30-70% higher than under low moisture, depending on sampling date. This was almost identical for shoot and root biomass. Lipid contents in plants were almost identical for both moisture variants, whereas previous studies demonstrated an effect of moisture on the lipid content and composition of plants.

Laboratory and field experiments provide evidence that especially the difference in biomass production under different soil moisture levels is the predominant factor influencing soil C incorporation and storage, even at a molecular level.

Keywords: moisture, fatty acids, alkanes, lipids, ^{14}C

Poster S5-P25

Impact of land-use change and climate on soil organic matter dynamics in subalpine grassland

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Little is known about the mechanisms of carbon sequestration in subalpine grasslands. These grasslands are enriched in labile soil organic matter (lSOM), and both land-use change and climate are expected to affect its distribution and turnover. The lSOM dynamics of two climatically different European subalpine grassland soils along land-use gradients (meadow, pasture, abandoned grassland) was examined by using soil density fractionation and radiocarbon dating. Abandonment and a drier climate increase the amount of lSOM in bulk soil and aggregates. Turnover rates indicate systematic patterns among soil fractions and show relatively long residence times for all but the light litter (wPOM) and root fractions. Land-use change influences both quality and quantity of plant residue input to soil. In this study, low decomposition rate but not a high input causes wPOM accumulation of abandoned grassland. Among density fractions, the wPOM fraction responds most sensitive to subalpine land-use and climatic change.

Keywords: Particulate organic matter, Land-use change, Radiocarbon

Poster S5-P26

Improving models of soil carbon dynamics: contribution from the long term bare fallow (LTBF) network.

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Understanding and modelling the dynamics of Soil Organic Carbon (SOC) with high turnover time is crucial to quantify and predict the ability of soil to sequester carbon. Long term bare fallow experiments, where organic C inputs are essentially zero for an extended period of time, are particularly relevant to investigate SOC with high turnover time.

In this work, we have used a unique dataset combining soil, plant and climatic data monitored on six sites presenting different pedo-climatic conditions (Askov (Denmark), Kursk (Russia), Rothamsted (UK), Ultuna (Sweden), Grignon (France) and Versailles (France)) to test and improve the 3-compartments model of SOC dynamics included in the ecosystem model "ORCHIDEE" and based on the CENTURY model (Parton et al. 1987). We show that ORCHIDEE can successfully reproduce carbon stock evolution under bare fallow plots for the six sites considering different but consistent turnover times for SOC pools. However, the difference between turnover times cannot be easily related to any pedo-climatic factors. We also show that the error correlation between slow and stable turnover time estimates (respectively ~10-50 years and ~ 500–1000 years) decreases with bare-fallow duration implying that the long-term bare-fallow experiments allow to distinguish the kinetics of these two pools.

LTBF data were satisfactory reproduced using ORCHIDEE. It would now be very interesting to compare ORCHIDEE's outputs to those of other SOC models on this unique dataset.

References: Parton, W.J., D.S. Schimel, C.V. Cole, D.S. Ojima. 1987. Analysis of factors controlling soil organic levels of grasslands in the Great Plains. Soil Sci. Soc. Am. J. 51:1173-1179

Keywords: Soil C dynamics, long-term bare fallow experiments, modelling

Poster S5-P27

Indicators for N mineralization in paddy rice soils in Bangladesh

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The N requirement for paddy rice cultivated in Bangladesh amounts to approximately 50-120 kg N ha^{-1}. Lack of knowledge on N mineralization from soil organic matter (SOM) leads farmers to fill up this N requirement exclusively by costly mineral fertilizers, which have typically an efficiency of less than 50%. After decades of searching for a practical tool to estimate the N mineralization capacity of soil, there is still no consistent methodology. We assessed different physical and chemical fractions of soil organic matter (SOM) as predictors for the net N mineralization measured from aerobic (field capacity) and anaerobic (saturated) soil cores in 100 days laboratory incubations.

First, N mineralization and C and N were assessed from long-term experimental plots of a highly weathered 'terrace soil' and a younger fluvisol, involving combinations of mineral fertilizer dressings and OM application. A positive correlation between N mineralization and soil N content, which was clearly related to management, was found for the terrace soil while no correlation was found for the fluvisol. Instead a strong negative relationship with soil OC content suggests a simultaneous accumulation of SOC and immobilization of N in this soil. Hence the relation between OM management for SOM accumulation and availability of N through mineralization is not straightforward in different soils in Bangladesh. Therefore other predictors than soil N content or C:N ratio were investigated .

A soil set consisting of 29 paddy rice fields were physically fractionated into particulate OM (POM) and silt and clay associated OM following mild ultrasonic dispersion and wet sieving. The silt and clay sized OM was further chemically fractionated by oxidation with 6% NaOCl to isolate an oxidation-resistant OM fraction, followed by extraction of mineral bound OM with 10% HF thereby isolating the HF-resistant OM (NaOCl-res. HF-res.OM). A parallel fractionation scheme involved a 'thermal fractionation' by sequential water extraction at 100, 150 and 200°C via accelerated solvent extraction.

Several physical and chemical fractions correlated positively with the linear fitted aerobic N mineralization rate, while no correlations were observed with anaerobic mineralization. The R^2 values of linear regressions between N content of the physicochemical fractions and aerobic N mineralization rate were, however, lower than the R^2 found for bulk soil N content. 'Thermal fractionation' yielded two fractions which correlated better with aerobic N mineralization, namely the 100+150°C extractable N and 200°C extractable N, but the R^2 were close to bulk soil N.

In conclusion, while some useful predictors for aerobic N mineralization were found, insight in the anaerobic N mineralization is lacking. Further research into importance of soil mineralogy, surface area, soil texture, etc. will be needed to increase our understanding of anaerobic mineralization.

Keywords: Soil Organic Matter, Nitrogen Mineralization Prediction, Paddy Rice Soil

Poster S5-P28

Influence of crop residue and flood-water management practices on SOM stabilisation in temperate paddy fields

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Alternating soil redox conditions play an important role in nutrient availability, biogeochemical cycling of elements, and ecological functions of rice ecosystems [1]. The adoption of large-scale intensive cropping and the need to offset the consequential decrease in soil organic matter (SOM) have promoted cropping systems and management practices that ensure greater amounts of crop residues returned to the soil [2]. However, the supply and decomposition of organic materials in rice fields, and the consequent nutrient bioavailability are markedly versatile and closely related to field management [3].

To enable an in-depth understanding of how different agronomic practices influence soil processes in paddy fields, soil samples were collected immediately after harvest (October 2009) at three soil depths from five hydrologically isolated plots within a research platform in Vercelli (NW Italy) under continuous rice cultivation since 2001. The major differences between each plot were related to organic matter (OM) input and flood-water management, and included burning of rice straw, crop residue incorporation in spring or autumn, seeding under dry conditions and delayed flooding (about 1 month), and a three-year rice-rice-maize crop rotation. The distribution of C and N between stable and more labile pools was evaluated by density fractionation of SOM.

On average 85% of the total organic C and 92% of total N in the soil samples above the plough pan (25 cm), were found in the mineral-associated OM (MOM) fractions, while only 8% of total organic C and 4% of TN were found in the more labile light fraction (LF). Treatments involving crop residue incorporation in autumn and crop rotation (that includes upland soil conditions for the cultivation of maize) resulted in less organic C and N stabilised in the MOM fraction, whereas crop residue incorporation in spring resulted in the greatest fraction of MOM-C and N in the first 25 cm. This suggests that crop residue degradation in flooded soil conditions enhances OM stabilisation in paddy fields. These results are consistent with the higher C stocks found in those plots in which crop residue incorporation was carried out in spring, proximate to paddy field flooding. On the other hand, although the LF represented only a small fraction of total SOM, this fraction was more susceptible to management practices than the more stable MOM fraction. In most plots, LF-C generally decreased with depth, more sharply beneath the plough pan, while in the first 5 cm, LF-C and C/N ratios of this fraction decreased as a function of the combined effects of time between crop residue incorporation and the onset of flooded soil conditions, as well as the season during which crop residues are incorporated.

Eight years of continuous rice cultivation and crop residue incorporation have therefore evidenced that (i) association of OM to the mineral fraction is an important process for SOM stabilisation in paddy fields, and (ii) turnover of the more labile OM pools does not only depend on flood-water management but also on the timing of crop residue incorporation.

References: [1] Yu, K.W. *et al.* (2007) *Soil Sci Soc Am J*, **71**, 1406-1417.
[2] Majumder, B. *et al.* (2008) *Soil Sci Soc Am J*, **72**, 775-785.
[3] Kimura, M. *et al.* (2004) *Soil Biol Biochem*, **36**, 1399-1416.

Keywords: Paddy fields, crop residue incorporation, OM stabilisation, density fractionation.

Poster S5-P29

Influence of manganese concentration in beech leaf litter on lignin quality, carbon (DOC) and nitrogen releases during decomposition: field experiment

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Lignin degradation is considered to be the rate limiting step of litter decomposition, a vital process in forest biogeochemical cycles. Among the factors affecting the degradation of lignin, Mn concentration may play a key role since Mn is a cofactor of manganese peroxydase (MnP), the most wide-spread enzyme of the lignin degrading system secreted by the white-rot fungi (Hofrichter, 2002). Correlation between Mn concentration and litter carbon mineralization was previously reported (Berg *et al*., 2007), but the role of Mn on litter decomposition has not yet been experimentally tested.

This study aims to assess the impact of Mn concentration in beech (*Fagus sylvatica L.*) leaf litters on their composition and on their dissolved organic carbon (DOC) and nitrogen releases during decomposition, using a litterbags experimental design.

Therefore, leaf litters with identical composition, except Mn concentration (Mn1, 40; Mn2, 45; Mn3, 60; Mn4, 120 mmol/kg_{DM}), were obtained by dipping branches in Mn solutions (0 to 2.5 mM) for 10 days. Mn was transported through the transpiration stream and accumulated in leaves. Litter samples (2.5 g) were enclosed in separate litterbags (18 x 18 cm) and were placed below the L layer of a mor forest floor (Forêt de Soignes, Bruxelles) in a randomized design. The procedure was replicated 4 times by leaving the litterbags in 3 different locations to avoid pseudoreplication. The bags were then collected 4 (t_1), 10 (t_2) and 16 (t_3) months later. For each sample, we determined mass loss, C and N contents, cationic composition, lignin quantity (Van Soest, 1963) and quality (by chemolytic analyses conducted by CuO method adapted from Kögel and Bochter (1985)). We obtained leachates by water extraction from beech leaf litter subsamples. On these leachates, we quantified DOC, absorbance (280 nm) and inorganic nitrogen (NH_4^+ and NO_3^-).

After 16 months (t_3) in the field, Mn4 leaf litter exhibited a significant larger mass loss (35%) than the other leaf litters (25-30%). After 10 months (t_2), the leaf litter with the largest concentration (Mn4) exhibited a lower carbon content than the other leaf litters (t_2, 41.2% *vs* 44-45%, $P = 0.0024$; t_3, 40% *vs* 43-44%, $P = 0.0165$). After 16 months (t_3), the Mn3 and Mn4 leaf litter leachates exhibited larger DOC release than Mn1 and Mn2 leaf litter leachates ($P = 0{,}0274$). Furthermore, DOC in leachate of the Mn4 leaf litter exhibited a significant larger molar absorptivity (absorbance at 280 nm/DOC concentration) (Mn1, 13.5; Mn2, 20.6; Mn3, 21.3 < Mn4, 28.2, $P = 0.0673$). The $NO_3^-/NH_4^+ + NO_3^-$ ratio was significantly lower for the nitrogen release from Mn3 and Mn4 leaf litters leachates.

After 16 months (t_3), Mn4 leaf litter presented a lower VSC (sum of CuO oxidation products - vanillic acid and vanillin (V), syringic acid and syringaldehyde (S), *p*-coumaric and ferulic acids (C)) than Mn1 leaf litter (130 *vs* 200 µg/C-g, $P = 0.02$). Also, Mn4 leaf litter presented a lower S/V ratio and a larger $(Ac/Al)_S$ than Mn1 leaf litter ($P < 0.0001$ and 0.0655, respectively).

Our results suggest that Mn concentration affects the carbon and nitrogen releases. The larger DOC release by Mn rich litter could be explained by enhanced ligninolysis. Indeed, molar absorptivity, which estimates the aromaticity of DOC, suggests that the additional DOC originates from lignin degradation. The chemolytic analysis of lignin supports this hypothesis. Indeed, VSC estimates intact lignin structural units. S/V and $(Ac/Al)_S$ ratio are considered, respectively, as lignin condensation and alteration indicator.

The relatively small $NO_3^-/NH_4^+ + NO_3^-$ ratio in leaf litters with the largest Mn concentration could be explain by a depression of nitrification process. Dissolved polyphenolic compounds produced by ligninolysis could inhibit nitrification (allelopathy).

References:

Berg, B., Steffen, K.T., and McClaugherty, C.A. 2007. Litter decomposition rate is dependent on litter Mn concentration. Biogeochemistry 82: 29-39.

Hofrichter, M. 2002. Review: lignin conversion by manganese peroxydase (MnP). Enzyme and Microbial technology 30: 545:566.

Kögel, I. and Bochter, R. 1985. Characterization of lignin in forest humus layers by high-performance liquid chromatography of cupric oxide oxidation products. Soil. Biol. Biochem. 17(5): 637-640.

Van Soest, P.J. 1963. Use of detergent in the analysis of fibrous feeds. II. A rapid method for the determination of fibre and lignin. J. Ass. Office. Anal. Chem. 46: 829-835.

Keywords: Litter decomposition, manganese, lignin, litterbags, carbon and nitrogen release, beech

Poster S5-P30

Influence of sedimentation dynamics on SOM stabilisation in floodplain soils

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Chemical and physical properties of mineral soils in riverine floodplain systems are determined by flooding which controls sedimentation and erosion processes as well as redox conditions. Floodplain soils are assumed to hold high stocks of organic carbon in both topsoil and subsoil horizons (Batjes, 1997) due to the high biomass production (Giese et al., 2003; Naiman & Décamps, 1997) and the input of allochthonous organic material during flooding events (Pinay et al., 1992). Environmental changes (such as changes in flooding frequency or intensity due to global climate change or hydro-engineering activities) have an impact on the sedimentation conditions in riverine floodplains. Aim of our study was to determine the influence of changing sedimentation dynamics on SOM stabilisation within microaggregates. We hypothesise that a continuous input of less-aggregated sediments into the floodplain soils constrains the formation of soil aggregates and the amount of SOM occluded within the aggregates.

To test our hypothesis we are analysing the aggregate stability and the amount of occluded organic matter from selected soil profiles of our investigation area in the floodplains of the Nationalpark Donau-Auen (near Vienna, Austria). In a further study we were able to identify a gradient for the dynamic of sedimentation conditions by using vegetational and geomorphological parameters (Cierjacks et al., in press). We compared (1) samples of sites characterised by very dynamic sedimentation conditions and of sites with continuous delivery of sediments and (2) samples taken from topsoil horizons of the active floodplain with samples behind the dike, which was built in 1884.

We carried out a density fractionation procedure (Golchin et al., 1994; Grünewald et al., 2006) to obtain the amount of organic matter bound the following operationally defined fractions:

- fPOM, free particulate organic matter
- iPOM, intra-aggregate particulate organic matter
- MOM, organic matter associated to mineral surfaces.

These operationally defined fractions differ in their grade of stability against mineralisation and OM turnover times, consequently. The aggregate stability was determined using ultrasound dispersion.

Results of density fractionation show that the distribution of recovered OC of all analysed soil samples decreased in the following order: MOM >> iPOM > fPOM. This indicates that association of OM to mineral surfaces is the main stabilising mechanism of SOM in floodplain soils. In agreement with our hypothesis, soils with continuous sedimentation show lower aggregate stability and lower content of intra-aggregate particulate organic matter than soils with dynamic sedimentation conditions, where longer periods without delivery of sediments further particle aggregation. Recently we are analysing the aggregate stability and fractionation of SOM of soil samples taken at the river- and the land-side of the dike to further test our hypothesis.

To date our results indicate that changes of environmental conditions will influence the importance of the different stabilising mechanisms for SOM. Hence, the carbon sequestration potential of the riverine floodplain soils is supposed to be influenced by varying sedimentation conditions as a consequence of an altering environment.

References: Batjes NH (1996) Total carbon and nitrogen in the soils of the world. European Journal of Soil Science 47, 153-163

Cierjacks A, Kleinschmit B, Babinski M, Kleinschroth F, Markert A, Menzel M, Ziechmann U, Schiller T, Graf M, Lang F (accepted) Carbon sequestration by soil and vegetation on Danubian floodplains. Journal of Plant Nutrition and Soil Science, accepted.

Giese LA, Aust WM, Kolka RK, Trettin CC (2003) Biomass and carbon pools of disturbed riparian forests. Forest Ecology and Management 180, 493-508

Golchin A, Oades JM, Skjemstad JO, Clarke P (1994) Study of Free and Occluded Particulate Organic matter in Soil by Solid state 13C CP/MAS NMR Spectroscopy and Scanning Electron Microscopy. Australian Journal of Soil Research 32, 285-309

Grünewald G, Kaiser K, Jahn R, Guggenberger G (2006) Organic matter stabilization in young calcareous soils as revealed by density fractionation and analysis of lignin-derived constituents. Organic Geochemistry 37, 1573-1589

Naiman RJ, Décamps H (1997) The ecology of interfaces. Riperian Zones. Annual Review of Ecological Systems 28, 621-658

Pinay G, Fabre A, Vervier P, Gazelle F (1992) Control of C, N, P distribution of riparian forests. Landscape Ecology 6, 121-132

Keywords: Riverine floodplains, sedimentation dynamics, soil aggregates, density fractionation

Poster S5-P31

Influence of temperature on the turnover time of mineral-associated soil organic matter

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Soil organic matter (SOM) in intimate association with mineral surfaces represents a large portion of the earth's stabilized carbon (C). The dynamics of this 'chemically stabilized' pool of SOM will determine major feedbacks to the C cycle with global change. Despite this, the effect of increasing temperatures on chemical stabilization is not well understood. We used soils from the Old-Field Community, Climate, and Atmosphere Manipulation Experiment (OCCAM) on the Oak Ridge National Environmental Research Park to assess the impact of warmer temperatures on the turnover times of different soil fractions, including mineral-associated SOM. We isolated POM, microaggregate-associated C, and silt- and clay-associated C using a series of size and density fractionations. Microaggregate-associated C was further separated into mineral-associated C and POM-associated C by density fractionation. Because chemically stabilized C decomposes slowly, we expected this pool to be more sensitive to temperature than labile C that decomposes quickly. Preliminary data from Garten *et al*. suggests that temperature has little influence on the fraction of new C stabilized in the mineral-associated pool. By separating soil C into several fractions with potentially different temperature sensitivities, we increased the sensitivity of our analysis to changes in δ^{13}C values. This is one of several complementary studies designed to understand how rising temperatures are likely to affect the turnover of chemically stabilized SOM.

References: Garten, C. T., et al. (2009), Soil moisture surpasses elevated CO_2 and temperature as a control on soil carbon dynamics in a multi-factor climate change experiment, Plant and Soil, 319(1-2), 85-94.

Keywords: Mineral-associated soil organic matter, chemical stabilization, temperature sensitivity, turnover time

Poster S5-P32

Is the temperature sensitivity of a semi arid soil respiration modified by a labile carbon addition?

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Carbon stored in soils represents the largest terrestrial carbon pool. The respiration of heterotrophic microorganisms decomposing soil organic carbon (SOC), *i.e.* soil respiration (SR), releases CO_2 from soils to the atmosphere. Thus even a small rise of the SR could have important effect on the global CO_2 emissions to the atmosphere. It is therefore important to fully understand the temperature dependence of SR. However, there is still disagreement on the explanations proposed for the SR response to long-term increasing soil temperatures that mostly include depletion of fast-cycling SOC pools and thermal adaptation of microorganisms.

An understanding of SR temperature dependence is critical in semi-arid regions such as North West Tunisia, where SOC stocks are low and where agricultural productivity is already limited by climatic conditions. Temperatures in these environments can easily reach 40°C and may even rise to 50°C during heat waves. Yet very few experimental data reported SR temperature sensitivity above 20-30°C. The objectives of this study were (i) to investigate the response of SR to temperature increases from 20 to 50°C in a Tunisian cultivated Cambisol (22.1 g SOC kg^{-1}), and (ii) to test the labile SOC depletion hypothesis as the explanation of the decrease of SR sensitivity to temperature when soil samples have been pre-incubated at high temperatures. For that, soil samples were incubated with and without glucose addition (+ 2.4 g C kg^{-1} soil) for 28 days after a 28-day pre-incubation period. Pre-incubation and incubation were carried out at 20°C, 30°C, 40°C and 50°C.

High temperatures stimulated SR during the pre-incubation period. There was likely higher consumption of labile SOC during pre-incubation at high temperatures. During the incubation period, high temperatures stimulated SR also. This SR stimulation was higher in soil samples without glucose addition than in soil samples with glucose addition, respectively Q_{10}=2.0 and 1.2). In addition, the pre-incubation modified SR response to temperature during incubation period, but only for soil samples which were not added with glucose. Smaller SR increases were noted when soil samples were pre-incubated at high temperatures (40, 50°C). With glucose addition soil samples showed equal SR increase with increasing temperature regardless of the temperature of pre-incubation.

The relation between mineralized SOC during the two incubation periods (56 days) and the sum of the temperatures during the two incubation periods have been investigated. The cumulated mineralized SOC in soil samples with added glucose linearly increased with increasing temperature sum. Cumulated mineralized SOC is independent of the temperature order between the two incubation periods. On the contrary, although cumulated mineralized SOC in soils without glucose addition also increased with temperature sum, these increases were dependent of the pre-incubation temperature. The increase is sharper with low pre-incubation temperatures (20, 30 and 40°C) than with high pre-incubation temperature (50°). Thus, labile substrate depletion in pre-incubated soils at high temperature seemed to mitigate the SOC decomposition during the second incubation period.

Mineralisation rates of glucose are greater at higher than at lower incubation temperatures. Furthermore high pre-incubation temperatures (40, 50°C) modified the mineralisation rate of glucose especially at 50°C.

The shape of the glucose induced respiration kinetic suggested an initial low microbial biomass in the soils pre-incubated at 40 and 50 °C.

Decreases in the microbial biomass and substrate availability certainly contributed to the reduction in the SR rate in soils heated up to 40°C, which is very common in Tunisian semi arid soils. Further research focusing especially on microbial biomass quantification and dynamics in these soils at temperature up to 50°C is now required.

Keywords: Climate change, Temperature perturbations, Soil respiration, Microorganism activity, Glucose addition, Pre-incubation temperatures

Poster S5-P33

Leaf litter leaching, soil carbon sorption and phosphorus availability in lowland tropical forests

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Dissolved organic carbon leaching from decomposing leaf litter may enhance phosphorus availability in strongly-weathered soils, yet the mechanisms involved remain poorly understood. To investigate this, we used radio-labeled phosphate as a sensitive tracer to quantify the effect of litter leachate from 22 tropical tree species on soil phosphate sorption. First, the effect of leachate on ^{32}P sorption was investigated using five species and three soils that had uniform texture and mineralogy but differed in organic carbon concentration (2.7 – 3.5% total organic carbon) due to six years of experimental leaf litter manipulation. In a second experiment, we assessed the influence of leachate from a further 17 species on phosphorus sorption in two soils varying in both total carbon and nutrient status (total phosphorus: 209 and 872 mg kg^{-1}; total organic carbon: 3.9 and 4.6%). For both experiments the effect of litter leachate on ^{32}P sorption was evaluated for one hour with a simulated throughfall solution as a control. Covariance with initial phosphate in solution was accounted for, all litter was recently senesced, and leachates were standardized by solution to litter ratio and time of extract. In the first experiment, soil with the lowest carbon concentration (litter removal treatment) showed markedly greater phosphate sorption, and leachate from all five species investigated decreased phosphate sorption. In contrast, only two species significantly decreased phosphate sorption for the high carbon soil. In the second experiment, nine of the eighteen species decreased phosphate sorption in at least one soil and six of these species significantly decreased phosphate sorption in both soils. Sorption of ^{32}P was negatively related to leachate ionic strength for all soils, whereas ^{32}P sorption was related to dissolved organic carbon sorption only for the soils with lower organic carbon content (ie the litter removal soil and the lower nutrient status soil in the respective experiments showed negative relationships between ^{32}P and DOC sorption). In summary, results demonstrate that water extracts of litter can decrease phosphate sorption to soil. Regressions suggest that competition for sorption sites between phosphate and dissolved organic carbon is important in maintaining phosphate in solution in soils with lower carbon content, while the effects of ionic strength are important regardless of soil carbon content.

Keywords: dissolved organic carbon, litter leachate, tropical forest, strongly-weathered soil

Poster S5-P34

Linking soil organic matter pools, vegetation and land degradation in dryland ecosystems

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Drylands occupy ~ 45 % of the earth's surface and are prone to land degradation by different processes such as soil erosion, salinisation, loss of nutrients and biodiversity changes (Lal, 2001, Nosetto et al., 2006). Despite the low C status of drylands, soil organic carbon (SOC) is the largest C pool in these systems (Nosetto et al., 2006) and estimated at ~16% of the global soil C pool (Jobbagy and Jackson, 2000). It is obvious that restoring these systems could yield significant ecosystem carbon gains and better ecosystem function.

Traditionally, most studies quantified the dryland ecosystem changes by studying the variation in vegetation structure and phenology (e.g. Asner et al., 2003, Mueller et al., 2007). Studying vegetation dynamics is meaningful, but the direct role of life is not easy to separate from the role of climate, because biota are strongly affected by water and heat and reflect short term reactions of the system (Amundson et al., 2007). As SOC integrates many ecosystem processes, including plant litter inputs, microbial decomposition, nutrient dynamics, faunal activities and hydrological processes. It is regarded as a good indicator for the long-term balance of C and N inputs and outputs. Therefore, it is hypothesized that studying dryland degradation through changes in SOC composition, rather than through changes in vegetation characteristics, will more directly assess the long-term integrated effects of land degradation (Janzen, 2005).

The aim of this research project is to study the spatial distribution of soil organic carbon (SOC) and its role and stability (to decomposition) along topographical and degradation gradients in order to better understand long-term land degradation in semi-arid ecosystems.

In order to be able to explain the heterogeneity of SOC in function of soil, topography and land use history soil profiles were taken in SE Spain (Province of Almeria). Preliminary results show that SOC content in the top 5 cm varies between 0.19 and 5.06 %, with the lowest values reported for recently abandoned fields on steep convex upslope positions and high values for deposition zones that have been abandoned for a long time.

In a next step the spatial distribution of topsoil SOC will be studied in detail along a land use gradient and will be related to the vegetation pattern. It is hypothesized that 1) following land degradation and desertification, the SOC pattern will decrease differently compared to the vegetation pattern and 2) that following desertification, the temporal variation of stored SOC decreases whereas its spatial variation increases.

References: Amundson, R., Richter, D.D., Humphreys, G.S., Jobbagy, E.G., Gaillardet, J. 2007. Coupling between biota and earth materials in the critical zone. Elements, 3: 327-332.

Asner, G. P., Borghi, C.E., Ojeda, R.A. 2003. Desertification in central Argentina: changes in ecosystem carbon and nitrogen from imaging spectroscopy. Ecological Applications, 13: 629-648.

Janzen H.H. 2005. Soil carbon: A measure of ecosystem response in a changing world? Canadian Journal of Soil Science 85:467-480.

Jobbagy, E.G., Jackson, R.B. 2000. The vertical distribution of soil organic carbon and its relation to climate and vegetation. Ecological Applications, 10: 423-436.

Lal, R. 2001. Potential desertification control to sequester carbon and mitigate the greenhouse effect. Climatic change, 51: 35-72.

Mueller, E.N., Wainwright, J., Parsons, A.J. 2007. The stability of vegetation boundaries and the propagation of desertification in the American Southwest: a modelling approach. Ecological Modelling, 208: 91-101.

Nosetto, M.D., Jobbagy, E.G., Paruelo, J.M. 2006. Carbon sequestration in semi-arid rangelands: comparison of Pinus ponderosa plantations and grazing exclusion in NW Patagonia. Journal of Arid Environments, 26: 142-156.

Keywords: land degradation, soil organic carbon dynamics, land use, topography

Poster S5-P35

Litter decomposition in lowland tropical forests: isolating the influence of rainfall, leaf traits, and soil properties

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Changes in precipitation regimes are a dominant feature of climatic change predictions in tropical forests in Central America, with likely consequences for the decomposition of organic matter and hence ecosystem carbon balance. Precipitation has a direct effect on decomposition by influencing soil moisture and, therefore, decomposer abundance and community composition. Precipitation also affects decomposition indirectly, by influencing the amount and 'quality' of leaf litter through changes in productivity and composition of plant species.

The importance of these two pathways was investigated using reciprocal leaf litter transplants along a strong precipitation gradient in Panama. Mean annual rainfall increases from 1800 mm per year on the Pacific Coast to 3500 mm per year on the Atlantic Coast over 40 km, and is inversely correlated with dry season length. Senesced leaves from ten plant species, including trees, understory shrubs and lianas, varying in litter chemical composition and in their distribution across the gradient, were placed in 1 mm mesh bags at 19 sites across the rainfall gradient that vary markedly in soil nutrient status due to differences in parent material. Soil microbial community composition was assessed using phospholipid fatty acid analysis. Litter bags were recollected at the end of the 9 month dry season and analysed to determine mass loss, nutrient loss and associated enzyme activity.

Species identity exerted a strong control on mass loss through differences in leaf chemistry. In contrast, mean annual precipitation alone explained little of the variation in mass loss, presumably due to interactions with soil nutrient availability. This indicates that differences in wet season rainfall *per se* do not control rates of decomposition, but that decomposition may differ with the dry season rainfall or length. Analysis of soil microbial community composition and the activity of hydrolytic enzymes are being investigated to determine their influence on underlying mechanisms of decomposition. In summary, our results suggest that changes in mean annual precipitation are more likely to influence rates of leaf litter decomposition indirectly via changes in species composition, or within species variation in nutrient quality, than directly by influencing physical and biological processes in soil.

Keywords: decomposition, precipitation, decomposer fauna, tropical forests, litter chemistry

Poster S5-P36

Long-term bare fallow experiments offer new opportunities for the study of stable carbon in soil

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Soil organic Carbon (SOC) is divided into three pools of different turnover times in most soil C models. The difference of vulnerability of stable C (turnover of several hundred years) compared to labile (turnover of a few years) and intermediate C (turnover of several decades) to environmental changes is highly debated. As soil C respiration is largely dominated by labile and intermediate C respiration, stable C respiration modification induced by environmental changes is very difficult to assess. From this point of view, finding soils containing nearly exclusively stable C would open large research avenues to study stable SOC vulnerability to global change.

Long-term bare fallow (LTBF) experiments, in which the decay of SOC is monitored during years after input from plant material has been shut down, can potentially provide such highly valuable kind of soils. A LTBF network was initiated and the results from 6 long-term experiments (Askov (Denmark), Grignon & Versailles (France), Kursk (Russia), Rothamsted (UK), and Ultuna (Sweden)) lasting for decades will be presented. The conceptual model of SOC being divided into three pools with increasing turnover times, a labile pool (~years), an intermediate (~decades) and a stable pool (~several centuries or infinite) fits well with the long term SOC decays observed in bare fallow soils. The modeled stable pool estimates ranged from 2.7 at Rothamsted to 6.8 gC kg^{-1} at Grignon, though with considerable uncertainty. At Versailles, where the uncertainty associated with the inference of a stable pool is the lowest, soil contains stable C only after 79 years of continuous bare-fallow duration. Consequently, Versailles soil represents a truly unique research platform for future experimentation addressing the characteristics of stable SOC and its vulnerability to global change.

Keywords: bare fallow, long-term experiment; soil carbon dynamics; stable soil carbon.

Poster S5-P37

Long-term fertilization effects on carbon and nitrogen sequestration in mono-rice paddy soil cultivation

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Soil organic carbon (SOC) has an important role in enhancing soil quality and sustaining production by increasing carbon sequestration. A long-term fertilization study was conducted to investigate changes in SOC and its relation to soil physical properties in a rice paddy soil. The paddy soils analyzed were subjected to different fertilization practices: continuous application of inorganic fertilizers (NPK, N–P–K = 120–34.9–66.7 kg ha^{-1} yr^{-1} during 1967–1972 and 150–43.7–83.3 kg ha^{-1} yr^{-1} from 1973 to 2007), straw based compost (Compost, 10 Mg ha^{-1} yr^{-1}), a combination of NPK + Compost, and no fertilization (control). Continuous compost application increased the total SOC and STN concentration in plough layers. Total SOC and STN accumulation in the surface layer of the paddy rice field for the past 41 years were significantly increased in the compost-treated plots, but gradually decreased in the NPK treatments and unfertilized control. The decreasing trend of SOC and STN in the plots that were only applied with inorganic fertilizers and no fertilization might be due to the reducing soil N and C sequestration. Specifically, the gained C and N in the NPK treatment were very high at 3.5 and 0.98 Mg ha^{-1}, respectively, with respect to the control treatment, but compost addition to NPK significantly increased the sequestered C and N at 12.3 and 1.05 Mg ha^{-1}, respectively with the lapse of years. Conclusively, long-term compost addition to inorganic fertilization in paddy soils can be a very effective soil management to increase C and N sequestration, improve soil quality and sustain crop productivity.

References: Bhattacharyya R, Prakash V, Kundu S, Srivasta AK, Gupta HS, Mitra S (2010) Long term effects of fertilization on carbon and nitrogen sequestration and aggregate associated carbon and nitrogen in the Indian sub-Himalayas. Nutr Cycl Agroecosyst 86:1-16

Keywords: long-term fertilization, carbon sequestration, nitrogen sequestration, soil profile

Poster S5-P38

Manipulation of temperature and precipitation alter CO_2 fluxes from an arable soil

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Carbon cycling in terrestrial ecosystems provides a feedback mechanism to climate change by releasing or sequestering additional atmospheric CO_2. However, the response of terrestrial carbon cycling to the interactive effects of both a changing temperature and precipitation regime is still unclear. The Hohenheim Climate Change (HoCC) field experiment was established in summer 2008 to manipulate both soil temperature and precipitation on an arable field. Plots are covered by roofs which are closed with a UV-transparent greenhouse film during summer. Roof control plots (without roof) were additionally established to account for the impact of the roof on micro-environmental conditions (only ambient precipitation). Each treatment is replicated four times. Soil temperature is increased by 2.5°C at 4 cm depth using heating cables placed on the surface. Each ambient and elevated temperature plot is 4 x 1 m² and is divided into 4 subplots according to the following precipitation manipulation treatments: a) ambient, b) precipitation amount decreased by 25% during summer and increased by 25% during winter, c) drought periods increased by 50% during summer, d) combination of b and c. Each subplot is surrounded by a PVC barrier to a depth of 0.5 m to avoid lateral water movement between subplots and the surrounding soil. Soil temperature and soil moisture are monitored continuously at each plot. Experimental plots were planted with spring wheat (*Triticum aestivum*) in 2009. Plants were harvested in August and aboveground biomass was determined. We measured CO_2 fluxes weekly using the closed chamber method.

Soil moisture remained relatively low beginning with closure of the roofs at the start of June until the rewetting of the soil in October. During this period the heated roof plots were much drier (Ø 12.8% vol. H_20) than the heated control plots without roofs (Ø 17.7% vol. H_20), indicating a roof effect. This roof effect modified the temperature effect on cumulative CO_2 production, significantly increasing CO_2 production by 21% at the roof control plots and with no effect below the roofs. The reduction in precipitation amount interacted with the temperature manipulation showing only a significant decrease in cumulative CO_2 production at the non-heated plots. Both the interaction between roof effect and temperature as well as between precipitation amount and temperature indicate that at the heated roof plots CO_2 production was water limited, which eliminated the enhancing effect of the temperature increase. This is supported by preliminary results of the seasonal temperature sensitivity of soil respiration data, which indicate that Q_{10} values are lowest at the heated roof plots and that soil moisture is an effective constraint on temperature sensitivity of soil respiration. Beside soil respiration the effects of temperature and precipitation manipulation on other important parameters of the soil carbon cycle like microbial biomass and aboveground biomass will be presented.

Keywords: climate change, soil warming, precipitation manipulation, soil respiration

Poster S5-P39

Mechanisms of soil organic matter stabilization in buried paleosol horizons

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Paleosols and their stored soil organic matter (SOM), integrate biogeochemical information of historic climatic conditions and the processes which led to carbon (C) storage on millennial time-scales. The present research combines isotopic, spectroscopic, and geochemical techniques, as well as an understanding of sedimentary processes, to study the types of plant and microbially-derived compounds sequestered in Holocene loess deposits and the processes responsible for their long-term stabilization.

Loess depositional sites accumulating over millennial time periods in the central Great Plains of the United States reveal a dark, almost 1 m thick, buried horizon at 5-6 m depth referred to as the Brady Soil. These loess deposits have been used to reconstruct paleoclimate and vegetation history (Miao et al. 2007). The Brady soil, in particular, developed between 13,500 and 9000 years BP, at the time of transition from C3 to C4 dominated plants, which is attributed to a drying and warming period (Mason et al. 2003). The buried horizon is dark colored like a typical surface humic mineral horizon, yet it has very low C concentrations (< 1 %) (Feggestad et al. 2004). The buried soil has become exposed in recent decades due to road construction. Due to its depth and geographic extension, the Brady Soil represents considerable C stocks.

We sampled: (1) a modern surface A horizon, (2) a buried (Ab) horizon (1.1 m depth), and (3) the top (6 m depth) and (4) bottom (7 m depth) horizons of the Brady Soil from a Holocene Bigness Loess deposit near Wauneta, in southwestern Nebraska. All samples were subjected to physical density fractionation using 1.85 g/ml sodium polytungstate, yielding the following fractions: (a) a free, light or particulate organic matter (fPOM) fraction, (b) large occluded POM (oPOM), and (c) small (< 20 um) occluded POM (oPOMsmall). The residual heavy, mineral-associated fraction was further separated by particle size ((d) sand, (e) silt, (f) clay).

Bulk soil in the buried Brady Soil horizon has narrow C/N ranges, indicating a dominance of microbial residues. Preliminary results indicate that SOM is mainly stabilized by the occlusion within soil aggregates and through association with the mineral phase. The distribution of total and organic C, elemental HNS, and stable C and N isotopic composition between different physical fractions, will provide insight into mechanisms of physical and chemical stabilization. Radiocarbon based mean residence times will be determined for the physical fractions. The chemistry of reference plant materials (leaf and root litter) from modern day analogues of C4 and C3 vegetation and of the fractions will be analyzed using solid-state ^{13}C-NMR and pyrolysis gas chromatography mass spectrometry to determine decomposition state and potential sources of the buried organic matter. Long-term depositional sites provide a unique opportunity to document changes in SOM chemistry and residence time with changes in climate and vegetative cover over long time scales of centuries to millennia.

References: Feggestad et al. 2004. Physical Geography 25, 170-190.
Mason et al. 2003. Quaternary Research 60: 330-339.
Miao et al. 2007. Paleaeogeography, Palaeoclimatology, Palaeoecology 245: 368-381.

Keywords: paleosol; soil organic matter; stabilization; loess; aeolian deposit

Poster S5-P40

Modeling soil carbon sequestration in Integrated Crop Livestock System of Brazil

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Changes in soil organic carbon (SOC) stocks affects soil physical, chemical and biological processes and the flux of greenhouse gases between land surface and atmosphere (Lal, 2009). Soil cultivation often leads to diminution of SOC stocks, however, management systems, such as, no tillage and integrated crop -livestock, which increase biomass production, decrease mineralization and protect SOC against microbial processes, can improve soil quality to those found in forest soils (Leite et al.,2004). Simulation models (e.g.CENTURY, ROTHC, EPIC) have been used to estimate SOC stocks in different agroecosystems. On the other hand, these mechanistic models are often too complex and show multicompartmental structure based on qualitative concepts rather than measurable entities and the required parameters or input variables are generally difficult to obtain. Therefore, it is important that simpler but mechanistic models be developed and validated under field conditions CQESTR is a process-based model that simulates the effect of management practices on SOC stocks. It requires few input variables and these variables are readily available. The objective of this study was to estimate soil carbon sequestration under Integrated Crop-Livestock System (ICL) in Central and Northeastern Brazil using CQESTR model. The model was evaluated with data from two experiments. One experiment was established in 1993, under an Oxisol (560 g clay kg^{-1}), at the Experimental Station of Embrapa Rice and Beans, in Santo Antônio de Goiás (SAG) (16^{o} 28’ S and 49^{o} 17’ W), Goiás state. The other experiment was established, in 2005 also in Oxisol (340 g clay kg^{-1}), at São Marcos Farm, in Bom Jesus (BJ) (09º 49” S and 45º 06” W), Piaui state. In SAG and BJ experiments, the treatments, which consisted of tillage systems and crop rotation (soybean-corn-pasture or soybean-rice-pasture), were: SAG:1) No-tillage and Integrated Crop-Livestock System, rotation each 4 years (ICL4); 2) No-tillage and Integrated Crop-Livestock System, rotation each 2 years (ICL2); 3) Conventional tillage and Integrated Crop-Livestock System, rotation each 3 years (ICL3); 4) No tillage and Crop Rotation (NT) and; 5) Conventional tillage and Crop Rotation (CT) and in BJ: 1) No tillage and Crop Rotation (NT-BJ); 2) No tillage and Integrated Crop-Livestock system, rotation each 2 years (ICL-BJ) and; 3) Conventional Tillage (CT) (soybean). Adjacent areas with the same soil type and native vegetation (Cerrado-CER) were selected as reference plots at both locations. In SAG, CQESTR estimated to 0-20 cm depth, an decrease in the SOC stocks after conversion of the native forest (1983: 47 Mg ha^{-1}) to management systems (2000: from 34 Mg ha^{-1} (NT and CT) to 36 Mg ha^{-1} (ICL4 and ICL2). However, from 2007, there was an increase in ICL4 and ICL2 reaching, in 2040, 49 and 57 Mg ha^{-1}, respectively. Considering SOC stocks, in the begin of the experiment (1993; 36,6 Mg ha^{-1}) and in 2007, there was carbon sequestration in ICL4 (0.4 Mg ha-1 year^{-1}) and ICL2 (0.34 Mg ha^{-1} year^{-1}) and carbon emission in the other systems. Similarly in BJ, SOC stocks decreased after change from native vegetation (2000: 49 Mg ha^{-1}) to conventional systems (prior to experiment, 2000-2005: 45 Mg ha^{-1}) and recovery, in 2020, with NT-BJ (56 Mg ha^{-1}) and ICL-BJ (51 Mg ha^{-1}) systems. No tillage associated to integrated crop livestock can be an excellent strategy to sequester carbon in Brazilian Oxisol.

References: Lal, R.; Follet, R. Soil and Climate Change. In: Lal, R and Follet, R. F. Soil Carbon Sequestration Rate and the Greenhouse Effect. SSSA. Madison. 2009

Leite, L.F.C., Mendonca, E.S., Machado, P.L.O.A., 2004. Simulating trends in soil organic carbon of an Acrisol under no-tillage and disc-plough systems using the Century model. Geoderma 120, 283–295.

Rickman, R.W., Douglas Jr., C.L., Albrecht, S.L., Bundy, L.G., Berc, J.L., 2001. CQESTR: a model to estimate carbon sequestration in agricultural soils. J. Soil Water Conserv. 56, 237–242.

Keywords: tropical soil, no tillage, CQESTR model, soil organic matter

Poster S5-P41

Organic matter and heavy metals: their interaction and impact to each other

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Lead, copper, and zinc interacted with the soil organic matter when applied to an ordinary chernozem in a pot experiment. Two years after the treatment, an appreciable part of the metals applied was found in the organic substances, predominantly in a loosely bound state. These organic substances were supposed to be organomineral complexes, the formation of which resulted in the partial destruction of humic acid molecules. These processes increased the content of aliphatic structures and the share of fulvic acids and decreased the content of humic acids in the organic matter of the chernozem.

Along with the direct toxicological biochemical effect, the metal contamination can also result in the degradation of soils and the deterioration of the pedochemical parameters. The single-step contamination of the soils with relatively low metal rates (2-3 MPC) resulted in a partial mobilization of the humus two years after the treatment, which was manifested in an increase in the relative content of the mobile organomineral compounds and the share of fulvic acids in the humus composition. The fact that this phenomenon was observed in a chernozem whose humus is a relatively stable system points to its ecological hazard. A slight increase in the content of the humus in the contaminated soils under study is a temporary phenomenon occurring under the specific experimental conditions. The decrease in the content of the humus in the strongly and lastingly contaminated soils, which was repeatedly described in the literature, can be due not only to the damage to plants and the decrease in the mass of arriving plant residues but also to the degradation of the humus because of its mobilization by the metals.

Keywords: heavy metal, mobile organomineral compounds, Chernozem

Poster S5-P42

Organic matter dynamics in agricultural calcareous soil in the North-East of Tunisia

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Soil organic matter represents a significant component of theglobal carbon pool and soil processes are important regulators ofCO_2 in the atmosphere. Quantitative and qualitative aspects of soil organic matter (SOM) are investigated in an calcareous subsoil under agricultural use. The aim of this research was to evaluate the carbon stocks as well as the potential of SOM to be degraded by the soil microbial biomass.

Soil samples were collected in the basin of "Kamech" in Tunisia from four soil profiles at five depths (0-30 cm, 30-50 cm, 50-70 cm, 70-110 cm and 110-140 cm). Samples were incubated at 28°C during 90 days and CO_2 evolution was monitored throughout the incubation using NaOH (1N) traps. The soils sampled had a high clay content of more than 50 %. They were classified as Vertisols (WRB-FAO classification).

The SOM content decreased from topsoils to subsoils. The carbon mineralization from top- and subsoils after 70 days ranged between 530 and 572 mg C-CO_2 kg sol^{-1}. The difference is not significant after 70 days of incubation with no significant differences between both. We conclude that. The incubation indicated that there were metabolically active microbes in the subsoil which can degrade the organic matter.

Keywords: soil organic matter, subsoil, North-East of Tunisia, calcareous soil

Poster S5-P43

Oxyhydrates-mediated C stability controls on aerobic mineralization of organic matter from a red earth paddy under different long-term fertilizations

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Abstract

Soil organic carbon (SOC) mineralization and its response to warming has been a critical issue for assessing the potential contribution of cropland management to global climate change. However, SOC accumulation and decomposition are profoundly influenced by soil nutrient status which is affected by fertilization practices in croplands. Topsoil samples were collected from a long-term fertilization trial on a red earth rice paddy from Jiangxi Province, China and SOC mineralization was studied using aerobic incubation for 58 d at 20□ and 25□, respectively. SOC mineralization rates varied between 0.62 and 0.76 mgC·g-1OC·d-1 at 20□, and between 0.65 and 0.97 mgC·g-1OC·d-1 at 25□, respectively. There was no significant correlation between the mineralization potential and SOC content for the samples under different treatments. However, a close correlation was found between total C mineralization and CSI (Carbon Stability Index,), an indicator of the resistant portion to chemical oxidation. This suggests a control of C lability, rather than total SOC, on the potential of C release from soil. Furthermore, calculated Q_{10} quotient was correlated significantly with the content of DCB-extracted Fe of the samples, which was much accumulated under the combined organic/inorganic fertilization. It is supposed that the free Fe-oxhydrates, rich pedogenetically in the red-earth derived paddy soil which was reported by pan et al (1999) and subject to change under the different long-term fertilization practices, have controls on biological decomposition through a chemical protection mechanism of SOC against enhanced mineralization under warming. Our results suggest that reducing decomposability via enhancing physico-chemical protection of labile SOC by free Fe-oxhydrates would be a soil mechanism for C sequestration and stabilization against warming. This could explain, in part, the rapid accumulation of SOC for the last decade found for the paddy soils from East and South China. Compound inorganic fertilization compared to N fertilization only facilitate C sequestration in rice agriculture of South China with extensive red earth derived paddies.

References:

Blair, J.G., Lefroy, R.D.B., Lisle, L., 1995. Soil carbon fractions based on the degree of oxidation and the development of a carbon management index for agricultural systems. Austrian Journal Agriculture Research 46, 1459-1466; Baldock, J.A, Skjemstad, J.O., 2000. Role of the soil matrix and minerals in protecting natural organic materials against biological attack. Organic Geochemistry ,31 , 697-710; Davidson, E.A., Janssens, I.A..2006. Temperature sensitivity of soil carbon decomposition and feedbacks to climate change. Nature, 440, 165-173; Fang, C., Smith, P., Moncrieff, J.B. and Smith, J.U..2005. Similar response of labile and resistant soil organic matter pools to changes in temperature. Nature, 433,57-59; Giardina, C.P., Ryan, M.G.,2000. Evidence that decomposition rates of organic carbon in mineral soil do not vary with temperature. Nature, 404, 858–861. ; Gulledge, J., Schimel, J.P., 2000. Controls on soil carbon dioxide and methane fluxes in a variety of Taiga Forest stands in Interior Alaska. Ecosystems, 3, 269-282.; Hu, C., Cao, Z.P., Ye, Z.N., Wen, W.L., 2006. Impact of soil fertility maintaining practice on soil microbial biomass carbon in low production agro-ecosystem in northern China. Acta Ecology Sinica, 26, 808-814; Jenkinson, D.S., Powlson, D.S., 1976. The effects of biocidal treatments on metabolism in soil. V.A method for measuring soil biomass. Soil Biology and Biochemistry, 8, 209-213; Jenkinson, D.S., 1990. The turnover of organic carbon and nitrogen in soil. Philosophical Transactions of the Royal Society, B329, 361-368; Kirschbaum, M.U.F., 1995. The temperature dependence of soil organic matter decomposition, and the effect of global warming on soil organic carbon storage. Soil Biology Biochemistry, 27, 753–760; Knorr, W., Prentice, I.C., House, J.I., Holland E.A.,2005. On the available evidence for the temperature dependence of soil organic carbon. Biogeosciences Discussions, 2, 749-755; Leirós, M.C., Trasar-Cepeda, C., Seoane, S. et al., 1999. Dependence of mineralization of soil organic matter on temperature and moisture. Soil Biology and Biochemistry, 31, 327-335; Macdonald, N.W., Randlett, D.L., Donald, Z.R.,1999. Soil warming and carbon Loss from a Lake States Spodosol. Soil Science Society of America Journal,63, 211-218; Meng, L., Ding, W.X., Cai, Z.C., Qin, S.W., 2005. Storage of soil organic C and soil respiration as effected by long-term quantitative fertilization. Advanced Earth Science, 20, 687-692; Pan, G.X., Li, L., Wu, L., Zhang, X.,. 2004. Storage and sequestration potential of topsoil organic carbon in China's paddy soils. Global Change Biology, 10, 79-92; Parton, W.J., Schimel, D.S., Cole, C.V., Ojima, D.S., 1987.Analysis of factors controlling soil organic matter levels in Great Plains grasslands. Soil Science Society of America Journal, 51, 1173–1179; Qi, Y., Xu, M., Wu, J.G., 2002. Temperature sensitivity of soil respiration and its effects on ecosystem carbon budget Nonlinearity begets surprise. Ecological Modeling, 153, 131-142; Schlesinger, W.H., Andrews, J.A., 2000. Soil respiration and the global carbon cycles. Biogeochemistry, 48, 7-20; Smith, V. R., 2003. Soil respiration and its determinants on a sub-Antarctic island. Soil Biology and Biochemistry, 35, 77-91; Song, G.. H., Li, L.Q., Pan, G.X., et al., 2005. Topsoil organic carbon storage of china and its loss by cultivation. Biogeochemistry, 74, 47-62; Thorn, M. S., Trumbore, S. E., Chadwick, O. A. , Vitousek, P.M., Hendricks, D.M., 1997. Mineral control of soil organic carbon storage and turnover. Nature, 389 , 170- 173; Valentini, R., Matteucci, G., Dolman, A. J. et al., 2000. Respiration as the main determinant of carbon balance in European forests. Nature, 404, 861-865; Xu, M., Qi, Y., 2001. Spatial and seasonal variations of Q10 determined by soil respiration measurements at a sierra Nevadan forest. Global Biogeochemical Cycles, 15(3), 687-696; Zhang, J.B., Song, C.C., Yang, W.Y., 2005. Temperature sensitivity of soil respiration and its effecting factors in the different land use. Journal of Environment Science,125, 1537- 1542. (In Chinese; Zhang, X.H., Pan, G. X., Li, L., 2006. Organic Carbon Mineralization and CO2 Evolution from paddy Topsoils and the Temperature Dependence. Journal of Environment Science,19, 319-326; Zheng, J.F, Li L.Q., Pan G.X., Zhang, X.H., 2007. Effect of long-term fertilization practices on production of CH4 and CO2 from bulk and particle size fractions of a typical paddy soil of a typical paddy soil from Taihu Lake Region, China. Agriculture Ecosystem and Environment , 120:129-138; Zhou, Y.C., Pan, G.X., Li, L.Q., 2003. Change of Organic Carbon Pools and the Responses to Soil Warming during Laboratory Incubations under Different Temperatures of 3 Kinds of Paddy Soils in Tai Lake Region, China. Environment Science, 124, 46-51 (In Chinese); Zhou, P., Song, G.H., Pan, G.X., et al. 2009. Role of chemical protection by binding to oxyhydrates in SOC sequestration in three typical paddy soils under long-term agro-ecosystem experiments from South China. Geoderma, 153: 52–60

Keywords: Long-term experiment; C mineralization; Paddy soils; Temperature dependence; soil organic carbon; fertilization

Poster S5-P44

Plant litter decomposition in tropical headwater streams following rubber plantations in Xishuangbanna, SW China

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Streams can be a significant sink of organic carbon derived from terrestrial ecosystems. We designed this study to examine factors controlling plant litter decomposition in tropical headwater streams following rubber tree plantation in Xishuangbanna of southwestern China. We found that converting tropical rain forest to rubber plantations can (1) increase seasonal variation in plant litter decomposition in tropical headwater streams, (2) reduce the mineralization of organic nitrogen and phosphorus, and (3) increased the diversity of stream microinvertebrates. Changes in the decomposition of plant litter in tropical headwater streams following rubber tree planting is predominantly controlled by the altered chemical and physical stream properties. Both stream biota and rubber leaves had relatively minor influences on the decomposition of plant litter in these tropical head water streams.

Keywords: Tropical Headwater Streams, Rubber Plantations, Water Quality, Macroinvertebrates, Litter Decomposition

Poster S5-P45

Pool Sizes and Turnover of Soil Organic Carbon of Farmland in Karst Area in Guilin

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The three pools comply with three first order model. The paper uses the model and decomposition curves of soil organic carbon to fit active pool and its decomposition rate, slow pool and its decomposition rate. The results show that the size of active pool from different profiles accounts for 2.09%-3.08% of total soil organic carbon and the mean residue time is 3.57-17.21 days. And the size of slow pool from different profiles accounts for 3.19-43.55% of total soil organic carbon and the mean residue time is 1.12-4.94a. Acid hydrolysis is used to fractionate passive organic carbon, which accounts for 50.83%-94.44% of total soil organic carbon.

Keywords: karst area， farmland， soil organic carbon pool， turnover time

Poster S5-P46

Priming effects in pasture soils of Southern Ecuador

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In the mountain rainforest region of the South Ecuadorian Andes natural forests often have been converted to pastures by slash-and-burn. With advanced pasture age the pasture grass (*Setaria sphacelata,* a C4-plant species) is replaced more and more by the tropical bracken (*Pteridium arachnoideum,* a C3-plant species) leading to the abandonment of this unproductive pastures. To prevent any further forest clearing for the establishment of new pastures, a development of sustainable management strategies for existing pasture land is a prerequisite. Therefore, a pasture fertilisation experiment has been established where urea is used as nitrogen fertiliser. Furthermore, the impact of bracken and grass litter on mineralisation processes has been assessed.

To track the effects of urea fertilisation on soil organic matter (SOM) mineralisation a laboratory incubation experiment with the addition of ^{14}C- or ^{15}N-labelled urea (74 mg urea-N kg^{-1} dw soil) has been carried out for 28 days at 22°C in the dark. The fate of ^{14}C into CO_2 or microbial biomass and that of ^{15}N into the KCl extractable NH_4-N or NO_3-N or microbial biomass pool has been monitored during incubation. Furthermore, the structure of the soil microbial community was assessed using phospholipid fatty acid analysis (PLFA). Top soil samples from active pasture sites and abandoned pasture sites dominated by bracken were examined. Urea accelerated the mineralisation of SOM directly after addition up to 17 % (positive priming effect) compared to the non-fertilised control and induced a shift in the microbial community composition towards a relative lower abundance of PLFA marker characteristic of Gram positive bacteria and a higher one of those typical of Gram negative bacteria and fungi. This shift was positively correlated with the increase in NH_4, NO_3 and DON availability. In addition to the activation of different microbial groups, the abolishment of energy limitation of the microbes seemed to be an important mechanisms for the enhanced mineralisation of soil organic matter (Hamer et al., 2009).

In the second experiment bracken and grass litter – differing in their biochemical compounds as characterised by their lignin content, C/N and C/P ratio as well as by their availability of organic C and N sources and their natural ^{13}C abundance– were incorporated in top soils of their corresponding origin sites and vice versa. Both amendments significantly changed not only the structure of the soil microbial community but also nutrient cycling dynamics resulting in a retardation of SOM mineralisation (negative priming effect) after the addition of grass litter. After the addition of bracken litter to the abandoned pasture soil a positive priming effect seemed to be supported by an N limitation at the end of incubation (Potthast et al., 2010). Thus, soil organic matter dynamics in pasture soils of the South Ecuadorian Andes were complex and at least partly controlled by fertilisation regime and litter quality.

References: Hamer, U., Potthast, K., Makeschin, F., 2009. Urea fertilisation affected soil organic matter dynamics and microbial community structure in pasture soils of Southern Ecuador. Applied Soil Ecology 43, 226-233.

Potthast, K., Hamer, U., Makeschin, F., 2010. Impact of litter quality on mineralization processes in managed and abandoned pasture soils in Southern Ecuador. Soil Biology & Biochemistry 42, 56-64.

Keywords: priming effect, PLFA

Poster S5-P47

Priming effects under elevated atmospheric CO_2: consequence of the increased microbial turnover in soil?

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Increasing the belowground translocation of assimilated carbon by plants grown under elevated CO_2 can cause a shift in the structure and activity of the microbial community responsible for the turnover of organic matter in soil. We investigated the long-term effect of elevated CO_2 in the atmosphere on the contribution of fast- (r-strategists) and slow-growing (K-strategists) microorganisms in soil macro and microaggregates in root-free and rhizosphere soil. We evaluated also the effect of elevated CO_2 on four extracellular enzymes representing the main steps of soil biogeochemical cycles: β-glucosidase, chitinase, phosphatase and sulphatase.

The experiments were conducted under two free air carbon dioxide enrichment (FACE) systems: in Hohenheim and Braunschweig, as well as in the intensively managed forest mesocosm of the Biosphere 2 Laboratory (B2L) in Oracle, AZ. Microbial biomass (C_{mic}), and specific microbial growth rates (μ) were determined using the substrate-induced respiration response from bulk soil and aggregates after glucose and/or yeast extract addition to the soil. Extracellular enzyme activities were measured using fluorogenically labelled substrates. To estimate the potential enzyme production, we activated microorganisms by substrate (glucose and nutrients) amendment.

Although Corg and Cmic were unaffected by elevated CO_2, μ values were significantly higher under elevated than ambient CO_2 for bulk soil, small macroaggregates, and microaggregates. We conclude that elevated atmospheric CO_2 stimulated the r-selected microorganisms, especially in soil microaggregates (Dorodnikov et al., 2009a). For B2L and both FACE systems, up to 58% higher μ were observed under elevated vs. ambient CO_2, depending on site, plant species and N fertilization (Blagodatskaya et al., 2010). The μ-values increased linearly with atmospheric CO_2 concentration at all three sites. The effect of elevated CO_2 on rhizosphere microorganisms was plant dependent and increased for: Brassica napus=Triticum aestivum

References: Blagodatskaya, E., Blagodatsky, S., Dorodnikov, M., Kuzyakov, Y., 2010. Elevated atmospheric CO_2 increases microbial growth rates in soil: results of three CO_2 enrichment experiments. Global Change Biology 16, 836-848.

Dorodnikov M., Blagodatskaya E., Blagodatsky S., Fangmeier A., Kuzyakov Y. 2009a Stimulation of r- vs. K- selected microorganisms by elevated atmospheric CO_2 depends on soil aggregate size. FEMS Microbiology Ecology. V.69. P.43-52.

Dorodnikov, M., Blagodatskaya, E., Blagodatsky, S., Marhan, S., Fangmeier, A., Kuzyakov, Y., 2009b. Stimulation of microbial extracellular enzyme activities by elevated CO_2 depends on aggregate size. Global Change Biology 15, 1603-1614.

Kuzyakov, Y. 2010. Priming effects: Interactions between living and dead organic matter. Soil Biology & Biochemistry, doi:10.1016/j.soilbio.2010.04.003.

Keywords: Elevated CO_2, Priming effect, Microbial growth strategies, enzyme activities, Soil aggregates

Poster S5-P48

Role of carbon availability for lignin degradation in decomposing plant litter

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Lignin is considered to be among the most stable components of plant litter. Its degradation is thought to control litter mass loss in later decomposition phases. We aimed at revealing the role of lignin degradation for the release of dissolved organic carbon (DOC) and evolution of CO_2 during incubation of fresh and decomposed leave and needle litter. Therefore, freshly fallen and field exposed litter (up to 27 months) of 5 tree species (ash, beech, maple, spruce, pine) was incubated in the laboratory for 2 years. Strong lignin degradation occurred in the first period of incubation period (< 200 days), revealed by decreasing yields of lignin-derived phenols upon CuO oxidation. After 200 days, no more lignin degradation was found. This pattern was similar for fresh and decomposed litter. These data challenge the common view that lignin degradation depends on decomposition stage of the litter, and does not occur in fresh litter because more easily degradable substrates are present. Dissolved organic C and CO_2 also peaked in the first period of the incubation but were not interrelated. Beyond 200 days of incubation, both remained on low and constant levels. In that later phase of incubation, CO_2 production was positively related to the amounts of DOC in water extracts, suggesting that bioavailable dissolved compounds became a limiting factor for CO_2 production. The results suggest that DOC produced during litter decomposition is an indicator for bioavailable C and that solubilization of organic C may be the limiting step of CO_2 production. Lignin degradation occurred only when CO_2 production was high, thus under conditions with high supply of easily degradable C compounds. In turn, lignin degradation could not explain differences in DOC and CO_2 production over the study period. We conclude that the traditional model of lignin degradation during litter decomposition is not correct. Lignin degradation as a co-metabolic process is controlled by the availability of easily decomposable C sources and will be hampered at later stages of litter decomposition, which are characterized by little available C compounds.

Keywords: litter decomposition, lignin, dissolved organic carbon, C availability, respiration

Poster S5-P49

SOM accumulation after glacier retreat: stocks, quality and mechanisms during initial soil formation

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Global warming may have strong effects on weathering, soil formation and soil organic matter (SOM) accumulation, and lead to the retreat of glaciers resulting in the exposure of pristine glacial till to atmospheric weathering conditions. This provides a unique set-up to understand how mineral weathering and soil formation control SOM accumulation. We studied the accumulation of SOM after retreat of the Dammaglacier in the Central Alps, Canton Uri, Switzerland, about 2000 m above sea level. Due to the retreat of the Dammaglacier the proglacial area offers a time sequence from three classes of surface age (ca. 15 yrs, 60 – 80 yrs, 110 – 140 yrs). Mature soils outside the proglacial area are older than 700 years. The parent material is granitic rock which derives from the Aare-massif. The soils in the forefield are Leptosols and Regosols, whereas Cambisols have developed outside the proglacial area.The increase of SOM stocks (organic surface layers, mineral soil from 0 – 4 cm depth and total) from the young soils (total: 65 g m^{-2}) to the 110 – 140 year old soils (total: 2285 g m^{-2}) is significantly larger as compared to the increase from the oldest forefield soils to the mature soils (total: 3726 g m^{-2}). Organic surface layers show increasing contributions to the total OC stock from 15 yrs (0 %) to 110 - 140 yrs (63 %) reaching amounts as similar to those of the mature soils (1450 g m^{-2}). In contrast to the oldest forefield soils, mature soils have accumulated the major amount of OC in the mineral soil (60%). The OM loading of the clay fractions increases from 44 mg g^{-1} in the young soils to 190 mg g^{-1} in the 110 - 140 year old soils and to 323 mg g^{-1} in the mature soils. This leads to decreasing specific surface areas of the clay fraction as determined by N_2-adsorption (BET approach). The clay fraction minerals are dominated by illite, irregularly interstratified mica/vermiculite, and ferrrihydrite. A strong correlation is found between increasing ferrihydrite contents (determined as oxalate-soluble iron) and increasing OM contents of the clay fraction with soil formation. H_2O_2 resistant OC also increases with soil age, again strongly correlated with increasing amounts of ferrihydrite in the clay fraction. This implies a major role of ferrihydrite for the stabilization of OM during initial soil formation. Solid-state ^{13}C NMR spectroscopy revealed the compositional changes of SOM in bulk soils as well as clay fractions. The increase of O/N-alkyl and alkyl C with soil age is due to the specific accumulation of these components in the clay fraction, whereas the OM inherited from the glacial till is rich in aromatic and carboxyl C. Formation of organo-mineral associations starts with the accumulation of O/N-alkyl C in the proglacial area, which is in line with hydrolysable neutral sugar contents of the clay fractions. Accumulation of alkyl C is detected at a later stage only in the mature soils. This is associated with a change in the C/N ratio of the clay fraction from 10 in the proglacial area to 13 in the mature soils.

In summary, initial soil formation and SOM accumulation after glacier retreat is surprisingly fast. The accumulation of SOM in the clay fraction of these soils is controlled by weathering and formation of ferrihydrite, which in turn leads to a specific accumulation of O/N alkyl C compounds during initial soil formation.

Keywords: initial soil formation, soil organic matter accumulation, glacier forefield, chronosequence, organo-mineral associations

Poster S5-P50

Sorption and charaterization of dissolved organic matter (dom) in deep soil profiles

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Understanding dissolved organic matter (DOM) behaviour through the soil profile requires the knowledge of its chemical composition and its reactivity which are both driven by its genesis and origin. The objective of the present study was to quantify and to characterize DOM sorption to subsurface soils from two contrasted different agroecosystems. The study was conducted on long term observatory for environmental research (ORE): The ORE-ACBB, site of Lusignan (introduction of leys within arable crop rotations) and the Feucherolles QualiAgro site (an arable soil amended with different organic waste composts). In both sites DOM samples were extracted by distillated water from the top soil horizon (0-28 cm). At Lusignan site, a 6 years and a 20 years temporarily grassland soil were compared with an arable soil. At Feucherolles site, comparisons were conducted between soils amended respectively with a co-compost of sewage sludge and green wastes (SGW), with municipal solid waste compost (MSW), with biowaste compost (BIO) and a non amended control soil (CONT). Batch equilibration experimentations were performed to quantify DOM sorption (K_{DOC}) to deep soil horizons originating from soil profiles present at each site. Concentrations of DOC were measured by a Shimadzu TOC-5050 analyzer. Initial extracted and equilibrium DOM after sorption were characterized by the specific UV-absorbance (SUVA, L g^{-1} cm^{-1}) and fluorescence emission-extinction spectra analysis. The results so far indicated that the differences of K_{DOC} between soil profiles and land management clearly showed that soil physico-chemical properties such as pH, oxides and clay fractions where key factors in DOM sorption. Comparing K_{DOC} for DOM of different origins of the same soil profile suggested that DOM reactivity was related to soil management. The DOM from grassland soil was sorbed in less extent than DOM extracted from control soil. In the second situation, the DOM from SGW treatment exhibited the greatest K_{DOC} whereas DOM from MSW and BIO had lower K_{DOC} than CONT.

Keywords: dissolved organic matter

Poster S5-P51

Soil respiration in association with soil organic carbon fractions from different land-uses

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Mass distributions of different soil organic carbon fractions are influenced by land-use and management, which, in turn may affect soil CO_2 emission from the soil to atmosphere. The objectives of this study were to determine the role of soil organic carbon fractions, temperature and water filled pore space (WFPS), in regulating the soil CO_2 emission under different land-uses. Soil CO_2 emission was measured between 09:00 to 11:00 a.m. over a three year study period from representative land-uses (upland, vegetable field, orchard, pine forest) in hilly Three Gorges Reservoir area of subtropical China. Annual mean CO_2 emissions ranged from 6.5 to 10.6 Mg CO_2 ha^{-1} yr^{-1}. Soil CO_2 fluxes from upland were 1.4, 1.3 and 1.1 times higher than pine forest, orchard and vegetable field, respectively. Differences in soil CO_2 fluxes among different land-uses were primarily the result of different organic carbon fractions. Soil temperature dominantly controlled the soil CO_2 emission from all land-uses. Dramatically, during three years of study, despite annually increasing air temperature, soil CO_2 emission only gave response to decreased annual soil temperature, and did not have a clear trend with the annual precipitation pattern. Different Q_{10} values (2.11-2.65) were observed from various sites, which significantly correlated with heavy fraction organic carbon (HFOC), light fraction organic carbon (LFOC) and dissolved organic carbon (DOC) contents from different land-uses, indicating that substrate quality might be a prominent factor controlling the Q_{10} values from the soil. The Q_{10} values, in turn, derived the CO_2 emission from the soil. Significantly negative correlations were found between HFOC, and soil CO_2 fluxes. However, LFOC and DOC had a significant positive correlation with soil CO_2 fluxes which suggests that, in order to reduce the soil respiration, LFOC contents needs to be protected with relative management practices.

Keywords: Soil Respiration, Soil Organic Carbon Fractions, Subtropics

Poster S5-P52

Soil organic carbon mineralization under combined levels of temperature and moisture

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Soil carbon stability is still a widely discussed issue and the theory behind stabilization and decomposition processes in soils is far from being resolved. Many studies are currently focused on mechanisms limiting decomposition, on quantifying and modeling SOM pools. The question of determining the temperature sensitivity of soil organic matter (SOM) decomposition rates has also been the focus of many recent studies. Although a theoretical basis explaining many of the observed temperature effects on different SOM pools has been discussed (Davidson and Janssens 2006), changes in temperature sensitivities as a result of interactions with other factors, most importantly moisture, have been observed (Reichstein et al. 2003; Reichstein et al. 2005) but not still well explained. Since temperature response experiments are typically performed at optimal soil water contents, there is little information on how drier or wetter conditions may influence such temperature relations. Next to this, relations used to explain moisture effects on SOM decomposition remain only approximate (Rodrigo et al. 1997), meaning that careful studies on this topic are still needed.

As a research project, we plan to use a bare fallow soil (yearly tilled soils with no vegetation growth) and adjacent cropland soil to advance our understanding of the above questions. With bare fallows we have unique conditions where the present SOM is the remainder after several decades of almost no C input, i.e. a highly stable carbon pool free of most labile matter. To put this into perspective, one can argue that this soil has been “pre-incubated in the field” for a period of several decades, while in most studies looking at the stable or passive SOM pools, pre-incubations last at most a year or two. Applying combined levels of temperature and moisture will thus provide clear information on the sensitivity of stable carbon and total SOC to these factors. Although laboratory studies do not reflect natural conditions and are difficult to extrapolate directly to the field, they are well suited for looking at the effects of single factors or, as in this case, the interaction of two factors. Both bare fallow and cropland samples will be sieved to reduce variability among samples and incubated in parallel at different moistures and sequentially at different temperatures, with periodic measures of soil respiration. An especially detailed moisture curve is important in this work given its non-linear nature and the need to find discontinuities at critical moisture values (such as moisture of capillary breakdown and water holding capacity expected as lower and upper boundaries of optimal moisture). This also implies using different measures of soil moisture (water potential, water filled pore space, etc.) that can be well related to e.g. soil texture. What we expect to obtain is i) further evidence for the particular temperature sensitivity of stable vs. labile SOM, ii) a precise relation for the effects of moisture on the decomposition of stable SOM vs. labile pool, and last but most importantly, iii) information on how temperature sensitivity is related to soil moisture.

References: Davidson, Eric A., and Ivan A. Janssens. 2006. Temperature sensitivity of soil carbon decomposition and feedbacks to climate change. *Nature* 440, no. 7081 (3): 165-173. doi:10.1038/nature04514;Reichstein, M., A. Rey, A. Freibauer, J. Tenhunen, R. Valentini, J. Banza, P. Casals, et al. 2003. Modeling temporal and large-scale spatial variability of soil respiration from soil water availability, temperature and vegetation productivity indices. *Global Biogeochemical Cycles* 17, no. 4: 1104; Reichstein, M., J.A. Subke, A.C. Angeli, and J.D. Tenhunen. 2005. Does the temperature sensitivity of decomposition of soil organic matter depend upon water content, soil horizon, or incubation time? *Global Change Biology* 11, no. 10 (October): 1754-1767; Rodrigo, A., S. Recous, C. Neel, and B. Mary. 1997. Modelling temperature and moisture effects on C-N transformations in soils: comparison of nine models. ECOLOGICAL MODELLING 102, no. 2 (October 29): 325-339.

Keywords: soil organic matter, temperature and moisture interactions, bare fallow, stable pool, active pool, decomposition, soil respiration

Poster S5-P53

Soil organic carbon under different tillage systems and farm manure levels in wheat-rice cropping system

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The conservation of organic matter in soil as soil organic carbon (SOC) has proved its worth in offsetting carbon emissions into the atmosphere. The scientific community is now facing the questions of permanence of C sequestration and alternative land uses. Carbon may be sequestered or stored in soil by increasing the organic matter return to the soil. The agricultural management practices (tillage or farm manure application) can affect the soil carbon storage under long term operations. The energy intensive technologies may be replaced with energy efficient processes with eco-friendly behavior. The wheat and rice are the most important cereal crops in Asia feeding a fair proportion of inhabitants as staple food. This cropping system can affect the soil carbon balance to appreciable extent. Soil tillage operations and manure applications are being practiced to maximize crop yield in various agro-climatic conditions and diverse soil system. The judicious management of wheat-rice system by the resource poor farmers of this particular area will enhance soil carbon storage without detrimental effects on soil quality. Three tillage systems namely deep, minimum and conventional tillage systems and three application levels of farm manure viz. 0, 15 and 30 Mg ha^{-1} were used in field studies. The investigations were continued for successive two years and soil carbon was estimated alon gwith crop yield and soil properties. Significant differences were observed regarding SOC under the set of treatments applied. SOC distribution in soil up to 100 cm also showed varying trend for different tillage systems. The data regarding SOC (0-10 cm depth) indicated that SOC was affected significantly by the tillage and FM application. However, the interaction was non-significant ($P \le 0.05$). But, during second year of cropping after wheat only FM had significant effect on SOC. As for as SOC at rice harvest is concerned, tillage and FM had significant effect on SOC after rice. After harvest of second rice crop the data showed highly significant effect of tillage on SOC ($P < 0.001$). The effect of FM was also significant ($P < 0.0315$) but interaction of tillage and FM was non-significant. It may be concluded from these studies that OC may be conserved/stored or sequestered in soil by adopting appropriate tillage system in conjunction with the use of organic residues. The farmers may get a favorable soil tilth for their succeeding crops by the use of these techniques. Similarly, dependency on mineral fertilizer may b reduced by the resource poor farmers of the area.

References: Ibrahim, M., A. Hassan, M. Arshad and A. Tanveer. 2010. Variation in root growth and nutrient element of wheat and rice: effect of rate and type of organic materials. *Soil & Environment.* 29: 47-52.

Ibrahim, M., A. Hassan, M. Iqbal and E.E. Valeem. 2008. Response of wheat growth and yield to various levels of compost and organic manure. *Pakistan Journal of Botany*. 40(5): 2135-2141.

Iqbal, M., A. Hassan and M. Ibrahim. 2008. Effects of tillage systems and mulch on soil physical parameters and maize (Zea mays L.) yield in semi-arid Pakistan. Biological Agriculture & Horticulture. 25(4): 311-325.

Sarwar, G., N. Hussain, H. Schmeisky and S. Muhammad, M. Ibrahim and S. Ahmad. 2008. Efficiency of various organic residues for enhancing rice-wheat production under normal soil conditions. *Pakistan Journal of Botany*. 40(5): 2107-2113.

Sarwar, M.A., M. Ibrahim, M. Tahir, K. Ahmad, Z.I. Khan and E.E. Valeem. 2010. Appraisal of pressmud and inorganic fertilizers on soil properties, yield and sugarcane quality. *Pakistan Journal of Botany*. 42: 1361-67.

Sarwar. G., H. Schmeisky, N. Hussain, S. Muhammad, M. Ibrahim and E. Safdar. 2008. Improvement of soil physical and chemical properties with compost application in rice-wheat cropping system. *Pakistan Journal of Botany*. 40(1): 275-282.

Keywords: SOC, tillage, farm manure, wheat-rice

Poster S5-P54

Spring drought effects on carbon turnover in and below temperate grasslands

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Carbon (C) conservation in grassland soils is desirable to mitigate climate change. However, climate change components, e.g. extreme drought in spring may affect functions of temperate grasslands and are likely to affect the C stock. The drought may affect C stock in two opposite directions: 1) decrease of C input by plants into the soil, and 2) decrease of microbial decomposition of plant residues and soil organic matter (SOM). Within FORKAST project we evaluate the importance of both effects induced by extreme droughts conditions by analyzing C fluxes between atmosphere, plants and soil. Coupling of $^{(13)}CO_2$ fluxes (eddy covariance: EC, and hyperbolic relaxed eddy accumulation: HREA) with ^{13}C and ^{15}N tracing after pulse labelling allows to evaluate both effects in one experiment. A decrease of organic C input by grassland plants in the soil and lower CO_2 efflux from the soil were observed on drought plots, compared to normal precipitation plots. Based on ^{13}C natural abundance in CO_2 (HREA) and after the labelling, the total CO_2 fluxes were partitioned for root-derived CO_2 and microbial decomposition of SOM. Combining long-term EC (> 1 year) and chamber measurements of CO_2 fluxes the drought influences on larger scale were determined. The observed species specific changes in photosynthetic activity and modified assimilate translocation from leaves to roots and soil provide a basis to evaluate stability and resilience of the species composition of the ecosystem under extreme drought.

Keywords: carbon, stock, grassland, drought, pulse labelling, eddy

Poster S5-P55

Stable mineral-associated soil organic matter pools revealed by combined physical and chemical fractionation

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Long-lived soil organic matter (SOM) pools are critical for ecosystem stability and the global carbon cycle. Physical and chemical protection offered by soil minerals is thought to enhance SOM longevity by separating organic matter from decomposer organisms and their enzymes and by binding active sites on organic compounds. However, it is difficult to isolate homogenous mineral-associated SOM pools that are meaningful on decadal to centennial time scales, thus there is limited understanding of the dynamics and potential contribution of such pools to C-sink capacity of soil. Several comprehensive studies have proposed that combining physical fractionation with chemical separations offers the most promise for isolating moderate- to long-lived SOM pools.

We took advantage of a C_4-C_3 switch at the Fermi National Accelerator Laboratory (Fermilab) in Illinois, USA, where a field was taken out of continuous corn (C_4) and replaced by a mixture of cool-season perennial grasses (C_3). The site is well suited to examining slower-turnover SOM, as previous work has established that retention of C_4-C in the soil is quite high, and archived samples collected over nineteen years present a rare opportunity to study decadal-scale SOM dynamics. To investigate the stabilization mechanisms that give rise to the apparently long-lived SOM at the Fermilab C_4-C_3 switch site, we utilized the natural ^{13}C isotopic label in archived soil samples collected over two decades to study C dynamics in pools isolated with a combined physical (particulate organic matter, silt, and clay) and chemical fractionation (acid hydrolysis followed by peroxide oxidation) scheme.

We found that H_2O_2 oxidation had a greater effect than acid hydrolysis on mineral C, and sequential treatment with HCl and H_2O_2 destroyed almost all of the organic matter in the silt and clay (89% C loss in silt and 91% C loss in clay). There was no significant change in the C content of any fraction during the sampling interval; however, the dynamics of some fractions were detectable by partitioning C_4- and C_3-derived C. The proportion of C remaining from C_4 plant residues declined in all cases, from 80-100 % in 1986 to 57-83% in 2004. Nevertheless, C remaining from before the vegetation switch was remarkably stable, especially in the oxidation-resistant silt and clay, and the C_4-derived C pool was surprisingly large even after 32 y without new C_4 inputs.

Our combined fractionation approach shed light on the relatively high stability of SOM following change to a less disturbed land use, but the fractions isolated are likely still composites of multiple pools. Although SOM is typically represented as discrete pools, it is probably better conceptualized as a continuum, with fresh inputs on one end and the most stable material on the other. Soil C may cascade through this continuum such that each pool provides the inputs for the next, but because interactions with physico-chemical protection mechanisms can disrupt the linear flow from fresh inputs to passive SOM, material in a laboratory-isolated fraction may contain SOM derived from several different conceptually defined pools. More insight into moderately long-lived SOM might come from closer examination of silt-sized soil components or inclusion of the spatial position of minerals in the soil structure instead of such aggressive destruction of mineral-associated material.

Keywords: physical fractionation, chemical fractionation, ^{13}C, grassland

Poster S5-P56

Storage and loss of soil C and N under increasing N fertilisation of hill country pasture

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Intensification of pastoral agricultural in New Zealand has been characterised by increased soil nutrient concentrations and animal stocking rates. With pasture development, soil C/N ratios have declined. These soils are presumably less able to store additional N and subsequent losses of N to air and water are a concern. To increase profitability, New Zealand hill country farmers have considered increasing herbage production of traditionally lower fertility pastures by fertilising with N. We hypothesized that in contrast to intensively managed pastures, less intensively managed hill country soil still maintained the capacity to store N applied in fertiliser and reduce N losses. This hypothesis was tested using a grazing trial where urea was applied to sheep grazed hill country pasture at increasing rates from 0 to 750 kg N/ha/y for 3 years, with sheep stocking rate being increased to consume the increased DM produced. We characterised C and N storage within soil functional pools, N leaching, and natural abundance $\delta^{15}N$ and $\delta^{13}C$ as means to consider the flow of organic matter into the functional pools. These functional pools constituted unprotected organic matter (OM), physically protected OM, and biochemically protected and unprotected OM.

Field lysimeters were installed and leachate was analysed for NH_4-N and NO_3-N. After 3 years, soils from lysimeters in the 0, 200 and 400 kg N/ha/y treatments were analysed for soil microbial biomass C (MBC) and N (MBN), C, N, $\delta^{15}N$ and $\delta^{13}C$. The soils were also fractionated into the functional pools components: particulate organic matter (POM) outside soil microaggregates (inter-POM), POM inside microaggregates (intra-POM), silt and clay from within microaggregates (agSC), and free silt and clay found in macroaggregates but not from microaggregates (non-agSC).

We found the rate of change with time of $\delta^{15}N$ increased with N fertiliser rate. This increased rate of change in $\delta^{15}N$ suggested increased N isotopic ratio fractionation due to increased N cycling and therefore increased N losses from soil. Indeed, inorganic N (NH_4-N + NO_3-N) leached increased with time for fertiliser rates greater than 300 kg N/ha/y. In contrast, at 0, 100 and 200 kg N/ha/y N leaching was constant throughout the study. The step difference in leaching N losses with time and N fertiliser rate and the attendant increases in stocking rates, suggested the soil was capable of storing N in organic matter pools for the lower N fertiliser rates and/or plant uptake was sufficient to minimise surplus soil N. A positive relationship between soil C and N concentrations was observed for all soil fractions. There was a slight increase in soil N concentration with increased N fertilisation. Inter-POM, intra-POM and agSC carbon per unit sand free soil weight increased with increasing soil N concentration. Furthermore, as MBC and MBN increased, leached N declined.

Previous studies have shown that increased N inputs may cause a decline in soil C concentration. However, in this study, a decline in soil C did not occur. There was no relationship between $\delta^{15}N$ and $\delta^{13}C$ in any soil fraction and N leached, suggesting OM decomposition was not a contributing factor to N leached. Rather, there was an increase in intraPOM, the physically protected POM, with increasing N fertiliser rate. The increased intraPOM suggested protection was afforded this POM fraction within microaggregates in contrast to the unprotected interPOM. Not surprisingly, interPOM was the first or most susceptible fraction to be decomposed at this early stage of increasing soil N nutrition.

Keywords: functional pools, soil physical fractionation, particulate organic matter, $\delta^{15}N$, $\delta^{13}C$

Poster S5-P57

Study of C dynamics under changing climatic conditions in the field and in incubation studies

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The increase of carbon dioxide in the atmosphere and the following climate change may have a large impact on plant biomass production and the subsequent allocation of carbon to the soil. Environmental factors, such as soil temperature, play an important role in soil carbon dynamics and must be considered for modelling of those processes. Three regions of Germany differing in climate and land use intensity were studied (Kraichgau, Schwäbische Alb, Bad Lauchstädt). Short-term and long-term incubation experiments were performed in the laboratory with the respirometer Respicond IV. A portable infrared gas analyser was used to measure soil surface CO_2 evolution in the field on bare and vegetation plots. Soil CO_2 emissions in the field were measured under three crop cultures (oilseed rape, winter wheat, and maize) and in adjacent bare plots during three time intervals during the year. Both field and incubation experiments confirm the positive correlation of intensity CO_2 fluxes from soil with temperature. While all the plots had increased emissions with temperature, the response to increased temperature was not equal between bare and vegetation and also the sites. Short-term incubation experiment with different temperatures confirms higher CO_2 emission from fertilized soils compared to non-fertilized soils. Long-term incubation experiment shows significant decrease of soil organic matter (SOM) with increase of soil depth, which leads to reduce of biological activity of the C and N pools and CO_2 emission from soil. Results of this study may be used for modelling soil organic matter turnover including soil CO_2 evolution on the regional scale.

Keywords: Soil carbon dynamics, climate change, soil respiration.

Poster S5-P58

Temperature response of organic matter turnover in a boreal forest ecosystem: impact of long-term nitrogen fertilization

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In northern high latitude ecosystems, soil organic matter turnover and nutrient availability are most likely affected by climate warming. In boreal forests, plant productivity and microbial activity are both limited by temperature and soil nutrient availability, specifically nitrogen (N). Warmer temperatures can thus increase plant productivity and rates of soil organic matter turnover, which in turn affect nutrient availability as well as ecosystem carbon (C) balances. However, in those ecosystems little is known about the effects of change in mineral N availability on the temperature response of microbial processes such as N turnover rates (gross N mineralization and immobilization). Because of uncertainties in modeling N processes, global C climate coupled models rarely have explicit terrestrial N feedback mechanisms incorporated. This is a serious omission because, for example, increased N mineralization may enhance primary plant production that counteracts CO_2 effect on climate. On the other hand, a recent meta-analysis on forest ecosystems [1] reported that high N deposition may reduce soil organic matter decomposition, resulting in an increase of soil C sequestration. Knowledge of both soil C and N turnover response to environment (*e.g.* temperature) and their interactions is therefore vital to perform reliable projections of soil carbon sequestration and climate change.

To improve our understanding on how N cycling affects C dynamics in boreal soils, we investigated C and N dynamics as well as soil microbial communities (PLFA) responses to a gradient of temperature that is pertinent in such ecosystems*, i.e.* temperatures ranging from 2 to 15°C. We hypothesized that (i) mineral N availability affects organic matter turnover and its response to temperature and (ii) there are differences in temperature dependences of C and N processes at low temperatures (*i.e*, there is a decoupling of C and N processes). To test these hypotheses, we sampled soils from a long-term N fertilization field experiment (75kg $N.ha^{-1}.y^{-1}$) established on a boreal forest ecosystem in Northern Sweden in 1987. At the end of the vegetation period (September 2009), soil samples were taken from N fertilized and control treatments (organic horizon and the first 10 cm of the mineral horizon), sieved through a 4-mm sieve and stored frozen until further analysis. Short-term laboratory incubation experiments (2 weeks) were then carried out at 4 different temperatures (2, 5, 10 and 15°C).

Both total soil organic C and N contents as well as the amount of mineral N were significantly higher in the fertilized treatment compared to the control treatment. Long-term fertilization also affected soil microbial communities as shown by differences in PLFA profiles. Irrespectively of temperature, rates of C mineralization in relation to total soil organic C were lower in the fertilized soils. Despite these differences, there was no difference in the temperature sensitivity of C mineralization when applying an Arrhenius-type function to the mineralization data. These results indicated that N fertilization altered soil organic matter content, soil microbial communities and C organic matter turnover without affecting the temperature response of C mineralization. Net and gross N processes as well as a characterization of microbial communities' changes in soils exposed to different temperatures will be further investigate to test the hypothesis of a decoupling of C and N processes at low temperatures (see above). The mechanistic bases of these processes and their importance for feedback mechanisms between the atmosphere and terrestrial carbon cycle will be discussed in this presentation.

References: [1] I. A. Janssens, W. Dieleman, S. Luyssaert, J-A. Subke, M. Reichstein, R. Ceulemans, P. Ciais, A. J. Dolman, J. Grace, G. Matteucci, D. Papale, S. L. Piao, E-D. Schulze, J. Tang and B.E. Law, *Reduction of forest soil respiration in response to nitrogen deposition*. Nature Geoscience, 2010. 3: p. 315 - 322

Keywords: Boreal forest soil, low temperature, carbon and nitrogen cycling, fertilization

Poster S5-P59

The effect of Pb contamination on some microbial populations in soil treated with maize residue.

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Heavy metals could have long-term hazardous impacts on the health of soil ecosystems and adverse influences on soil biological processes. The objective of this study was to determine the effects of different levels of Pb on some microbial populations in a soil treated with maize residue. A soil was sampled from the top 30-cm layer of an agricultural land in Hamadan, in northwest of Iran, which has a semiarid climate. The soil was treated with mild (d < 2 mm) maize residue at a rate of 20 g kg^{-1} (dry weight basis). After that, It was treated with 0, 150, 300 and 600 mg Pb kg^{-1} soil as $Pb(NO_3)_2$. Each treated soil was incubated in field capacity and lab temperature conditions. After 1 and 90 days of incubation a portion of each soil was taken for analysis. Bacterial, actinomycetes and fungal populations were determined by soil dilution and plate count method and statistically analyzed. Results showed that the effects of maize residue application, incubation time, Pb application, and their interactions on microbial populations were significant ($p< 0.01$). Microbial populations were higher in soil treated with maize residue. In control soil the populations of actinomycetes and fungi increased but bacterial population decreased significantly after 90 days soil of incubation. In control soil the effects of Pb contamination on actinomycetes and fungi populations were not significant after 1 and 90 days of soil incubation. However bacterial population was significantly decreased with increasing Pb levels in soil after 1 day of incubation. The effect of Pb contamination was not significant on microbial population in soil treated with maize residue after 1 day of soil incubation. However the negative effect of Pb contamination on microbial population was increased after 90 days of soil incubation. In soil treated with maize residue the populations of bacteria, actinomycetes and fungi decreased with increasing Pb level. This decrease was higher for bacterial population. The decrease of actinomycetes population was relatively lower than those for fungi and especially bacterial populations.

References: Alef, K., and P. Nannipieri. 1995. Methods in applied soil microbiology and biochemistry, Academic Press, Harcourt Brace & Company, Publishers, London.

Ebrahimi, P. and Safari Sinegani, A. A. 2004. Lead contamination and impacts on microorganisms in the vicinal soils of Razan-Hamadan highway, Iran. In: 4th International Iran and Russia Conference Agriculture and Natural Resources, September 8-10, 2004, ShahrKord, Iran. 463-469.

Ghorbani, N. R., Salehrastin, N. and Moeini, A. 2002. Heavy metals affect the microbial populations and their activities. 17 th WCSS. Thailand, Symposium no. 54, paper no. 223: 1-11.

Rajapaksha, R. M., Tobor-Kaplon, M. A. and Baath, E. 2004. Metal toxicity affects fungal and bacteria activities in soil differently. Appl. Environ. Microb. 70: 2966-2973.

Saggar, S., McIntosh, P.D., Hedley, C.B., Knicker, H., 1999. Changes in soil microbial biomass, metabolic quotient and organic matter turnover under Hieracium (*H. pilosella* L.). Biol. Fert. Soil. 30:232–238.

Keywords: Lead, Soil contamination, Maize residue, Soil microbial populations, Soil incubation

Poster S5-P60

The effect of drought and warming on carbon balance in Welsh heathlands

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Terrestrial ecosystems are under increasing pressure from escalating temperature and more variable precipitation patterns linked to global climate change (Knapp et al. 2008). These factors will undoubtedly impact terrestrial ecosystems as they are fundamental drivers of biological processes. In terms of the global carbon cycle, terrestrial ecosystems function as important carbon stores, holding two to three times more carbon than is present in the atmosphere (Schimel et al. 2001). The magnitude of this store however is projected to diminish with the increase in global surface temperatures, switching terrestrial ecosystems from carbon sinks to sources (Cox et al. 2000). Within this context the net ecosystem exchange (NEE) of an ecosystem gives a good indication of its carbon status (Larsen et al. 2007). The 'Integrated Network on Climate Research activities on Shrubland Ecosystems (INCREASE)', an extension of Vulcan and Climoor projects, provides a facility to understand the effect of warming and reduction in summer rainfall in European shrubland ecosystems (Beier 2004). Results from a Welsh heathland site indicate that treatment has a significant effect on soil respiration (Sowerby et al. 2008) and NEE (unpublished); the underlying mechanisms for this however have not been established. To consider treatment effect on belowground processes, seasonal measurements of soil microbial biomass and fungal community structure have been assessed. Preliminary results suggest that differences in fungal abundance and diversity drive observed differences in soil CO_2 efflux across treatment.

References: Beier, C., Emmett, B.A., Gundersen, P., Tietema, A., Penuelas, J., Estiarte, M., Gordon, C., Gorissen, A., Llorens, L., Roda, F., Williams, D. (2004) Novel approaches to study climate change effects on terrestrial ecosystems in the field: drought and passive nighttime warming. *Ecosystems*, 583-597.

Cox, P. M., R. A. Betts, C. D. Jones, S. A. Spall & I. J. Totterdell (2000) Acceleration of global warming due to carbon-cycle feedbacks in a coupled climate model. *Nature,* 408**,** 184-187.

Knapp, A. K., C. Beier, D. D. Briske, A. T. Classen, Y. Luo, M. Reichstein, M. D. Smith, S. D. Smith, J. E. Bell, P. A. Fay, J. L. Heisler, S. W. Leavitt, R. Sherry, B. Smith & E. Weng (2008) Consequences of More Extreme Precipitation Regimes for Terrestrial Ecosystems. *Bioscience,* 58**,** 811-821.

Larsen, K. S., A. Ibrom, C. Beier, S. Jonasson & A. Michelsen (2007) Ecosystem respiration depends strongly on photosynthesis in a temperate heath. *Biogeochemistry,* 85**,** 201-213.

Schimel, D. S., J. L. House, K. A. Hibbard, P. Bousquet, P. Ciais, P. Peylin, B. H. Braswell, M. J. Apps, D. Baker, A. Bondeau, J. Canadell, G. Churkina, W. Cramer, A. S. Denning, C. B. Field, P. Friedlingstein, C. Goodale, M. Heinmann, R. A. Houghton, J. M. Melillo, B. Moore III, D. Murdiyarso, I. Noble, S. W. Pacala, I. C. Prentice, M. R. Raupach, P. J. Rayner, R. J. Scholes, W. L. Steffen & C. Wirth (2001) Recent patterns and mechanisms of carbon exchange by terrestrial ecosystems. *Nature,* 414**,** 169-172.

Sowerby, A., B. A. Emmett, A. Tietema & C. Beier (2008) Contrasting effects of repeated summer drought on soil carbon efflux in hydric and mesic heathland soils. *Global Change Biology,* 14**,** 2388-2404.

Keywords: Climate change, Net ecosystem exchange, Peatlands

Poster S5-P61

Towards an optimized soil organic matter management under intensive cropping in the North China Plain: a study combining field trial and modeling work

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Extraordinary high N fertilization and intensive cropping in the North China Plain (NCP), the latter sharing the highest proportion of cultivated land in China, resulted in environmental problems and still low soil organic matter levels without achieving the crop yield potentials with stagnating or even decreasing wheat yields. This study aims to develop an integrated cropping system including optimized N-fertilization, tillage, irrigation and crop residues management strategies, potentially increasing the amount of total soil organic matter per hectare and meeting the proposed yield potential in the long term. However, soil organic matter content usually changes slowly in response to adapted agronomic management practices. Within a short timeframe, it is, thus, difficult to estimate long-term soil organic matter dynamics. To overcome this time limitation, a combination of field trials and computer modeling was applied in this study to estimate the trend of long-term soil organic matter development, crop production, soil N turnover and soil C turnover as a result of different cropping strategies under NCP conditions. Daisy, a soil-plant-atmosphere system model, was evaluated using data from a two years field trial. This field trial includes common winter wheat and summer maize double cropping systems with different N inputs, irrigation and soil tillage managements (conventional treatment and optimized treatment). Furthermore, each of the treatment has two sub-treatments of crop residue management with and without crop residue return to the field. Soil water content, soil mineral N content, above ground crop biomass, crop N content, particulate soil organic matter and soil microbial biomass were measured frequently over a period of two years. An optimized treatment and a conventional treatment were employed separately for model calibration and validation. After modification of soil water, crop and soil organic matter sub-models, Daisy produced satisfactory simulations of crop production, N turnover and C turnover, as well as temporary pattern of added organic matter and soil microbial biomass dynamics for all treatments of the field trail. In particular, simulation results performed well in representing the effects of various management strategies on the long-term soil organic matter development. Optimized soil organic matter management strategies could, thus, be identified, increasing and stabilizing the amount of total soil organic matter per hectare in the long term when compared to the common existing Farmer's practices in the NCP.

Keywords: Daisy model, the North China Plain, Particulate organic matter; Soil microbial biomass

Poster S5-P62

Transformation of buffalo manure by composting or vermicomposting to rehabilitate degraded tropical soils

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The addition of composted buffalo manure may lead to qualitative and quantitative improvement of the organic matter content of degraded tropical agricultural soils in Northern Vietnam. The objectives of this study were to follow the biochemical changes occurring during composting of buffalo manure with and without earthworms during 3 months and to study the effect of the end products (compost and vermicompost) on soil biochemical parameters and plant growth after two months of incubation under controlled conditions in an open pot experiment. Our conceptual approach included characterisation of organic matter of the two composts before and after addition to soil by elemental, isotopic analysis and analytical pyrolysis and comparison with conventional fertilisation. We also analysed for lignin content and composition.

Our results showed that composting in the presence of earthworms led to stronger transformation of buffalo manure than regular composting. Vermicompost was enriched in N-containing compounds and depleted in polysaccharides. It further contained stronger modified lignin compared to regular compost. In the bulk soil, the amendment of compost and vermicompost led a significant modification of the soil organic matter after 2 months of exposure to natural weather conditions. The lignin component of SOM was unaffected whatever the origin of the organic amendment. Compost and Vermicompost amendments both enhanced aggregation and increased the amount of organic matter in water stable aggregates. However, vermicompost is preferable to compost due to its beneficial effect on plant growth, while having similar positive effects on quantity and quality of SOM.

Keywords: compost, earthworms

Session 6 – HETEROGENEITY AND SCALING PROCESSES OF OM DECOMPOSITION AND STABILIZATION: MOLECULAR TO REGIONAL SCALES

Oral presentations – Session 6

Keynote lecture

Heterogeneity and scaling processes of OM decomposition and stabilization: molecular to regional scales

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Organic matter transformation depends on a myriad of metabolic andsignalling networks that regulate the microbial processes of nutrientcycling in soil. These processes, in turn, depend on the diversity andconnectivity of microenvironments in soil and across the landscape.Traditional systems biology approaches seldom look beyond the level of thecell, and yet we must go beyond this if we are to make progress in ourunderstanding of ecological processes at the landscape and global scales. Asa dynamical fusion of both physical and biological components, soil isunique and so we do not have a precedence anywhere else in science to drawinspiration. Reflecting on research relating to drug discovery in cancer,fungal network dynamics and self-organisation of the soil-microbe complex,I_ discuss some of the challenges we face in developing a systems biologyof soil carbon, and how much detail we really need to save the world!

Keywords: Organic matter transformatio

Localization of organic carbon pools in the soil matrix

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A better understanding of the mechanisms involved in the protection of SOM will be important in predicting the evolution of soil quality and the impact of SOM on global change. Few studies focused on the role of the soil pore system in SOM decomposition (Strong et al., 2004; De Gryze et al., 2005). The relationship between soil structure and SOM dynamics is indirect, as soil water and air distribution influence the biological activity in different pore classes (Strong et al., 2004). Soil water distribution is mainly influenced by pore necks,

which determine at given water potential if a pore will be water-filled or air-filled. It is thus necessary to quantify this pore neck size distribution if a relationship between soil structure and SOM dynamics is to be studied. X-ray computed tomography (X-ray CT), a non-destructive imaging technique, can provide us images of soil samples in three dimensions. When processing these images, it is possible to gain spatial information about the soil pore system, the pore neck size distribution and its water distribution and relate this spatial information directly to SOM dynamics.

In this research, we used X-ray CT to identify pore size classes relevant for SOM decomposition during an incubation experiment. Because of the trade-off between sample size and resolution in X-ray CT, the dimensions of the undisturbed soil columns were chosen to be small (D: = 1 cm, h = 1 cm) to attain a voxel resolution of 9.44µm (voxel = pixel in 3D). Thirty six undisturbed soil columns (sandy loam) were incubated for 35 days at 20°C and

C mineralization was measured with gas chromatography (at days 2-4-6-8-13-20-27-35).

All soil columns had similar carbon content (ranging between 4.34 - 4.45%), but were divided in three groups of different bulk densities (1.41, 1.67 & 1.79 g cm-^{3}), each incubated at two moisture contents (50% and 75% WFPS) in 6 replicates. After incubation, 3 soil columns per treatment were immediately scanned with X-ray CT to minimize possible moisture loss.

The high-resolution grey scale X-ray CT images in three dimensions were processed with Morpho+ (Cnudde et al., 2010) and 3-D information about water distribution in soil was combined with C mineralization data to identify the locations of SOM decomposition in the soil matrix.

First results show negative correlations between CO_2 respiration and bulk density and volume of small (< 180 µm equivalent diameter) pores. X-ray CT data indicated the majority of fine pores to be completely filled with water and hence a limited contribution of the finer pore space may be expected. Positive correlations with macro porosity (>1200 µm eq. diam.), which was not water-filled may suggest an indirect effect on SOM decomposition by improved aeration in finer surrounding pores that do contain water. Intermediately sized pore space (180-1200 µm equivalent diameter) constituted the majority of the pore space (±75%) and showed a weaker correlation with C mineralization. A further in depth subdivision of intermediately sized pore space according to shape parameters such as maximum opening, pore neck distribution, etc. is ongoing.

References:

Cnudde et al. (2010). Latest developments in 3D analysis of geomaterials by Morpho+. Advances in Computed Tomography for Geomaterials: GeoX 2010, 205-212.

De Gryze et al., 2005. Pore structure changes during decomposition of fresh residue: X-ray tomography analyses. Geoderma, 134, 82-96.

Sleutel et al., 2008. Comparison of different nano- and micro-focus X-ray computed tomography set-ups for the visualization of the soil microstructure and soil organic matter. Computers & Geosciences, 34, 931-938.

Strong et al., 2004. Spatial location of carbon decomposition in the soil pore system. Eur. J. of Soil Science, 5, 739-750.

Keywords: X-ray computed tomography, soil water distribution, SOM decomposition, incubation experiment

A sub micrometric-scale mapping of nitrogen at the surface of soil particles: a combined ^{15}N labelling and NanoSIMS approach

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The role of mineral-organic associations in soil is increasingly recognized as a key process in the protection of nitrogen (N) against decomposition. Yet to date only a very few studies have been able to image N at a scale relevant to mineral-organic interactions. Here, we study samples from a long-term (12 years) litter ^{15}N field experiment conducted in a German forest to explore mineral-organic associations at the sub micron scale by NanoSIMS. Mineral-organic structures are isolated by density fractionations from the 0-2.5cm depth horizon. Analytical conditions allow us to map carbon (C) and N, along with the ^{15}N/^{14}N ratio with a spatial resolution of 80 nm, at the surface of the soil particles (thickness sputtered corresponding to around 150-250 nm). Aggregates and mineral grains with organic coating are mounted without epoxy on clean flat windows; care is taken not to press then to preserve the spatial distribution of C, N relative to oxygen, which is used to locate the inorganic material in the association. Even though the areas of organic matter are very small, the analytical precision on the isotopic ratio is enough to identify spatially resolved domains with ^{15}N label.

Organic matter appears as patches at the surface or as a coating of aggregates and mineral grains (coating thickness < 0.5mm). C and N maps do not always overlap, indicating that the C/N ratio of the organic matter – i.e. its plant or microbial signature - is spatially highly heterogeneous. N-rich areas are often found at the edge of the soil structures, likely indicating a microbial coating of particles. We are also able to identify individual microorganisms. Twelve years after ^{15}N label application, few ^{15}N hotspots are found, what is in agreement with bulk soil measurements (see Hatton *et al.*, this session). These 200-300 nm wide hotspots do not correspond to areas rich in N, and they are not associated with a specific type of mineral, as checked by further SEM and EDS mapping.

This study shows that NanoSIMS is a suitable technique to study mineral-organic associations at the relevant scale to understand molecular process ruling the stabilization of organic components in soil.

Keywords: NanoSIMS, nitrogen, ^{15}N, mineral-organic association

Small scale heterogeneity of enzyme activities in the top- and subsoil of a forested Cambisol

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The soil habitat is characterized by very high spatio-temporal variability of regulating environmental factors like moisture, temperature or substrate availability at scales ranging over several orders of magnitude. The distribution and activity of soil biota are furthermore influenced by intrinsic population processes such as dispersal, reproduction or competition (Young et al., 2008), resulting in a heterogeneity that is poorly understood and has rarely been studied. As SOC content and microbial densities decrease with depth, patchiness increases, with biological hot spots often being associated with preferential flow paths or the rhizosphere (Bundt et al., 2001; Chabbi et al., 2009). Since enzymes are the main mediators of soil biological processes, the study of their diversity and activities provides an effective approach for examining functional diversity and heterogeneity in soils. The objective of this study was to determine enzyme activities at a very high spatial resolution in the top- and subsoil of visually homogeneous horizons of a loess derived cambisol in order to analyse spatial patterns and correlations with other soil parameters.

A soil profile of the loess-derived acidic Cambisol was excavated in a mixed deciduous forest stand in Bochum, Germany. Samples were taken in March 2010 from a grid with 20 horizontal and 3 vertical cells of 2 x 2 cm in a depth of 5-11 cm of the Ah horizon and 60-66 cm of the C horizon. In all 120 samples, the activities of 10 hydrolytic enzymes (b-glucosidase, b-galactosidase, b-xylosidase, b-glucoronidase, b-cellobiohydrolase, N-acetyl-b-glucosaminidase, acid phosphatase, leucine-, tyrosine-, aginine-aminopeptidase) were determined with a fluorimetric microplate assay (Marx et al., 2001). As expected, enzyme activities were generally higher in the topsoil samples and often below detection limits in the subsoil samples. However, some activity hot spots were found in both depths. Geostatistical analyses showed distinctly different spatial patterns for the different enzymes in both depths.

References: Bundt, M., Widmer, F., Pesaro, M., Zeyer, J. and Blaser, P., 2001. Preferential flow paths: biological hot spots in soils. Soil Biology & Biochemistry, 33(6): 729-738.

Chabbi, A., Kögel-Knabner, I. and Rumpel, C., 2009. Stabilized carbon in subsoil horizons is located in spatially distinct parts of the soil profile. Soil Biol. Biochem., 41: 256-261.

Marx, M., Wood, M. and Jarvis, S.C., 2001. A microplate fluorimetric assay for the study of enzyme diversity in soils. Soil Biology & Biochemistry, 33(12-13): 1633-1640.

Young, I.M., Crawford, J.W., Nunan, N., Otten, W. and Spiers, A., 2008. Microbial distribution in soils: Physics and scaling. Advances in Agronomy, 100: 81-121.

Keywords: enzyme activity, spatial heterogeneity, topsoil, subsoil

Substrate heterogeneity and quality convergence in decomposing litters

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Organic matter is a complex mixture of material with different biological, physical and chemical properties. However, most terrestrial decomposition models represent organic matter as a homogeneous substrate with one or a few pools with different susceptibilities to decomposition. Similarly, many models assume that only the quantity but not the quality of the substrate changes over time. Even though it is well recognized that this representation of organic matter in models is less than ideal, there is little work analyzing the effects of assuming substrate homogeneity on the mineralization of carbon and nutrients. Using concepts from the continuous quality theory, we performed a systematic analysis to explore the consequences of ignoring substrate heterogeneity in decomposition models. We found that the compartmentalization of organic matter in a few pools introduces approximation error when both the distribution of carbon and the decay rate are continuous functions of quality. This error is generally large for models that use three or four pools. In the long-term, stabilization and destabilization processes operating simultaneously result in the accumulation of carbon in lower qualities, independent of the quality of the incoming litter. We contrasted our model predictions with different field studies that explored changes in litter quality over time. Although quantitative comparisons were not possible, we concluded that the available information support the hypothesis that organic matter converges to distributions skewed to lower qualities, independent of the distribution of the incoming litter.

Keywords: continuous quality theory, representation error, organic matter decomposition, coupled carbon and nitrogen cycling, ecological heterogeneity

Soil organic matter dynamics and spatial heterogeneity in relation to landscape scale processes:

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Recent research has indicated that soil organic carbon dynamics are remarkably heterogeneous in space and time. Current methods to characterize this horizontal (across the earth surface) and vertical (with depth) variability at a regional scale are limited and very coarse. This significantly hampers our ability to account for and to understand the impact of processes that occur at larger spatial and temporal scales (Trumbore, 2009). Consequently, scaling up from point-scale process understanding to larger-scale dynamics and mass-balances typically introduces large uncertainties and biases (e.g. Ogle, 2010; Van Oost et al., 2007). Here, we present and apply a new method that addresses these issues.

We characterize the variation of SOC within the first meter of soils in three dimensions (spatial variation and vertical gradients). Spatial modeling is used to integrate soil surface data from airborne image spectroscopy (2m resolution) and vertical SOC gradients from high resolution (0.10m) soil sampling. This allows a 3D distribution of soils to be interpolated over an area of ca. 700 km² in Luxemburg which is characterized by intensive agricultural land use, a high variability in soils and a complex topographical terrain. We evaluate the potential of the methodology against the results obtained using traditional techniques. We integrate this analysis with an assessment of recent [since ≈1955] lateral fluxes of carbon as a result of soil erosion on our study area using the fallout radionuclide ^{137}Cs.

Our methodology provides new insights into the spatial heterogeneity of soil carbon storage at an unprecedented spatial resolution covering a large area. Analysis of the data provides clear evidence that geomorphic gradients play a key role in soil carbon profile development in agricultural landscapes, even at very short time periods, and must be considered for realistic SOC modeling. Our data shows, that in eroding agricultural landscapes the link between topography and carbon content is consistent throughout a large variety of soil types. Eroding positions have a sharp decline of carbon content with depth and lower topsoil carbon than stable and especially depositional sites, which in contrast store high amounts of carbon in greater depths. At the catena scale, geomorphic features are considered to be the most important factors controlling SOC distribution, due to their influence on soil redistribution rates. They also supersede or control other important parameters such as drainage and soil texture in regions of similar soil types. Therefore, topography can be employed to map carbon content of top- and subsoils and modeling on a regional scale.

An integrative approach from point to landscape scale of pedogenic and geomorphic processes and their feedback effects on SOC dynamics is needed to develop an evolving, realistic SOC model for agroecological regions.

References: Ogle S.M., Breidt F.J., Easter M., Williams S., Killian K., Paustian K. (2010): Scale and uncertainty in modeled soil organic carbon stock changes for US croplands using a process-based model, *Global Change Biology*, Vol. 16(2): 810 -822.

Trumbore E.S. (2009): Radiocarbon and Soil Carbon Dynamics, *Annual Review of Earth and Planetary Sciences*, Vol. 37: 47-66.

Van Oost K., Quine T.A., Govers G., De Gryze S., Six J., Harden J.W., Ritchie J.C., McCarty G.W., Heckrath G., Kosmas C., Giraldez J.V., Marques da Silva J.R., Merckx R. (2007): The Impact of Agricultural Soil Erosion on the Global Carbon Cycle, *Science*, Vol. 318: 626-629.

Keywords: spatial modeling,hyperspectral spectroscopy, soil organic matter, soil organic carbon

Upscaling peatland biodiversity and carbon dynamics to the ecosystem level

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Despite their global significance as concentrated terrestrial carbon stores (Gorham, 1991), peatlands are not yet explicitly represented in climate models (Wania et al., 2009). More comprehensive peat depth, carbon stock and greenhouse gas flux data are required for understanding and predicting peatland responses to climate change (Dise, 2009). However, the complex spatial and temporal variability of peatland carbon dynamics represents a key source of uncertainty. Upscaling carbon dynamics from the plot to the ecosystem scale is a way of resolving uncertainty, vital for the inclusion of peatland carbon feedbacks in models of future climate change.

Peatlands are heterogeneous environments comprising a mosaic of microhabitats with contrasting vegetation cover and hydrological regimes. They are colonised by distinctive plant communities, representing collections of Plant Functional Types (PFTs). Plant traits affect the quality and quantity of organic material entering the soil, and are important regulators of soil microbial communities (Bardgett et al., 2008).

The overall aim of this project is to determine the interactions between PFTs, soil microbial biodiversity and terrestrial carbon dynamics across a range of scales, from plot to ecosystem. We want to test the hypothesis that mapping PFTs provides a means of modelling the spatial variability of peatland carbon dynamics and greenhouse gas fluxes at the ecosystem level. This is being achieved by combining extensive vegetation, microbial and peat property survey data, in situ measurements of greenhouse gas fluxes (CO_2, CH_4 and N_2O) and meta-statistical analysis with state of the art GIS methodologies.

As a first step we present initial conclusions based on comparisons of carbon accumulation rates between vegetation cover types and interactions between above- and below-ground communities at the ecosystem level, derived from 34 radiocarbon dates and ecosystem survey work conducted on the blanket bog at Moorhouse National Nature Reserve, north Pennines, UK.

References: Bardgett, R.D., Freeman, C. and Ostle, N.J. 2008: Microbial contributions to climate change through carbon-cycle feedbacks. *The ISME Journal* 2, 805-814.

Dise, N.B. 2009: Peatland Response to Global Change. *Science* 326, 810-811.

Gorham, E. 1991: Northern Peatlands: Role in the Carbon Cycle and Probable Responses to Climatic Warming. *Ecological Applications* 1, 182-195.

Wania, R., Ross, I. and Prentice, I.C. 2009: Integrating peatlands and permafrost into a dynamic global vegetation model: 1. Evaluation and sensitivity of physical land surface processes. *Global Biogeochemical Cycles* 23, 19

Keywords: ecosystem, carbon storage, greenhouse gas, peatland, microbial diversity, vegetation, scaling, GIS,

Posters – Session 6

Poster S6-P1

50 Years And 500 Radiocarbon Measurements Since 1959: What Has The “Bomb Spike” Taught Us About Soil C Dynamics In New Zealand Soils?

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In 1959, Athol Rafter began a substantial programme of monitoring the flow of C-14 produced by atmospheric thermonuclear tests through New Zealand’s atmosphere, biosphere and soil. The programme produced important publications, but also leaves a legacy of unpublished data critical for understanding soil C dynamics. A database of ~500 soil radiocarbon measurements spanning 50 years has now been compiled. The database contains over a dozen soil C-14 time series that provide an ideal tool for scaling understanding of soil C stabilization across soil, climate and land covers.

The highest resolution time-series, in the Judgeford silt-loam under permanent pasture, contains 11 points for the surface soil, including samples collected two years apart from 1959–1974. This unique dataset emphasizes that bulk soil radiocarbon can provide very robust measurements of soil C turnover, as long as three critical assumptions are addressed. These assumptions are: 1) the size and age of the “inert” or “passive” pool is accounted for; 2) non-steady state conditions are accounted for by modeling soil C accumulation or loss; and 3) the time lag between C leaving living vegetation and entering the soil pool in question is accounted for. The highest resolution data confirms that when these assumptions are addressed using a 2-box model, soil C dynamics in grassland soils closely follow the dynamics expected from the pool structures commonly assumed in ecosystem models. Moreover, soil radiocarbon measurements spaced ~10 or more years apart can be used to directly parameterize ecosystem models.

Among the most interesting data is a comparison of soil carbon dynamics in deforested dairy pastures under similar climate in the Tokomaru silt loam (non-Andisol) versus the Egmont black loam (Andisol), originally sampled in 1962-3, 1965 and 1969. After adding soil profiles sampled to similar depths in 2008, we use a 2-box model to calculate that the residence time of soil C (upper ~8 cm) in the Tokomaru soil is ~9 years compared to ~17 years for the Egmont soil. This difference represents nearly a doubling of soil C residence time, and roughly explains the doubling of the soil C stock. With three measurements in the 1960s, the data is of sufficient resolution to estimate the size of an “inert” or “passive pool” with an assumed residence time of 1000 years, to be 15% of soil C in the Tokomaru soil versus 27% in the Egmont soil. The Tokomaru/Egmont comparison is necessarily illustrative since the 1960s samplings were not replicated extensively, but provide globally unique data. Moreover, the Tokomaru/Egmont comparison supports evidence that C dynamics does differ in Andisols versus other soils.

Overall, a dozen time-series measurements have been completed, with more underway. Time-series results suggest that the main decadal soil C pool has a residence time that ranges from 10–50 years, with variation driven by soil properties, climate and the intensity of land use. Since many time-series measurements include resampling of multiple soil horizons, we have assessed whether the depth analyzed affects calculated residence times. We find that the model generally fails when non-surface horizons are analyzed separately, but produces reliable results when up to 3 horizons are combined. Residence times are either constant or increasing with the depth included in the analysis. More broadly, the large database of radiocarbon measurements creates opportunities to quantify carbon turnover and transport as a function of soil depth, and in non-steady state soil systems where the C stocks are known to be changing. This work emphasizes the value of time-series soil sampling and of uncovering the pioneering work of those who, like Athol Rafter, recognized and measured the C-cycle implications of the bomb-C spike as it was occurring.

Keywords: C-14 Bomb Radiocarbon Soil Carbon Dynamics Turnover Residence Time Pools Model Rafter Andisol Pasture Grazing

Poster S6-P2

Accumulation of recalcitrant fractions of SOM in Mediterranean soils

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Wildfires affect the biochemical quality of SOM, but the long-term relevance of these effects is unclear. The capacity of the ecosystem to recover after the fire must be taken into account: post-fire inputs of fresh organic matter could compensate for the loss of labile fractions due to the thermal shock, and the modifications in SOM characteristics could be difficult to detect after some decades.

We investigated this matter on mediterranean shrublands in La Vall de Gallinera (València, E Spain). Within a landscape of croplands in several stages of abandonment, we studied shrublands of the Rosmarino-Ericion type, which according to all available information have been never cultivated. The selected plots were classified in (i) plots having suffered no fires in the last 50 years, (ii) plots affected by 1 fire, and (iii) plots affected by 2 fires. We sampled the soil_first 5 cm of these plots (4 cores randomly taken from each plot), and we studied the main physical, chemical and biochemical characteristics of these samples. Our study has given already several papers (Duguy et al., 2007; Rovira et al., 2009; Duguy and Rovira, in press), which have shown a decrease in the SOM content driven by wildfires, but not a decrease in SOM biochemical quality. Here we try to detect increases in recalcitrant or refractory forms of SOM, and specifically increases in the aromatic C content - which has been reported to be a main result of wildfires.

We applied a sequential attack to our samples: (a) extraction with K_2SO_4 solution; (b) hydrolysis with boiling 2.5M sulfuric acid; (c) room-temperature hydrolysis with 70% sulfuric acid, then dilution to 1M and boiling. The residue remaining after (c) is taken as the recalcitrant fraction, and the ratio between the C in this fraction and the total C in the soil sample is taken as the recalcitrance index for carbon (RIC) (Rovira and Vallejo, 2002). This residue was submited to a further attack, (d) with 10% H_2O_2 at 50°C, to isolate highly refractory SOM forms. All extracts and hydrolysates were analyzed for total OC, carbohydrates, polyphenolics (Folin-Denis method), and aromatic C (specific absorption at 280 nm).

The recalcitrance of SOM increased with wildfires: RIC was 58% in never burned plots, 65% in plots affected by 1 fire, and 71% in plots affected by 2 fires. This was the most obvious effect of fires on SOM; the rest of studied parameters did not give such a clear result. Thus, carbohydrate C was about 20% of the total C in the studied soils, and polyphenolics about 10%; none of these parameters was affected by number of fires. Several consistent trends were observed: (1) The relative richness in carbohydrates decreases with C content, while (2) the ratio cellulose to total carbohydrates increases; (3) the relative amount of aromatic compounds, either as tannic acid equivalents or by absorption at 280 nm, decrease with total C in the soil sample. These trends are very clear and significant in never burned plots, a bit less in plots affected by 1 fire, and mostly disappear in plots affected by 2 fires.

A possible explanation is that the effect of fire in the biochemical characteristics of SOM depends on the intensity of the thermal shock and the conditions of the combustion of the materials above the soil: these factors are never homogeneous within a given plot. Thus the disappearance of most regularities suggests that a main effect of fires on SOM is an increase in the variability of its characteristics.

References: Rovira P. & Vallejo V.R. 2002. Labile and recalcitrant pools of carbon and nitrogen in organic matter decomposing at different depths in soil: an acid hydrolysis approach. Geoderma 107, 109-141.

Duguy B., Rovira P. & Vallejo V.R., 2007. Land use history and fire effects on soil fertility in eastern Spain. European Journal of Soil Science 58, 83-91.

Rovira P., Duguy B. & Vallejo V.R. 2009. Black carbon in wildfire-affected mediterranean shrubland soils. Journal of Plant Nutrition and Soil Science 172, 43-52.

Duguy B. & Rovira P. Differential thermogravimetry and differential scanning calorimetry of soil organic matter in mineral horizons: effects of wildfires and land use. Organic Geochemistry, in press.

Keywords: Wildfires, Aromatic C, Labile and recalcitrant C, Refractory C forms, Mediterranean

Poster S6-P3

Application of RothC Model to predict the effect of land use change on soil organic carbon in northern New South Wales, Australia

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Land use change (LUC) is known to be a major factor influencing the global carbon cycle and in particular soil organic carbon (SOC) content. The effect of LUC (conversion of woodland to cropping) on SOC was predicted using the RothC model on Alfisols (Typic Paleustalf) of northern New South Wales (NSW), Australia. This study aimed to test the accuracy of RothC to predict SOC change due to LUC in this environment. One uncleared remnant eucalypt woodland site and three adjacent paired cultivated sites were sampled in 2006. Cropping sites were cleared in the early 1940s and regularly cropped with winter wheat. The cropping system was simulated using APSIM (Agricultural Production Systems Simulator). Simulations were re-initialized every year before sowing of the wheat crop so that the climate was the only variable (i.e. there were no carry over effects of soil water or changing soil fertility). Soil organic C pools were determined on composite soil samples from each of the uncleared woodland and cultivated pairs. The paired set was modeled using the RothC 26.3 model, initialized using the SOC pool structure for the woodland site and compared with the measured data for the cultivated pairs, assuming the woodland systems had reached equilibrium in 2006. The model predicted that conversion of woodland to cropping would result in decreased total SOC stock in the top 30 cm soil layer from 18.54 t ha^{-1} to 6.7 t ha^{-1} after 66 years of continuous cropping. Similarly, RothC predicted decreased resistant plant material (RPM) C and humified organic matter (HUM) C from 7.96 to 1.4 t ha^{-1} and from 10.1 to 4.8 t ha^{-1}, respectively. The measured total SOC stocks in the three paired cropping sites were 5.4 t ha^{-1}, 7.4 t ha^{-1} and 6.6 t ha^{-1}, respectively. Similarly, measured RPM carbon was 1.52 t ha^{-1}, 1.82 t ha^{-1} and 1.58 t ha^{-1} and HUM carbon was 3.4 t ha^{-1}, 5.1 t ha^{-1} and 4.5 t ha^{-1}, respectively. Modeled and measured data were statistically similar with root mean square error (RMSE) of 12%, 5% and 16% for TOC, RPM and HUM, respectively. The t-test values also showed that the differences between the simulated and observed data were not statistically significant at the level of significance $P = 0.05$. On the basis of the result of the study, RothC represents a promising method for estimating SOC change due to LUC on Alfisols of northern NSW. Further work will validate the utility of RothC (and other modeling approaches) for SOC estimation across a range of soil types and land-uses in northern NSW.

Keywords: Land use change, RothC, soil organic carbon

Poster S6-P4

Carbon Sequestration and Soil Aggregation in Two Chronosequences of Mineral Hydromorphic Soils

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It is assumed that carbon stocks in mineral hydromorphic soils react very sensitively to land use changes. To get detailed insight into the development of soil organic matter stocks and soil aggregation following land use conversion, two chronosequence studies were conducted: One in soils influenced by stagnant water based on 10 sites, and one in groundwater affected soils based on 72 sites. Both chronosequences consist of sites, which have been converted from pasture to cropland at different times during the last 220 years. While most studies on soil aggregation so far focused either on carbohydrates or on glomalin-related soil protein (GRSP) as a binding agent for aggregation, we analysed the concentration of both compounds.

It was found that in the Stagnosols the total organic carbon (TOC) content declined by 84% from 195 t ha^{-1} to 45 t ha^{-1} in the uppermost 20 cm and from 68 to 26 t ha^{-1} in the second depth section (20 - 40 cm). It reached a new equilibrium concentration 23 years after the conversion. In the groundwater affected sandy soils the TOC content in the uppermost 20 cm decreased by 64% from 71 to 36 t ha^{-1} TOC during the first 46 years after the conversion of land use. The mean weight diameter (MWD) of the water-stable aggregates in the Stagnosols decreased monoexponentially ($R^2 = 0.99$) by 69% and reached a new equilibrium 33 years after the conversion. For the groundwater affected soils it was found that MWD decreased by 72% during the first 46 years after conversion of the soils from pasture to cropland.

The carbohydrate concentration in the Stagnosols decreased by 61% in the uppermost 20 cm ($R^2 = 0.96$), while the GRSP concentration declined by 63 % ($R^2 = 0.94$). A new equilibrium was reached 23 (carbohydrates) and 56 (GRSP) years after the land use conversion. For the groundwater affected soils it was found that the carbohydrate concentration decreased very rapidly after the land use change by 64%, and the GRSP concentration decreased more slowly by 57% during the first 46 years after the conversion. In both chronosequences TOC, carbohydrates and the GRSP concentrations were sigmoidally correlated with the MWD. TOC, carbohydrates, and GRSP exhibited higher concentrations in the macroaggregates than in the microaggregates, independently of the duration of cropland use. The GRSP concentration, however, was more equally distributed among the four water-stable aggregate fractions. The average radiocarbon age of the TOC in the different aggregate size fractions of a cropland site eight years after conversion ranged from 65 (± 25) years in the size fraction >2000 µm to 251 (± 30) years in the size fraction >200 µm.

The two studies show that conversion of mineral hydromorphic soils from pasture to cropland is associated with large losses of TOC and a strong decrease in soil aggregation. Secondly, we showed that the carbohydrate concentration in both soil groups react very fast to the land use change, while the GRSP concentration need more time to reach a new equilibrium. Thirdly, it can clearly be seen that both carbohydrates and GRSP are significantly correlated with the MWD of the water-stable aggregates.

References: Spohn, M., Giani, L., accepted. Total, hot water extractable, and oxidation-resistant organic carbon in sandy hydromorphic soils - Analysis of a 220-year chronosequence. Plant and Soil, DOI: 10.1007/s11104-010-0322-5.Spohn, M., Giani, L., under review. Water-Stable Aggregates, Glomalin-Related Soil Protein, and Carbohydrates in a Chronosequence of Sandy Hydromorphic Soils. Soil Biology and Biochemistry.Spohn, M., Giani, L., under review. Carbon stocks, Glomalin-Related Soil Protein, Carbohydrates and the Turnover of Water-Stable Aggregates in a Chronosequence of Stagnosols. Global Change Biology.

Keywords: Chronosequence, Land Use, Hydromorphic Soils, Soil Aggregation, Carbohydrates, Glomalin, Radiocarbon

Poster S6-P5

Carbon input differences is the main factor explaining the variability in soil organic C storage in no-tilled compared to inversion tilled agrosystems

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Land conversion to no-till (NT) is increasing worldwide. Several studies suggest that conversion to NT increases soil organic carbon (SOC) stocks in comparison to tilled systems with total residue incorporation (inversion tillage or IT)(e.g. Kern & Johnson, 1993; West & Post, 2002). However, there is an important and unexplained variability of the changes in SOC stock following NT adoption that impedes accurate prediction of the NT potential for C sequestration (Angers & Eriksen-Hamel, 2008). We performed a meta-analysis n order to determine the pedo-climatic and crop factors better explaining this variability. The database comprises SOC stocks in the upper 30 cm expressed for an equivalent soil mass, climatic characteristics (annual precipitation, mean annual temperature and aridity), soil texture and C inputs. As only one third of the studies provided data on C inputs, two databases were used: the first with 92 paired cases without C inputs and the second with 35 pairs (already included in the first database) with C inputs. Greater SOC stocks were observed under NT using the first database, although the net difference (6.7%, corresponding to 3.4 Mg C/ha) was smaller than often found in the literature. We investigated the effects of pedo-climatic factors and C inputs on SOC storage under NT using multiple linear regressions. Crop C input differences were the only factor significantly and positively related to SOC stock differences between NT and IT. They explained 30% of this variability. SOC storage variability induced by NT conversion is thus related to the variability of crop production response to NT conversion. This meta-analysis provides evidence on the need of considering the effects of C inputs on SOC storage under NT for a more accurate assessment of the potential of NT for C sequestration, which implies studying changes at the agro-ecosystem level, and not only at the soil level.

References: Kern JS, Johnson MG (1993) Conservation tillage impacts on national soil and atmospheric carbon levels. Soil Science Society of America Journal, 57, 200-210.

West TO, Post WM (2002) Soil organic carbon sequestration rates by tillage and crop rotation: a global data analysis Soil Science Society of America Journal, 66, 1930-1946.

Angers DA, Eriksen-Hamel NS (2008) Full-inversion tillage and organic carbon distribution in soil profiles: A meta-Analysis. Soil Science Society of America Journal, 72, 1370-1374.

Keywords: No-tillage, C sequestration, crop primary production, soil C, C sinks.

Poster S6-P6

Contribution of soil organic matter decomposition processes to the land-atmosphere exchanges in US croplands: implications from a fine resolution land surface model

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Croplands are important man-made ecosystems which have unique processes and management events compared to natural ecosystems, thus well contributing towards the anthropogenic impacts on the land-atmosphere carbon exchanges. Croplands encompass more than 40 percent of the land area in the US mid continental region, thus significantly influencing the overall land-atmosphere exchanges and the climatic variability in the region. SiBcrop (Lokupitiya et al., 2009) is a recently developed fine resolution land surface model, especially designed for predicting carbon and other exchanges in agricultural ecosystems. The model uses weather data, vegetation and soil characteristics as the main inputs. SiBcrop is a modified version of the Simple Biosphere model (SiB; Sellers et al., 1996 a,b), and the major improvements in the model include the crop-specific phenology and physiology scheme within the model (against the phenology based on remotely sensed NDVI in SiB) and better parameterization and representation of carbon cycling in croplands. The performance of SiBcrop has been evaluated by testing it against the site specific observed data at several Ameriflux eddy covariance flux tower sites and some crop sites in China. The model has been able to well predict sub hourly carbon (net ecosystem exchange) and energy fluxes, onset and end of the growing season, harvest, interannual variability associated with crop rotation, day time carbon draw down, and day to day variability in the carbon exchanges. The biomass in different plant pools (roots, leaves, stems, and products) predicted by the model has shown good agreement with the observed biomass at field sites; the yields predicted by the model were mostly within 10 percent of the yields reported for major crops by the National Agricultural Statistics Service (NASS). SiBcrop has been coupled with the regional Atmospheric Modeling System (RAMS, a model developed at Colorado State University) for predicting regional scale carbon and other fluxes, and the predicted fluxes have been evaluated against the observations.

Soil plays a major role in land-atmosphere carbon exchanges, mostly though the decomposition process of the organic matter by soil microbes. Recently we developed aboveground and belowground litter pools (to include residue inputs from different plant pools) and two soil carbon pools in SiBcrop model, to assess the contribution of soils to the overall land-atmosphere carbon exchange in US croplands. The soil carbon scheme runs based on the daily litter input from the different plant pools to generate multi scale carbon fluxes (i.e. sub hourly soil respiration fluxes, daily, annual and long-term carbon flux (storage/loss) in soil carbon pools). The model involves daily decomposition and soil environmental coefficients that vary with soil depth. The inclusion of the new soil carbon scheme improved the predictability of carbon and other exchanges with the atmosphere by crops, as compared against the observations at several sites in the US Mid continental region. In future, we plan to incorporate this new soil carbon scheme to the coupled SiBcrop-RAMS modeling system for regional scale predictions.

References: Lokupitiya, E., Denning, S., Paustian, K., Baker, I., Schaefer, K., Verma, S., Meyers, T., Bernacchi, C., Suyker, A., and Fischer, M.: Incorporation of crop phenology in Simple Biosphere Model (SiBcrop) to improve land-atmosphere carbon exchanges from croplands. Biogeosciences, 6 (6), 969-986, 2009 .

Sellers, P.J., Randall, D.A., Collatz, G.J., Berry, J.A., Field, C.B., Dazlich, D.A., Zhang, C., Collelo, G.D., and Bounoua, L.: A revised land surface parameterization (SiB2) for atmospheric GCMs. Part 1: Model formulation. J. Clim., 9, 676-705, 1996a.

Sellers, P.J., Los, S.O., Tucker, C.J., Justice, C.O., Dazlich, D.A., Collatz, G.J., and Randall, D.A.: A revised land surface parameterization (SiB2) for atmospheric GCMs. Part II: The generation of global fields of terrestrial biophysical parameters from satellite data. J. Clim., 9, 706-737, 1996b.

Keywords: SiBcrop, land surface models, soil carbon & land-atmosphere carbon exchanges, cropland soils, US croplands, agroecosystems

Poster S6-P7

Dynamics of microbial community within different soil fractions during the decomposition of ^{13}C-labelled rice straw

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Soil environment is made of a huge diversity of microenvironments in which the biological component exists and is active. The physical architecture of solid and pore space results in a complex distribution of oxygen, water films and gradients of solutes spanning distances as small as a few micrometers. These microenvironments form the microbial habitat in soil, but they are dynamic and change with soil aggregation.

There is a particularly strong niche differentiation during the formation of macroaggregates in the vicinity of fresh organic matter residues, as large amounts of organic substrate are locally available. Although the relationship between microbial community structure and soil structure has been studied in the past, it is not known how these evolve as the structure of soil changes. We aimed to determine how microbial community structure evolves with the *de novo* formation of macroaggregates. Accordingly, the objectives of this study were to test the hypotheses that the structure of microbial communities within macroaggregates formed during the decomposition of organic matter residues: i) would be different from the microbial communities in other soil size fractions and ii) would incorporate more C from the residue.

This was achieved by amending crushed soil (< 200 µm) with uniformly ^{13}C-labelled rice straw and measuring changes in soil aggregation, in ^{13}C distribution among soil size fractions and in total and ^{13}C-labelled fatty acid methyl esters (FAME) profiles to assess microbial community structure, during an incubation that lasted 21 days.

Large macroaggregates (> 2000 µm) and small macroaggregates (200-2000 µm) formed rapidly during incubation with the rice residues, the former doubling within two days, compared to the reference. In a same way, newly formed soil fractions >200 µm contained approximately twice C-Straw than the other fractions after 2 days of incubation, whereas concentration of C-Straw was higher in 50-200 µm and 0-50 µm soil fractions at day 0. After 21 days, the concentration of C-Straw in all the > 50 µm fractions decreased significantly while that of the 0-50 µm fraction increased slightly. However, the >2000 µm soil fraction was still the most C-Straw enriched.

This rapid soil aggregation is followed by different FAME proportion in each soil size fractions. Thus, gram – bacteria were mostly in soil fractions > 200 µm, whereas gram+ bacteria were in soil fractions < 200 µm. The ^{13}C-labelled FAME profiles showed that the microbial communities which decomposed the ^{13}C-labelled rice were not located in a specific soil size fraction, but had different structure between the soil size fractions.

This study confirms that soil aggregation and micro habitats were dynamic during the early degradation of rice residues: (i) *de novo* macraggregatesincorporated more C from the residue than the other soil size fraction and (ii) bacterial communities which mineralised fresh organic residues differed with soil size fraction.

Keywords: ^{13}C-straw, Aggregation, Mineralisation, FAME, Bacterial communities structure

Poster S6-P8

Edaphic and climatic controls on soil organic matter storage and dynamics in temperate broadleaf forests in the Eastern USA

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Forest soils represent a significant pool for C sequestration and storage, but the factors controlling soil C cycling are not well constrained. We used density fractionation and radiocarbon measurements to assess differences in soil organic matter (SOM) cycling amongst five intensively studied temperate broadleaf forests that vary in climate, soil type, parent materials, and soil ecology.

The five forests range in mean annual temperature from 7 to 13 °C and in mean annual precipitation from 600 to 1300 mm. The colder sites are the University of Michigan Biological Station (UMBS) and Colonial Point (CP) in northern Michigan and Bartlett Experimental Forest (BEF) in New Hampshire. Harvard Forest (HAF) in central Massachusetts is slightly warmer and the warmest site is in the Missouri Ozarks (MOZ). Soil textures range from sandy (UMBS) to clay loamy (MOZ) and drainage from well drained (UMBS) to poorly drained (CP). At each site, we collected forest floor and mineral soil to 90 cm or as deep as possible (at least 60 cm). We fractionated soil samples from 0-5 and 5-15 cm depth by density into free light (unprotected SOM), occluded light (physically protected SOM), and dense (mineral-protected) fractions using sodium polytungstate (1.65 g ml^{-1}), measured C concentration and radiocarbon in bulk soil and fractions, and used a three-pool steady-state model to determine radiocarbon-based turnover times for fractions.

Bulk soil C storage (forest floor plus mineral soil) was highest at the poorly drained CP site and declined as follows: CP > BEF > HAF > MOZ > UMBS. Bulk soil radiocarbon values ($\Delta\ ^{14}C$) decreased with depth and were lower at northeastern sites than Midwestern sites, ranging from -23 to 100 ‰ for the top 15 cm of mineral soil.

Soil C distribution amongst fractions was similar for BEF, HAF, and MOZ, where the unprotected free light fraction containing about 40 % of bulk soil C for 0-5 cm and 20 % of bulk soil C for 5-15 cm. At these three sites, the physically protected occluded light fraction contained about 10 % of bulk soil C, with the mineral-protected dense fraction containing the remaining 50-70 %. CP, the site with poor drainage, had a similar portion of bulk C in the dense fraction, but about 25% was recovered in the occluded light fraction. UMBS, the site with the sandiest soil, had a greater portion of bulk soil C recovered in the unprotected free light fraction and very little C recovered in the occluded light fraction.

Fraction radiocarbon values also declined with depth. Free light fraction values were greater than those for the other fractions while those for occluded light fractions were more varied. Radiocarbon-based SOM turnover times for the sites suggest that soil carbon pools in all three fractions turn over much more quickly at MOZ, the warmest site, than the other sites and more slowly at cool and wet BEF and HAF. In addition, turnover times were shorter at UMBS than the finer-textured BEF.

These results suggest that soil type, moisture, and climate interact to control soil organic matter cycling in temperate broadleaf forests. Specifically, soil organic matter decomposition is slower in cooler than warmer climates and C stabilization in protected soil organic matter pools is greater in soils of finer texture. However, site-specific soil carbon dynamics depend upon interactions of controlling factors.

Keywords: radiocarbon; density fractionation; turnover; forests

Poster S6-P9

Effects of inorganic N addition levels on microbial transformation of maize residue-^{15}N into amino sugars

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Incorporation of crop residues into soil can influence microbial processes involved in soil carbon (C) and nitrogen (N) transformations. Most of studies about crop residues mainly focused on residue-C transformation. Little information is available about microbial transformation of plant residue-N as a main N source. Amino sugars serves as reliable microbial biomarkers are usually used to elucidate C and N sequestration in microbial residues, as they are involved in microorganism-mediated soil organic matter cycling.

We conducted a 38-week incubation experiment where ^{15}N-labeled maize residues (*Zea mays* L.) (23.25 atom% ^{15}N) were added to a silt loam soil, along with a gradient of unlabelled sulfate ammonium. A GC/MS method was applied to trace plant residue-derived labeled ^{15}N incorporation into three amino sugars (D-glucosamine, D-galactosamine and D-Muramic acid) in this study. We found that more maize residue-N was incorporated into amino sugar in lower or no additional N treatment during the early stages of plant residue degradation. However, the trend was reversed at the later stages with greater amounts of maize residue-derived amino sugar in higher inorganic N addition treatments. This result indicates that sufficient inorganic N supply with high C/N plant residues would prolong the time of nutrient release from the added residues and enhance potential of the microbial community to sequester plant N into their cell wall residues over the long term. Decrease percentages of newly-formed amino sugar were larger than original portions that was present in soils at the onset of incubation, suggesting that the new amino sugar can be preferentially decomposed by microorganisms when available N gradually depleted in soils, which can play an important role in mediating soil N cycling. Furthermore, dynamic transformations of maize residue-N into individual amino sugars were compound-specific. The results indicated that bacteria were more competitive than fungi to assimilate liable substrates initially and played an active role in mediating soil C and/or N cycling. While fungi became dominant at later stage by utilizing recalcitrant or metabolized substrates,which contributed to the long-term maintenance of soil organic matter.

References: Amelung W, Miltner A, Zhang XD, Zech W (2001) Fate of microbial residues during litter decomposition as affected by minerals. *Soil Science* 166, 598-606.

Chantigny MH, Angers DA, Prévost D, Vézina LP, Chalifour FP (1997) Soil aggregation and fungal and bacterial biomass under annual and perennial cropping systems. *Soil Science of Society of America Journal* 61, 262-267.

Engelking B, Flessa H, Joergensen RG (2007) Shifts in amino sugar and ergosterol contents after addition of sucrose and cellulose to soil. *Soil Biology and Biochemistry* 39, 2111-2118.

Guggenberger G, Frey SD, Six J, Paustian K, Elliot ET (1999) Bacterial and fungal cell-wall residues in conventional and notillage agroecosystems. *Soil Science Society of American Journal* 63, 1188-1198.

He HB, Xie HT, Zhang XD (2006) A novel GC/MS technique to assess ^{15}N and ^{13}C incorporation into soil amino sugars. *Soil Biology and Biochemistry* 38, 1083-1091.

Liang C, Zhang XD, Balser TC (2007) Net microbial amino sugar accumulation process in soil as influenced by different plant material inputs. *Biology and Fertility of Soils* 44, 1-7.

Stevenson FJ (1982) Organic forms of soil nitrogen. In _trogen in agricultural soils_(Eds FJ Stevenson) pp. 101-104 (American Society of Agronomy: Madison).

Zhang XD, Amelung W (1996) Gas chromatographic determination of muramic acid, glucosamine, mannosamine, and galactosamine in soils. *Soil Biology and Biochemistry* 28, 1201-1206.

Keywords: Microbe, biomarker, inorganic N, crop residue-N, SOM.

Poster S6-P10

Geomorphic controls on soil organic carbon pool composition of agricultural sites:

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In the past, a majority of soil carbon science has relied on process-understanding derived from soil profiles in flat, non-undulating, and hence geomorphologic inactive landscapes. Recent scientific evidence strongly suggests that these approaches result in an underestimate of the complexity of carbon dynamics in agricultural landscapes. Erosion processes control the variation in soil and soil horizon thickness, the flowpaths of sediment and water through hillslopes, and therefore the spatial heterogeneity of biomass productivity, carbon stock/pool composition and hence carbon cycling and trace gas emissions.

To understand the geomorphic controls on SOC pool heterogeneity and carbon cycling, we conducted a series of chemical and physical fractionations (SIX et al. 2002, modified) on samples from agricultural sites in Belgium in order to identify important SOC pools and their distribution with depth at different slope positions. We accompanied this work with a 50 day incubation to assess differences in CO_2 and N_20 emission potentials within the landscape and as a base for future risk assessments.
Our data shows that size and composition of SOC pools depend largely on slope position with high amounts of organic carbon at depositional sites, especially at greater depth. Preferential erosion of soil colloids in aggregates and not in the form of discrete particles led to a higher amount of microaggregates in colluvial profiles compared to eroded ones. The observed respiration rates lead to the conclusion that older deep soil carbon from colluvial sites decomposes under surface conditions at a similar rate as topsoil carbon resources. With climatic changes (i.e. higher precipitation during shorter time periods are expected for this region) there is growing danger of exposing this vulnerable deep soil carbon to surface.

References: Six J., Conant R.t., Paul E.A., Paustian K. (2002): Stabilization mechanisms of soil organic matter: Implications for C-saturation of soils, *Plant and Soil*, Vol. 241: 155-176.

Keywords: carbon fractionation, soil respiration, soil organic matter, soil organic carbon

Poster S6-P11

Hyperspectral assessment of the three-dimensional variability of various soil properties in a stagnic luvisol

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Most studies in soil science assume diagnostic horizons to be homogeneous and consequently take a low number of replications. But many horizons are obviously heterogeneous and show clear patterns with widely varying physical and chemical properties on small spatial scales, e.g oxidised and reduced areas in the temporarily water-logged stagnic horizon. An associated problem is that most analytical techniques in soil science are destructive and the sample is lost when one parameter is measured. So even if we have enough replications and patterns are sampled accurately, only one or few properties can be measured before the sample is lost. A solution to this problem can be the bi-directional reflectance of a sample as it contains much information on a wide variety of a sample's properties which can be measured fast and simultaneously. But the problem is that most of these devices measure disturbed samples that were milled to powder size - again, no information on the small-scale variability of the parameters is provided. We are looking for a fast, non-invasive tool to estimate the horizontal and vertical heterogeneity of an undisturbed soil and quantify important physical and chemical properties with high statistical significance.

We sampled a stagnic Luvisol (siltic) under a Norway spruce monoculture in Southern Germany (Freising, Bavaria) using a stainless steel box (100x100x300 mm). A hyperspectral camera (400 to 1000 nm in 160 bands) equipped with a translation stage (moves the sample under the detector) was used. The spatial resolution was 62x62 µm per pixel and 1600 pixels were recorded in each row. Up to 5000 rows were recorded for the complete sample length. After recording the image, representative patterns (e.g. high and low oxide concentration) were sampled for further analyses (70 areas). Then 15 mm of the soil core were carefully removed and the surface smoothened prior to the next image (seven images in total). OC, Fe_{dcb}, Fe_{ox}, Mn_{dcb} and Mn_{ox} were determined with standard laboratory measurements for quantification and correlation with the measured spectra.

The heterogeneity of the sample was evaluated using different statistical tools on the hyperspectral image. We evaluated the spatial heterogeneity of the sample in two directions – in the vertical direction, along the profile and in the horizontal direction with 7 images. With principal component analyses the two bands with the highest factorial loading were selected and analysed using semivariograms. Classification analyses were used to identify homogeneous regions in the profile and to quantify the oxidised and reduced areas. We were able to calculate maps of total C, Fe and Mn concentrations for all 7 images based on the bidirectional reflectance and the elemental concentrations determined with standard laboratory methods. We show that this technique is a powerful tool to accurately quantify important soil properties and concurrently estimate their spatial heterogeneity in three dimensions on the small scale in an undisturbed soil system.

Keywords: Imaging spectrometry, profile heterogeneity, classification, elemental mapping

Poster S6-P12

Improving estimates of the maximal organic carbon stabilization potential of fine soil particles

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Organic carbon (C) retained on fine soil particles (< 20 µm) is relatively stable and accounts for a large proportion of total soil organic C (SOC). Soil carbon saturation deficit (i.e., the difference between current SOC and the maximum stabilization potential) affects the amounts and rates of SOC storage. In this study, we propose two alternative approaches to improve predictions of the maximal SOC content of fine soil particles proposed by Hassink (1997): boundary line analysis and monolayer-equivalent organic C loading.

We collected 216 data points from 21 studies, all of which have organic C content of fine soil particles, mass portion of fine soil particles in bulk soil, dominant soil clay mineralogy, and land use. Predictions of the maximal organic C stabilization potential using Hassink_model are disputed because in 22% of the data, actual organic C contents were greater than the maximal contents predicted using Hassink_model. In the boundary line analysis, regressions of organic C contents with fine soil particle mass portions were developed using data from soils assumed to have reached the maximum stabilization potential, making such predictions more reasonable. Boundary line regressions differed significantly between soils dominated by 2:1 clays and 1:1 clays, suggesting the influences of soil mineralogical properties on maximal organic C stabilization of fine soil particles.While the boundary line approach is an improvement over the Hassink approach, it still lacks a mechanistic foundation. Several studies have demonstrated a consistent organic C loading of soil minerals (mg C m^{-2}), which has been termed the monolayer-equivalent and though to be a potential maximum stabilization capacity for soil minerals (e.g., Mayer 1994). Predictions of maximal organic C stabilization using organic C loadings at the monolayer-equivalent value generated reasonable regressions for soils dominated by 2:1 clays, but not for soils dominated by 1:1 clays. Calculations of the maximal organic C concentration of fine particle fractions generate values of 41 mg C g^{-1} using Hassink's model, 40 mg C g^{-1} for 1:1 clays and 71 mg C g^{-1} for 2:1 clays using boundary line analysis, and 15 mg C g^{-1} for 1:1 clays and 80 mg C g^{-1} for 2:1 clays using the monolayer-equivalent organic C loading.

While the alternative approaches proposed here address several of the deficiencies of using the approach proposed by Hassink to estimate the maximal organic carbon stabilization potential of fine soil particles, the boundary line approach remains purely statistical, and the use of the monolayer-equivalent organic C loading requires further study to determine if this C loading represents an actual maximum stabilization capacity.

References: Hassink, J., 1997. The capacity of soils to preserve organic C and N by their association with clay and silt particles. Plant and Soil 191, 77-87.

Mayer, L.M., 1994. Relationships between mineral surfaces and organic carbon concentrations in soils and sediments. Chemical Geology 114, 347-363.

Keywords: Soil organic carbon; soil carbon saturation; boundary line analysis; monolayer–equivalent C loading; fine soil particles

Poster S6-P13

Influence of humification to humic acid properties in peat profile

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In the ombrotrophic bogs are accumulated a lot of natural organic matterwhich consists from moss, plants and microorganisms. Bog's vegetation wither away during the climatic condition and age. Transformation of living organic matter into refractory part of organic matter - humic substances is called humification. Both degradation and synthetic processes during decay of living organic matter are described as humification and in general it describes transformation of numerous groups of substances (proteins, carbohydrates, lipids etc.) and individual molecules present in living organic matter into groups of substances with similar properties (humic substances). The aim of this study is to analyse relations between the peat properties and humification degree on example of analysis of peat profiles in ombrotrophic bogs in Latvia.

Humic substances are a general category of naturally occurring, biogenic, heterogeneous organic substances that can generally be characterized as being yellow to black in color, of high molecular weight, and refractory. Structure of humic substances is characterised by presence of numerous aromatic, carboxylic and phenolic functionalities, linked together with alkylmoieties, imparting a measure of flexibility to the polymer chains.

In the peat transformation and decay process of living organic matter (humification) is retarded in acidic and anaerobic environment. The effect of organic matter transformation shows infrared spectroscopy. With increasing peat profile depth increase C-H and C=C bonds, but decrease C-O bonds (polysacharides). Unstable structures dominating in upper bog's layers, deeper layers are more stable organic matter structures. Infrared spectroscopy shows intensity of humification process, which occur slowly, especially, in anaerobic layers of bog. Association shows significant effects of organic matter humification which depends on peat botanical composition, decomposition degree and age.

Despite the heterogenity of peat in Eipuru bog profile in Latvia, humic substances shows very similar molecular properties (elemental composition, E_4/E_6, carboxyl groups and total acidity). For the studied humic substances these properties demonstrates insignificant transformation of organic matter and their influence to HS. Organic matter humification process shows hydrophobicity of humic substances which strongly correlates with peat decomposition degree. More hydrophobic humic substances are from cotton grass - *Sphagnum* raised bog peat and pine raised bog peat, and decomposition degree for these layers is 3-4 times higher to *Sphagnum fuscum* peat. The similarity in the structure and properties of humic substances from peat column suggests the importance of intensity of biological transformation of organic matter on their structure.

Keywords: peat, humification, humic substances

Poster S6-P14

Influence of organic carbon compositions and climates on litter decomposition rates on the forest floors:

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To quantitatively evaluate the contribution of organic carbon components to slowing of litter mass loss rates during an litter decomposition in various forest ecosystems, litterbag experiments were conducted for 4 years (2003 – 2007) at five sites from subtropical (Okinawa) to boreal (Hokkaido) zones in Japan. Litters provided for the litterbag experiment were from six dominant species in the respective sites. Solid-state ^{13}C cross polarization magic angle spinning nuclear magnetic resonance (CPMAS NMR) signals were monitored for phased-decomposed litters to determine the 4-year compositional changes in litter materials.

Litter mass decreased exponentially and their mass loss rates slowed down along with litter decomposition for all forests. Four-year remnant masses for initial litter mass ranged from 14 to 33%. Litter mass loss patterns were similar among the species and they did not differed significantly among the forests in spite of different climate zones that each forest belongs to.

Masses of all carbon components also decreased exponentially and their loss rates also slowed down with litter decomposition. Mass loss patterns of organic carbon components differed significantly among the forests, differing from mass loss patterns of whole litters. Aliphatic and carbonyl carbons would strongly contribute to slowing of litter mass loss rates for all forests. For carbonyl carbon, hydrolysis and oxidation reactions, which are common in decomposition and humification processes of litters on forest floors, would contribute to the formation of carbonyl carbons. Mass loss rates of aliphatic carbon for hardwood forests, especially, were markedly higher than loss rates of whole litter masses in comparison with that of coniferous forests. Generally, conifers have a richer content of aliphatic carbon (derived from resins and waxes) than hardwood. Moreover, aliphatic carbon was susceptible to be leached from the decomposed litters by rainwater at the beginning of litter decomposition. This result of the present study might reflect in lower loss rates of aliphatic carbon mass in the beginning of litter decomposition. Also, higher contribution of aliphatic carbon in hardwood forest to recalcitrance for litter decomposition than in conifers was due to relatively lower initial content of aliphatic carbon than that in conifers. Contrary to aliphatic and carbonyl carbons, mass loss rates of *O*-alkyl carbon, that is the most abundant component in litters, were higher than those of the rest components and whole litters for all forests. *O*-alkyl carbon might not generally contribute to increasing recalcitrance of litter with time due to the selective decomposition of *O*-alkyl carbon in litter that was derived from labile cellulosic compounds for soil decomposer organisms. Contribution of aromatic carbon to the increment of litter recalcitrant was recognized in temperate coniferous forests and subtropical hardwood forest only. Mass loss rates of aromatic carbon for temperate and boreal hardwood forests were almost the same as the loss rate of whole litter masses.

In conclusion, the present study clarified the process of increasing litter recalcitrance during the early humification stage for various forests in Japan. The findings in the present study may provide useful information that will help to quantitatively understand of the carbon accumulation processes on and in the forest soils during litter decomposition, e.g., the very beginning stage of the litter humification.

Keywords: solid-state ^{13}C CPMAS NMR, early humification of litter, forest floor, soil organic matter, Japan

Poster S6-P15

Location of mineralizable organic matter and soil pore structure interactions with C mineralization: a combined incubation, X-ray CT study

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The interactions between soil organic matter (SOM) decomposition, soil structure and availability of water are very complex, and our understanding of the mechanisms that regulate these interactions is incomplete. The traditional narrowing down of soil structure to soil aggregation is a gross oversimplification. In reality, the undisturbed soil matrix, i.e. the habitat of decomposers, exists as a continuous convoluted pore, bounded by solids.Thispore structure of soil can have a significant impact on soil processes like SOM decomposition by protecting micro-organisms from predation, by regulating the diffusion of substrate and metabolites and by regulating aeration and presence of moisture, both critical for microbial activity. Despite the growing body of evidence, a lack of knowledge on the interaction between structure and microbial processes is due to limitations in current techniques to spatially explore undisturbed soil. Advances in non-destructive techniques such X-ray computed tomography (X-ray CT) scanning combined with spatial analysis open up new opportunities.

We have set up a controlled incubation experiment aimed at investigating the influence of spatial location of added organic matter and soil pore structure on OM decomposition, consisting of two experiments: The first was aimed at investigating the feasibility of a number of artificial operations (1 compaction, 2 source of OM added, 3 artificial change in particle size distribution and 4 pH) to manipulate soil pore structure and the decomposer community. A sandy loam cropland soil (Belgium) was sieved at 53 µm, the sand fraction was ashed to remove particulate organic matter and recombined with the < 53µm fraction. We incubated the pre-treated soils in PVC tubes (D: 4,5 cm; H: 5cm) during 5 weeks and followed C mineralization, and determined microbial biomass OC and PLFA signatures at the end of the experiment. Additionally, a parallel set of tubes were incubated and placed on a sand-box with hanging head to assess soil pore neck distributions from determination of the moisture retention (pF) curve.

Based on the outcome of the first experiment a second main short term (4 weeks) incubation experiment was initiated, with application of an external C source (ground grass, 100-300 µm sized) and different manipulations of soil structure. Small metal incubation tubes (D: 1cm;H: 1cm) were filled with the sandy loam soil mixed with the grass powder and moistened by water addition at different levels. The mineralization was followed by regularly analyzing CO_2 concentration in the headspace of small incubation containers using a GC. At the end of the incubation period, the soil cores were scanned on the nano X-ray CT system of the UGent Centre for X-ray CT (at resolution appr. 10 µm).Since any particulate organic matter initially present was removed prior to the experiment (see above), the added OM can be localized by means of X-ray CT. 3D Software analysis of the pore space and OM localization, and correlation analysis of both with C-mineralization data is ongoing.

Keywords: X-ray computed tomography, soil pore structure, soil organic matter, decomposers, incubation experiment

Poster S6-P16

Organic matter dynamics in Technosols as a key factor of their functioning

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Technosols are characterized by a strong anthropogenic influence and contain, by definition, high amounts of organic and/or inorganic technic parent materials (Lehmann 2006, Rossiter 2007). The increasing number of sites affected by technogenic materials, and their impact on the environment as growing media for plants or as source of pollutants requires an understanding of their functioning and evolution. It is why we are interested in knowing the organic matter dynamics in such ecosystems. Using our approach of ultrastructural study by Transmission Electronic Microscopy of natural organic matter in soils (Watteau et al., 2006), we sought to characterize Technosol's organic matter, indicating their nature, their decomposition state, their stabilization within aggregates or their association with polluting elements.

We chose three contrasted examples in order to link the organic matter dynamics to the genesis and bio-functioning of Technosols. If these three Technosols presented initially a similar organic carbon content (around 70 g.kg^{-1}), the origin of organic matter was different.

- Technosol 1: a young technosol consisting in material originated from a former steel industry containing steel and coke residues, recently colonised by plants
- Technosol 2: a constructed soil (30 months) resulting from the combination of paper-mill sludge, thermally treated soil material excavated from a former coking plant site, and green-waste compost
- Technosol 3: 30 years old technosol developed on flotation ponds of a former steel mill containing fine dusts from blast furnaces with strong metallic pollution, on which grows a forest ecosystem

Main ultrastructural results showed:

- the involvement of bacterial activity in the degradation of root organic matter of colonising plants in Technosol 1 and the genesis of organo-mineral associations in the proximity of roots. These results suggest the specific habitat that represents the rhizosphere, even in such particular materials.
- the degradation state of organic matter (e.g., cellulosic fibres from paper-mill sludge and ligneous tissues from green-waste compost) over the past 30 months in Technosol 2. Compost appeared to have a significant role as source of microbial activity and organic matter appeared stabilized within micro-aggregates.
- the association of plant residues to pollutant metallic elements (Pb, Zn, Mn) in Technosol 3. Availability of such elements is so highlighted and transfer to the fauna will be discussed. Manganese silicate was also involved in organo-mineral associations including bacteria.

This scale of study really highlights the impact of microbial activity generated by the presence of plant organic matter, on the short (0-2 years) and mean-term (30 years) bio-functioning of Technosols. Link with results obtained at other scales concerning soil structure, overall analytical data or fauna determination will be discussed. According to our results, organic matter dynamics represents a main factor of Technosol's evolution.

References: Lehmann A (2006) Technosols and other proposals on urban soils for the WRB (World Reference for Soil Resources). *International Agrophysics* **20** (2),129–134.

Rossiter DG (2007) Classification of Urban and Industrial Soils in the World Reference Base for Soil Resources. *J Soils Sediments* **7** (2), 96–100.

Watteau F, Villemin G, Burtin G, Jocteur-Monrozier L (2006) Root impact on the stability and types of micro-aggregates in silty soil under maize. *Europ J Soil Sci* **57**, 247-257.

Keywords: Technosol biofunctioning – Rhizosphere - Plant – Microorganisms – Microscale

Poster S6-P17

Pore geometry and stabilization of organic carbon in soil aggregates under contrasting land uses on the Northern Tablelands, NSW, Australia

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Microaggregates (< 250µm) play a key role in protecting soil organic carbon (SOC) from microbial decomposition. The concept of physically protected organic matter is widespread in the literature, but relatively little is known about how organic matter interacts with soil surfaces in 3D. A study was conducted to examine the effect of land use change on SOC storage in microaggregates and the role of physical and physico-chemical protection mechanisms on SOC stabilization. Contrasting land uses [native pasture (NP); crop/pasture rotation (CP); woodland (WL)] were selected on a Dermosol on the Northern Tablelands of NSW, Australia. Soil aggregate stability was determined with low energy shaking prior to wet sieving. Total SOC (TOC) and SOC pools associated with 4000-250 µm, 250-53 µm and < 53 µm aggregates were determined. Light fraction carbon (< 1.6 g cm^{-3}) (LF-C) was determined by density fractionation by NaI. Intra-particulate organic carbon (iPOC) and mineral associated carbon (mSOC) of heavy fraction (>1.6 g cm^{-3}) was determined by complete dispersion with 0.5% sodium hexametaphosphate. Carbon analyses were undertaken with a LECO carbon analyser (TruSpec CN) and Carlo Erba NA1500 micro-analyser depending on the amount of organic carbon recovered. The basal respiration rates of the separated aggregates were also determined to assess the decomposition rates of SOC associated with each aggregate size groups. Soil aggregates of 4000-250 µm, 250-53 µm and < 53 µm obtained by wet sieving were incubated with KOH trap at 25^0C for 30 days at moisture content of 70% of field capacity. The amount of CO_2-C produced during incubation was then determined by TIM 850 Titration Manager. Pore size distribution and pore connectivity of aggregates were determined using microfocus X-ray computed tomography (µCT) (v|tome|xs 240, Phoenix|X-ray). Aggregate stability decreased from NP (0.81±0.06 mm)>WL(0.6±0.054 mm)>CP(0.39±0.02 mm). In NP and WL 63.21% and 53.87% of water stable aggregates respectively, were in the 4000 to 250 µm size range, whereas in CP 46.28% of aggregates were in 4000-250 µm size range. The percentages of aggregates in the 250-53 µm size range were 23.45%, 15.96% and 21.5% in CP, NP and WL, respectively. For NP, CP and WL the 4000-250 µm aggregates contained higher TOC than aggregate fractions of 250-53µm and < 53µm. TOC in 4000-250 µm and < 53 µm aggregates decreased in the order of WL>CP>NP while TOC in 250-53 µm aggregates was in the order NP>WL>CP. These data indicates rapid turnover of SOC in 250-53 µm and < 53 µm aggregates under crop/pasture rotation. The µCT analysis revealed that pore connectivity was significantly higher in >500 µm aggregates. We believe that the presence of small pores in microaggregates drive the considerably higher respiration rates of smaller aggregates but more detailed work is needed to confirm this conclusion.

Keywords: Aggregate stability, soil organic carbon pools, pore geometry

Poster S6-P18

Soil organic carbon and aggregate stability relationship as governed by the diversity of agricultural management practices.

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Under temperate climate, SOM is considered as the major factor of soil aggregate stabilization (Abiven et al, 2009) and, as a feedback, aggregate stability contributes to SOM protection and stabilisation (Angers and Chenu, 1997). In agro-ecosystems, SOM and aggregation depend on land management practices. The relationship between soil organic carbon (SOC) and aggregate stability (MWD) is well known and documented but the specific and interactive effects of various agricultural management practises are much a matter of debate. This is in part due to the non-standardized method used to measure aggregate stability when considering a wide range of situations in terms of soil texture, climate and cropping systems in which this property is studied.

Each cropping system is characterized by a combination of agricultural management practices which may contribute to soil aggregation in different ways because of differences in quality, quantity and frequency of organic matter input as well as other factors such as tillage. The objective of this work was to explain the variability in the response of aggregate stability to soil organic carbon in relation to the diversity of the agricultural management practises adopted by farmers at a regional scale.

To investigate the interactions between soil, climate, cropping system attributes, and aggregate stability, a multivariate analysis (PCA) was performed on a data set including basic soil properties, location and cropping system attributes. Data were collected between 2000 and 2009 in different regions of Brittany (France) from experimental sites and farm fields. Soil properties such as texture, organic carbon, aggregate stability and pH were measured using the same methodology (from sampling to analysis). Regional attributes (average annual air temperature, average annual rainfall, soil organic carbon median of the area) were extracted from climate and soil survey data bases. In Brittany, cropping systems are based on three major land uses: pasture, cereals and vegetable crops. The identified cropping system attributes, characterized through interviews with farmers, were: crop rotation (annual crops vs pasture), crop residue management (removed vs not removed, low C/N ratio vs high C/N ratio), fertilization (mineral vs organic, slurry vs compost, low amount vs high amount, low frequency vs high frequency).

Aggregate stability was significantly correlated to soil organic carbon (r=0.63). However, if we consider one level of SOC, different values of aggregate stability could be attained. The ratio MWD/SOC varied from 0.4 for the intensive vegetable cropping systems to 0.8 for pasture. Results clearly show that the effectiveness of the additional soil organic carbon formed with time on aggregate stability could be categorized by cropping systems. Performing a PCA (n=120), the first principal component, accounting for the majority of the total variance (approx. 50 %), is positively defined by the SOC, aggregate stability, clay content, soil organic carbon median of the area and the score affected to the cropping system. The second principal component is positively explained by the temperature and the frequency of the organic fertilization. As expected, for a given level of organic carbon, introducing pasture in the rotation is the more effective in controlling aggregate stability whereas adopting intensive vegetable cropping systems the less effective.

References:

Abiven, S., Menasseri, S., Chenu, C., 2009. The effects of organic inputs over time on soil aggregate stability – A literature analysis. Soil Biology and Biochemistry 41, 1–12.

Angers, D.A., and C. Chenu. 1997. Dynamics of soil aggregation and C sequestration, p. 199-206, In R. Lal, ed. Soil processes and the carbon cycle. CRC Press.

Keywords: soil aggregate stability; soil organic carbon; PCA; agricultural management

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Poster S6-P19

Soil organic matter mobility and redistribution in hillslopes of the Cantabrian Range (NW Spain)

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Under Atlantic climatic conditions (Cantabrian Range, NW Spain) mobilization of soil from eroded sites - steep slopes - to depositional sites - hillslope hollows and valley bottoms - takes place mainly by soil creep. Soil creep can be defined as any slow mass movement in the slope surface which is driven by downslope shear stresses and also by some biological and climatic processes.

Soil creep enhances mobilization of soil organic matter (SOM): some of the mobilized SOM is redistributed in the nearby landscape whereas another part is transferred to the watercourses. The relationships among topographic parameters, soil redistribution, and SOM accumulation would allow us to model the distribution of SOM in the landscape and SOM transference to river networks. Furthermore, it is known that different types of SOM are differently mobilized and redistributed by the erosion processes. Therefore, it is expected that environmental factors which condition SOM accumulation and composition, such as vegetation cover or fire incidence, also affect SOM mobilization and redistribution.

The main aims of this project (Ref.: PCTI IB09-024) are:

i) To obtain rates of soil creep in hillslopes of the Cantabrian Range. For this task, the fallout radionuclide 137Cs is used. 137Cs is a well-know and very effective tracer of soil and sediment redistribution.

ii) To link the information obtained about rates of soil creep with SOM properties; i.e.: SOM accumulation and SOM composition. For this purpose, thermogravimetry-differential scanning calorimetry (TG-DSC) is used for characterizing soil organic matter fractions (thermolabile, recalcitrant and refractory fractions). After that, statistical and geostatistical tools are used to find relationships among the analyzed parameters.

The study area is located in the Somiedo Natural Park (NW of Spain) and is characterized by an abrupt relief and a high variability of both the geological bedrock and the vegetation cover. The sampling protocol was designed in order to consider a high number of environmental parameters: geological bedrock, vegetation cover, topographical variables (slope, elevation, etc). Furthermore, wildfire incidence is also taken into account. Fire is a mayor disturbance in this Atlantic region of Spain and fire risk is expected to increase under future climate conditions.

Keywords: soil organic matter, mobilization, erosion, wildfire

Poster S6-P20

Spatial distribution of sediment and soil transfer properties in a stormwater infiltration basin

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Since the last half of the 20th century, urbanisation has become a strong demographic trend, leading to numerous environmental impacts such as air pollution and the degradation of surface and ground water. Urban runoff may contain pollutants and directly discharged into rivers and streams or sometimes collected before being infiltrated into the soil through best management practices such as infiltration basins (Chocat et al. 2007). The heterogeneity of the distribution of organic matter and fine particles within an infiltration basin makes it difficult to predict the rate of water infiltration in the soil throughout the basin. Thus, the aim of our study were: (i) to study the horizontal and vertical variability (profiles) of physico-chemical and hydrodynamic properties associated with the sediment layer and the sandy layer underlying it; and (ii) to establish correlations to understand the influence of physico-chemical parameters such as organic matter (OM) and clay on the soil structure (porosity) and the saturated hydraulic conductivity.

The study site is a retention/infiltration basin located in Nantes at the bottom of the bridge known as the "Pont de Cheviré" (northwestern France, 47°11'30''N, 1°36'50''W). It collects road runoff from the southern part of the bridge. Commissioned in 1991, this bridge currently supports daily traffic of 90,000 vehicles. The drainage area is 1.9 ha and the basin area is 0.078 ha, with a depth of 1.5 m. We established a grid of the basin with 11 sampling points. Samples were taken in two soil layers: the sediment layer (layer A - organo-mineral according to the pedological classification), and the sandy layer directly under it (layer S – structural). Soil water retention curves were derived from the evaporation based methods applied on undisturbed cores and the hydraulic conductivity curves from *in situ* water infiltration experiments. The soil pore size distribution were then derived from the water retention curves.

A highly heterogeneous organic matter (OM) distribution ranging from 45 to 222 g kg^{-1} was observed in the surface layer, with a sediment thickness ranging from 5 to 26 cm. The OM content of the underlying layer, primarily made up of sand, ranged from 7 to 32 g kg^{-1}. The pore size distribution is negatively correlated to the organic matter and fine mineral particles content, just as the saturated hydraulic conductivity (values between 1.3 10^{-5} and 7.2 10^{-6} m s^{-1} in layer A and close to 3 10-4 m s^{-1} in layer S). The lack of structuring aggregates could be attributed to the addition of exogeneous (partly anthropogenic) matter to the soil. OM contents and the relation between the soil properties and OM contents were used to propose a mapping of the soil transfer properties at the basin's scale. Such a mapping could be implemented through a 3D model to predict the hydric functioning of these basins at a yearly or even a pluri-yearly scale.

Nevertheless, the question arises as to the genericity of these equations. The correlations obtained are characteristic of the physico-chemical properties of the OM and the mineralogical composition of the soil. Therefore, the ability to predict the hydric functioning of infiltration basins depends on the characterisation of organic species, their degradation kinetics (i.e., mineralisation/humification), and their hydrophilic or hydrophobic properties. It is also necessary to determine the clay minerals present, as well as their adsorption properties. We must therefore take a closer look at the biogeochemical functioning of these anthropised soils. All these aspects will be the subject of further research.

References: Chocat B, Ashley R, Marsalek J, Matos MR, Rauch W, Schilling W, Urbonas B (2007) Towards the sustainable management of urban storm-water. Indoor Built Environ. 16: 273-285

Keywords: organic matter; stormwater infiltration basin; hydraulic conductivity; porosity; water retention curve

Poster S6-P21

Spatial distribution of soil and microbiological properties in grasslands: a question of land use intensity?

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The heterogeneity of soils is known to result in spatial dependence of soil properties over scales ranging from decimetres to several hundred metres. In contrast, the spatial distribution of soil microorganisms, which are the main processors of C and N cycling in soils, is less clear. Knowledge of soil properties controlling spatial variation in microbial abundance and microbiologically mediated decomposition and mineralization processes in soils is therefore important. The intensity and history of grassland land-use could additionally be important factors, modifying the spatial distribution of soil microorganisms and their activity.

The spatial distribution of soil (C_{org}, N_t, EOC, EN, pH, NO_3^-, NH_4^+), as well as microbiological properties (C_{mic}, N_{mic}, C_{mic}/N_{mic} ratio, and activities of 7 different enzymes involved in C, N, and P-cycling) were investigated for 9 grassland sites, subdivided into three different categories of land use intensity (LUI): low LUI (unfertilized pastures), mid LUI (fertilized mown pastures) and high LUI (fertilized mown meadows). At each site, 54 soil cores from the upper 10 cm were sampled in a 10 x 10 m area in spring 2008. Differences of spatial dependence of soil and microbiological properties between the three LUIs were analysed by fitting linear mixed models with geostatistical covariance structure.

As expected, the strongest effects of LUI were observed in soil nitrogen pools (N_t and NO_3^-), which were greater in fertilized grasslands of high and mid LUI. However, high LUI also resulted in greater C_{mic} and increased enzyme activities of ß-glucosidase and xylosidase. Practical ranges of microbial biomass, NH_4^+ and N_{min}, together with nitrate reductase activity, were smallest for high, and greatest for low LUI sites, whereas for EOC and pH the opposite order was observed. High correlations between C_{mic} and C_{org}, and between C_{mic} and two enzymes involved in C-cycling (ß-glucosidase, xylosidase) were found only for high LUI grasslands. Results revealed that spatial distribution and correlations between soil and microbiological properties differentially respond to land use intensity of grasslands. Possible explanations for the observed differences and implications for grassland management will be discussed.

Keywords: Spatial pattern, Enzyme activities, Soil properties, Microbial biomass, Grassland, Fertilization

Poster S6-P22

Studying soil organic matter (SOM) stabilization by coupling mid-infrared spectroscopy and thermal analyses to compliment traditional SOM fractionation procedures.

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Stability of soil organic matter (SOM) is important in agricultural systems, as stabilization mechanisms have an effect on SOM dynamics. Traditionally, investigating SOM has involved time consuming fractionation procedures. A more rapid and cost effective method for these investigations was studied through the use of SOM fractionations in combination with diffuse reflectance Fourier transform mid-infrared spectroscopy (DRIFT-MIRS) coupled with thermal analyses to gain information on SOM stabilization. It was proposed to use DRIFT-MIRS to identify different stabilities of SOM by selecting specific wavelength ranges in the mid-infrared. It was hypothesized that the 2930 cm^{-1} (aliphatic C) would represent labile compounds, 1620 cm^{-1} (aromatic C and –COO), and 1530 cm^{-1} (aromatic C) more stabile compounds, and 1159 cm^{-1} (C-O) unknown stability. Soil samples were obtained from the long-term Static Fertilization Experiment, Bad Lauchstädt, Germany from the treatments of farmyard manure, mineral fertilizer, the combination of both, and no fertilizer inputs (control). Hot water extractible C was analyzed as a measure of easily decomposed C, and bulk soil was fractionated by size and density methods. Bulk soil and fractions were also analyzed by mid-infrared spectroscopy at both room temperature and also at different temperatures up to 450°C which corresponded to exothermic reactions of SOM combustion. DRIFT-MIRS peaks for peak area integration were selected to include wavelengths of organic compounds, while avoiding wavelengths of mineral interference. The influence of treatment on peak areas was studied and the C contents of the SOM fractions were correlated to DRIFT-MIRS peaks. DRIFT-MIRS peaks were found to differ significantly with soil treatment. The relative peak area (rA) of 2930 cm^{-1} was highest in farm yard manure and mineral fertilizer treatment (37% relative area) and lowest under no fertilizer treatment (18% rA). Conversely, the peaks at 1620 cm^{-1} had the opposite trend with a rA of 53% in the manure and mineral fertilizer treatment compared with a rA of 70% in the control treatment. Positive correlations were found between the 2930 cm^{-1} peak and SOM fraction C contents of both the < 1.8 g cm^{-3} fraction C (r=0.86) and hot water extractable C (r=0.93). The 1620 cm^{-1} peak was negatively correlated to the same fractions (< 1.8 g cm^{-3} C r= -0.95, and hot water extractable C r= -0.79). These correlations imply that the 2930 cm^{-1} peak corresponded to more labile C compounds, while the 1620 cm^{-1} peak corresponded to more stabile C compounds. Preliminary results from thermal treatments showed that these same peak regions were found to respond differently to temperatures between 250-450°C, indicating the potential of thermal treatments to demonstrate different SOM stabilities. These results showed the utility of combining DRIFT-MIRS, thermal treatments, and fractionation procedures for studying SOM of different stabilities under long term management of both farm yard manure and mineral (NPK) fertilizer.

Keywords: soil organic matter, fractionation, stabilization, DRIFT-MIRS, thermal analyses, peak area integration

Poster S6-P23

Submicron analysis of soil organic matter dynamics using NanoSIMS

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Soils are structurally heterogeneous across a wide range of spatial and temporal scales, whereas, processes controlling the stabilisation of soil organic matter especially happen at submicron scales within soil aggregates (spatial inaccessibility) or on mineral surfaces (organo-mineral association). Although the knowledge about the factors controlling the preservation of soil organic matter (SOM) has substantially improved over the last years, these processes are still hard to evaluate in situ.

The specific features of the novel nano-scale secondary ion mass spectrometry (NanoSIMS) technology, which allows the simultaneous analysis of up to seven ion species with high sensitivity and lateral resolution, make it an unprecedented tool for the analysis of biogeochemical processes and properties of soils. With Cs^+ as primary ions, negatively charged ions, like e.g. $^{12}C^-$, $^{13}C^-$, $^{12}C^{14}N^-$, $^{12}C^{15}N^-$ and $^{28}Si^-$, are collected with a lateral resolution of up to 50 nm. Consequently, the NanoSIMS enables us to explore the elemental and isotopic composition of soils at the submicron-scale.

We developed a sample preparation procedure for primary soil particles (mineral particles and particulate organic matter) and intact soil aggregates (2 to 6.3 mm) to obtain samples that meet the requirements of the instrument. Incubation experiments with single particles of a fine silt / clay mixture (< 6.3 µm) of an Albic Luvisol, with the occluded small particulate organic matter fraction (< 20 µm) and intact soil aggregates (< 6.3 mm) of a Haplic Chernozem were carried out with a $^{13}C^{15}N$ labelled amino acid mixture as readily bioavailable organic matter input. NanoSIMS analyses demonstrated that after label addition, primary soil particles show an enrichment in both ^{13}C and ^{15}N, which decreases over time. In addition, line scans and depth profiles revealed a heterogeneous pattern of the organic matter distribution. The heterogeneous isotopic enrichment over a particulate OM cluster demonstrated the possibility to trace regions where microbial activity lead to the increased utilisation of freshly added organic matter and or different sorption capabilities. The observed enrichment in ^{15}N of the inner spheres of intact soil aggregates led to the assumption that diffusion of dissolved organic matter occurs into aggregate interiors. From these first results, we can conclude that the NanoSIMS analytical technology can be applied to a broad range of soil samples and enables us to locate the association of elements/isotopes in soil components at the submicron-scale. In the future, we thus expect a major step forward in the understanding of biogeochemical properties and processes in soils using this analytical technique.

Keywords: ^{13}C, ^{15}N, isotopic label, black carbon, particulate organic matter, stable isotope, submicron-scale

Poster S6-P24

The influence of tree species on soil organic matter dynamics

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Tree species vary in their influence on soil organic matter (SOM) pools, yet the mechanisms of tree-soil interactions are poorly understood despite their importance for shaping forest biogeochemical cycles. We evaluated SOM dynamics in mineral soils (0-20 cm) beneath 11 different tree species growing in monoculture stands at a 37-year-old common garden experiment in Poland. Previous studies of this site provide a rich data set on stand properties and species traits that we use to interpret patterns in SOM dynamics. We characterized SOM dynamics by conducting elemental and isotopic analyses of physically separated soil fractions and of carbon dioxide (CO_2) respired during bulk soil incubation. Mineral soil C pools were not statistically different among species, yet $\Delta^{14}C$ and C to N ratios demonstrated that tree species have significantly different rates of soil C cycling. Some characteristics of SOM dynamics were more related to stand-level properties (e.g. tree basal area) while other aspects of SOM dynamics were more closely related to species-level variation in plant traits (e.g. leaf litter calcium concentration). The $\Delta^{14}C$ of CO_2 respired by microorganisms during soil incubation increased with basal area, reflecting a greater contribution of post-bomb plant litter to microbial metabolism in plots with high basal area. Soil C to N ratios and cumulative CO_2 respired during the incubation were correlated with soil pH and earthworm abundance, which previous studies showed are a function of species level-variation in nutrient stoichiometry of leaves and roots. Species with high leaf litter calcium (e.g. *Acer sp.*) have more earthworm biomass and higher soil pH, leading to increased C mineralization by microbes and fauna and a greater extent of decomposition of residual organic matter. These apparent differences in soil C cycling and composition among species may translate into substantial differences in soil C stocks with increasing stand age.

Keywords: radiocarbon, incubation, carbon, nitrogen, calcium, litter, pH, respiration

Poster S6-P25

The relationship between specific surface area and soil organic carbon in loess derived soils, of northern Iran

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Soil organic carbon (SOC) can act as a sink or source of atmospheric carbon dioxide, therefore, it is important to understand the amount and composition of SOC in terrestrial ecosystems, the spatial variation in SOC, and the underlying mechanisms that stabilize SOC.

Relationships between mineral specific surface area and organic carbon (OC) concentration were examined for sediments and soil A-horizons from throughout the world (Mayer, 1994). The organic compositions can be adsorbed by minerals surface, and also exist a positive relation between SSA and OC. Much of our current understanding is based on laboratory experiments, the results of which often do not support observations made in the field (Kalbitz et al., 2000). The present study attempted to demonstrate the relationship between specific surface area, soil organic carbon (SOC) rate and clay content in the pasture soils, in Golestan province. 7 soil profiles informed different moisture regimes (Udic, Xeric and Aridic regimes) were sampled from surface horizon (depth 0-30cm). Correlation and linear regressions were performed between SOC, specific surface area (SSA) and particle clay size. Results indicate that SOC and the content of clay showed significant liner correlations with SSA ($r=0.66$, 0.64 respectively, $p< 0.05$). Saggar et al., 1996 demonstrated that mean residence time of organic carbon in soil increase with higher specific surface area. Soils with high clay levels show greater SOC than soils with high sand contents (Bredja et al., 2001).

References: Bouyoucos GJ (1962). Hydrometer method improved for making particle size analyses of soils. *Agronomy Journal* 54, 464–465.

Carter DL, Mortland MM, Kemper WD (1986). Specific surface area. In: Methods of Soil Analysis: Part 1, Physical and Mineralogical Methods, 2nd edn (ed. A. Klute), pp. 413 423. *American Society of Agronomy and Soil Science Society of America, Madison, WI.*

Franzluebbers AJ, Haney RL, Hons FM, Zuberer DA (1996). Active fractions of organic matter in soils with different texture. *Soil Biology and Biochemistry* 28, 1367–1372.

Kahle M, Kleber M, Jahn R (2002). Carbon storage in loess derived surface soils from central Germany: influence of mineral phase variables. *Journal of Plant Nutrition and Soil Science*, 165, 141–149.

Kennedy MJ, Pevear DR, Hill RJ(2002). Mineral surface control of organic carbon in black shale. *Science*, 295, 657–660.

Ladd JN, Amato M, Oades JM (1985). Decomposition of plant materials in Australian soils: III. Residual organic and microbial biomass C and N from isotope-labelled legume materials and soil organic matter decomposing under field conditions. *Australian Journal Soil Researcher*. 23, 603– 611.

Mayer LM, Xing, B (2001). Organic matter–surface area relationships in acid soils. *Soil Science Society of America Journal*, 65, 250–258.

Mayer LM (1994). Relationships between mineral surfaces and organic carbon concentrations in soils and sediments. *Chemical Geology*, 114, 347–363.

Nelson DW, Sommers LE (1982). Total carbon, organic carbon, and organic matter. In: Page, A.L. (Ed.), Methods of Soil Analysis. Part 2. Chemical and Microbiological Properties, second ed. Agronomy Monographs, 9. ASA-SSA, Madison, WI, pp. 539–579.

Page AL, Miller RH, Keeney D R (1982). Methods of Soil Analysis. Part 2. Chemical and Microbiological Properties, second ed. Agronomy Monographs, 9. ASA-SSA, Madison,WI.

Parton WJ, Schimel DS, Cole CV, Ojima DS (1987). Analysis of factors controlling soil organic matter levels in Great Plains grasslands. *Soil Science society of American Journal* 51: 1173-1179.

Saggar S, Parshotam A, Sparling GP, Feltham CW, Hart PBS (1996). 14C-labelled ryegrass turnover and residence times in soils varying in clay content and mineralogy. *Soil Biology and Biochemistry*, 28, 1677–1686.

SAS Software (1999). *SAS Institute. version 8*. Cary, NC, USA.

Soil Survey Staff (2006). Keys to Soil Taxonomy, 10th ed. *U. S. Department of Agriculture.*

Sollins P, Homann P, Caldwell BA (1996). Stabilization and destabilization of soil organic matter: mechanisms and controls. *Geoderma* 74, 65–105 Washington, D.C.

Wiseman CLS, Puttmann WW (2005). Soil organic carbon and its sorptive preservation in Central Germany. *European Journal of Soil Science*, 56, 65–76.

Keywords: Soil organic carbon, Specific surface area, Loess soils, Northern of Iran

Poster S6-P26

Transfer of nitrogen derived from leaf litter to mineral-organic associations at the decadal time-scale within a forest topsoil under temperate conditions

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The supply of plant-available nitrogen (N) in terrestrial ecosystems is controlled by the mineralization of litter and soil organic matter. However, only a small fraction of soil organic N is accessible to decomposers. Large amounts are stabilised in soil and mineral-organic associations are thought to play a key role in the N retention.

We took advantage of a long-term litter ^{15}N field experiment conducted in Germany to explore the extent to which mineral organic-associations explain N dynamics during the first decade after litter application (0-2,5cm horizon). We compared the accessibility of labelled N to decomposers and its degree of association to various mineral-organic associations 3 and 12 years after litter application. The accessibility of N to decomposers was measured by potential mineralization of organic N and ^{15}N. Mineral-organic associations were sequentially isolated by density fractionation with no disaggregating treatment. We studied mineral phases by X-ray diffraction and selective dissolution of pedogenic oxides; and investigated the degree of microbial processing of organic matter using indicators of decomposition (C/N, ∂^{13}C, ∂^{15}N and thermal analyses). The incorporation of the ^{15}N-label within the isolated organic mineral associations was quantified by EA-IRMS

Three main mineral-organic associations were distinguished: plant debris with few minerals attached, aggregates and mineral grains with patches of organic matter. Potential mineralization experiments indicated that the ^{15}N became less accessible to microorganisms over time. This was concomitant with an increasing incorporation of the ^{15}N-label within aggregates during the curse of the experiment: 60% and 40% of the label were found in plant debris and aggregates 3 years after litter application against 40% and 60% after 12 years. We concluded that aggregates efficiently protect N at the decadal time-scale. The kinetics of ^{15}N incorporation suggested that the slow and delayed input of litter-residues in protecting aggregates is constrained by their porosity and turnover. They are both dependent on the degree of microbial processing of the occluded organic matter, what also determines the aggregate density.

This study shows that non-disruptive sequential density fractionation is a powerful tool for the isolation of ecologically meaningful mineral-organic associations. Combining this method and stable ^{15}N isotope, we demonstrate that litter-derived N enters the mineral soils as plant debris to progressively passes through aggregates of increasing density.

Keywords: nitrogen, ^{15}N, density fractionation, aggregate, mineral-organic association, long-term experiment

Poster S6-P27

Transformation of organic sulfur compounds in sub-alpine Japanese forest soils

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Sulfur (S), an essential element for the growth of plants and microorganisms, is cycled between organic and inorganic forms. In contrast to the developed countries, a significant increase in S emission is foreseen in Asian countries because of their rapid economic growth. Thus, the excess amount of S through atmospheric depositions can be anticipated the disturbance of forest soil ecosystems. Although mineralization of organic S is a key process for regulating the S cycling in forest soils, the mineralization mechanisms has not yet been understood. Our previous study showed that Japanese forest soils contained a large amount of HI-reducible S (i.e., ester-sulfate-S) that was as same amount as pyrophosphate-soluble S binding with Al–humus complexes were strongly correlated each other. The aim of this study was to clarify the mineralization processes of organic S. We measured different forms of S under varied temperature and pH to infer the effect of environmental conditions onto S accumulation patterns. We hypothesized that the amount of ester-sulfate-S was independent thorough mineralization processes because of binding with Al-humus complex.

Three soil samples were collected from subalpine forests dominated by the genus *Tsuga* and/or *Betula* trees in eastern part of Japan. They were brought back to the laboratory and kept at 4 ºC until use. For each soil sample, 3 field-moist soil-grass beads mixtures were packed in plastic syringes and were incubated at both 20 ºC and 35 ºC incubators. The soil-glass beads mixture was leached with 100 ml of 0.01 M KCl to remove the mineral S, and excess water was removed under a vacuum condition. The leaching procedure was repeated every 2 week for an experimental period of 40 weeks. The rate of organic S mineralization was calculated based both on the cumulative amount of S leaching from the soils during the experimental period and on the increment amount of sulfate adsorbed in the soils after the experiment.

Collected soils contained more than 800 mg S kg-1 soil of sulfur constituents. Although the rate of S mineralization for both temperature settings ranged from 0.03 to 0.45 mg S kg–1 day-1, the rate at 35 ºC was higher than that at 20 ºC. Based on the temperatures, Q10 was varied according to the soils (1.0, 1.6, 5.2). The reduced amount of HI-reducible S was significantly negatively correlated with that of C-bonded S ($p< 0.05$). While the final contents of C-bonded S were less than their initial contents in all the soils, for two out of 3 soils samples, the final contents of HI-reducible S were larger than their initial contents. The reduction rate of HI-reducible S was significantly positively correlated with pyrophosphate-soluble aluminum content ($p< 0.05$ for both 20 and 35 ºC incubation). Since there were no significant correlations between the reduction rate of C-bonded S and an initial soil pH(H2O) for both the temperature settings ($p>0.05$), we combined the data for both the settings for the analyses. The reduction rate of C-bonded S showed a significantly negative correlation with an initial soil pH(H2O) ($p< 0.001$). These results imply that the selective conversion of C-bonded S either into ester-S or into inorganic sulfate-S depends on the extent of affinity of conversion of ester-S into Al-humus complex. The results further suggest that some sulfur compounds are strongly affected by temperature during a mineralization process whose speed might be controlled by pedogenic mineralogical properties.

Keywords: Sulfur mineralization, Al–humus complexes, C-bonded S, HI-reducible S

Poster S6-P28

Why isn't the priming effect taken into account in global change models?

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The priming effect, which is defined as a change in the Soil Organic Matter (SOM) mineralization rate induced by Fresh Organic Matter (FOM) amendment, is recognized as a major phenomenon in soil science (Kuzyakov et al. 2000). Indeed, it has been demonstrated recently that the priming effect may lead to the release of carbon stored for as long as 2,500 years (Fontaine et al. 2007). Moreover, the priming effect may be a general phenomenon occurring in every place where labile organic matter meets a more recalcitrant organic matter in presence of microorganisms (Guenet et al. 2010). In laboratory experiments, the priming effect may accelerate recalcitrant SOM turnover by 36% to 189% (Hamer et al. 2004). Consequently, it may have important consequences on carbon turnover leading to the increase of carbon released in the atmosphere. Thus, the priming effect may represent a major climate-carbon feedback to increasing global temperature. However, despite its consequences, this phenomenon is often ignored within coupled climate-carbon models operating at larger scales such as those used to predict climate changes. Indeed, while SOM mineralization dynamics is largely controlled by soil moisture and soil temperature (Friedlingstein et al., 2006) in these models, the principal actors of the priming effect—the microorganisms—are not explicitly represented (Wutzler and Reichstein 2008). Different reasons may explain why the priming effect is not taken into account. One possibility is that, although the priming phenomenon has been recognized for a long time (Löhnis 1926) the mechanisms behind it not well understood, and debate is still occurring within the community. Thus several critical questions remain, such as: what is the mathematical formalism which has to be used to represent the SOM dynamics (Manzoni and Porporato 2009) and in particular the priming effect (Neill and Guenet 2010)? What are the cases where the incorporation of the priming effect in SOM dynamics models are important (land use changes, modification of primary production)? The lack of a consensus for how to approach modelling the priming effect makes its incorporation into coupled climate-carbon models complicated. A second possibility is that, in order to model SOM dynamics, several parameters are also needed: microorganisms C:N ratios, microbial assimilation yields, etc. These are often not available at larger scales. After a presentation of the different causes explaining why the priming effect is not taken into account within coupled climate-carbon models we will propose a new priming effect modelling approach adapted to larger-scale modelling constraints.

References:

Fontaine, S., S. Barot, P. Barre, N. Bdioui, B. Mary, and C. Rumpel. 2007. Stability of organic carbon in deep soil layers controlled by fresh carbon supply. Nature 450:277- 281.

Friedlingstein, P., P. Cox, R. Betis, L. Bopp, W. von Bloh, V. Brovkin, P. Cadule, S. Doney, M. Eby, I. Fung, G. Bala, J. John, C. Jones, F. Joos, T. Kato, M. Kawamiya, W. Knorr, K. Lindsay, H.D. Matthexs, T. Raddatz, P. Rayner, C. Reick, E. Roeckner, K.-G. Scnhtzler, R. Schnur, K. Strassman, A.J. Weawer, Y. Oshikawa, and N. Zeng. 2006. Climate-carbon cycle feedbacks analysis: results from the C^{4}MIP model intercomparison. Journal of climate, 19:3337-3353.

Guenet, B., M. Danger, L. Abbadie and G. Lacroix. 2010. Priming Effect: bridging the gap between terrestrial and aquatic ecology. Ecology. Doi:10.1890/09-1968.

Hamer, U., B. Marschner, S. Brodowski, and W. Amelung. 2004. Interactive priming of black carbon and glucose mineralisation. Organic Geochemistry 35:823- 830.

Kuzyakov, Y., J. K. Friedel, and K. Stahr. 2000. Review of mechanisms and quantification of priming effects. Soil Biology and Biochemistry 32:1485-1498.

Löhnis, F. 1926. Nitrogen availability of green manures. Soil Science 22:253- 290.

Manzoni, S., and A. Porporato. 2009. Soil carbon and nitrogen mineralization: Theory and models across scales. Soil Biology & Biochemistry, 41:1355-1379.

Neill, C., and B. Guenet. 2010 Comparing two mechanistic formalisms for soil organic matter dynamics: a test with in vitro priming effect observations. Soil Biology & Biochemistry, doi:10.1016/j.soilbio.2010.04.016.

Wutzler, T., and M. Reichstein. 2008. Colimitation of decomposition by substrate and decomposers - a comparison of model formulations. Biogeosciences 5:749-759.

Keywords: Priming effect, SOM dynamics, Global change, Modelling, Climate-carbon models.

Author Index