Diversification options to address adaptation and mitigation objectives in forest management planning under climate change

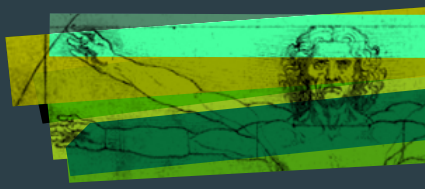
Jean-François Dhôte

LE STUDIUM®

CONFERENCES

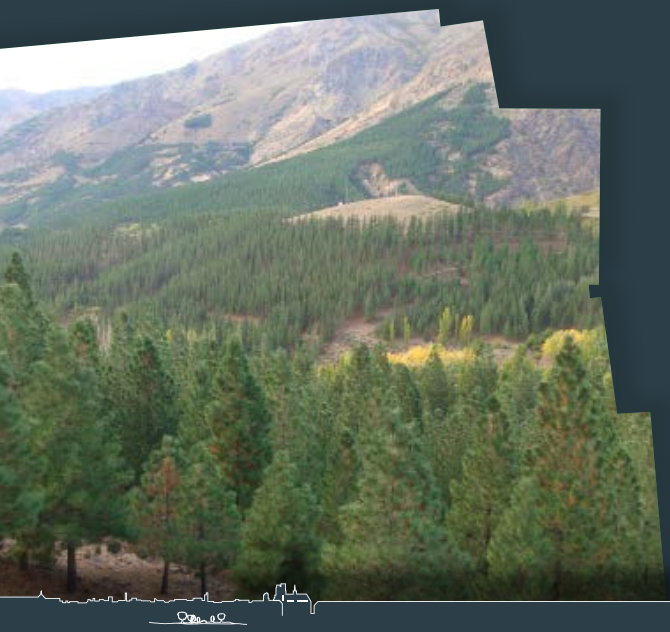
ORLÉANS | 2014

ABSTRACTS



18-19 November 2014

Natural and human-assisted adaptation of forests to climatic constraints: the relevance of interdisciplinary approaches



LOCATION

1, rue Dupanloup - Orléans, France
Centre International Universitaire pour la Recherche

CONVENORS

Dr Alejandro Martinez-Meier

LE STUDIUM® FELLOW
On leave from
INTA, EEA Bariloche, Argentina
In residence at
INRA Orléans, UR0588 (Unité d´Amélioration Génétique et Physiologie Forestières)

Dr Philippe Rozenberg

INRA Orléans, UR0588 (Unité d´Amélioration Génétique et Physiologie Forestières)

PROGRAM - REGISTRATION

conference@lestudium-ias.fr
www.lestudium-ias.com

Région Centre | Mairie d'Orléans | Conseil Général le Loiret | INRA SCIENCE & IMPACT | INTA LABINTEX | AGROPOLIS INTERNATIONAL

LE STUDIUM®

CONFERENCES

ORLÉANS | 2014

ABSTRACTS

Natural and human-assisted adaptation of forests to climatic constraints: the relevance of interdisciplinary approaches

CONVENORS

Dr Alejandro Martinez-Meier, LE STUDIUM® FELLOW
FROM
INTA, EEA Bariloche, Argentina
IN RESIDENCE AT
INRA Orléans, UR0588 (Unité d´Amélioration Génétique et Physiologie Forestières)

Dr Philippe Rozenberg,
INRA Orléans, UR0588 (Unité d´Amélioration Génétique et Physiologie Forestières)

ORGANIZING COMMITTEE

Sophie Gabillet, General secretary
LE STUDIUM® Loire Valley Institute for Advanced Studies • region Centre • France

Professor Nicola Fazzalari, Scientific director
LE STUDIUM® Loire Valley Institute for Advanced Studies • region Centre • France

Justine Thévenot
Bleu Nuit, Events Agency • Orléans • France

EDITO

Created in 1996 on the CNRS campus in Orleans La Source by Professor Paul Vigny, LE STUDIUM® has evolved to become a multidisciplinary Loire Valley Institute for Advanced Studies (IAS), operating in the region Centre of France. In December 2013 LE STUDIUM® moved to the city centre of Orleans and into a newly renovated 17th century building. These new facilities, at 1, Rue Dupanloup Orleans, are shared with the University of Orleans. This move into the city centre of Orleans is a major event in the evolution of LE STUDIUM®. During 2014 new and exciting developments are planned to strengthen existing IAS cooperative relationships and to build new programmes with the local and the international community of researchers, developers and innovators.

LE STUDIUM® IAS offers to internationally competitive senior research scientists the opportunity to discover and work in one of the IAS's affiliate laboratories from the University François-Rabelais of Tours, the University of Orleans and National Institute of Applied Science (INSA) Centre Val de Loire, as well as of nationally accredited research institutions located in the region Centre (BRGM, CEA, CNRS, INSERM, INRA). Our goal is to develop and nurture trans-disciplinary approaches as innovative tools for addressing some of the key scientific, socio-economic and cultural questions of the 21st century. We also encourage researcher interactions with industry via the IAS's links with Poles of Competitiveness, Clusters, Technopoles, and Chambers of Commerce etc.

LE STUDIUM® has welcomed over one hundred and thirty LE STUDIUM® RESEARCH FELLOWS, LE STUDIUM® RESEARCH CHAIRS and LE STUDIUM® RESEARCH PROFESSORS for periods of six months and up to two years. In addition to the contribution in their host laboratories, researchers are required to participate in the scientific life of the IAS through attendance at monthly interdisciplinary meetings called LE STUDIUM® THURSDAYS and LE STUDIUM® CLUB forums that involve participants from industry.

Researchers are also invited and supported by the IAS to organise, during their residency and in collaboration with their host laboratory, a two-day LE STUDIUM® CONFERENCE. It provides them with the opportunity to invite internationally renowned researchers to a cross-disciplinary conference, on a topical issue, to examine progress, discuss future studies and strategies to stimulate advances and practical applications in the chosen field. The invited participants are expected to attend for the duration of the conference and contribute to the intellectual exchange. Past experience has shown that these conditions facilitate the development or extension of existing collaborations and enable the creation of productive new research networks.

The present LE STUDIUM® CONFERENCE devoted to Natural and human-assisted adaptation of forests to climatic constraints: the relevance of interdisciplinary approaches is the 35th in a series started at the end of 2010 and listed at the end of this booklet.

We thank you for your participation and wish you an interesting and intellectually stimulating conference. Also, we hope that during these two days some of you will see an opportunity to start a productive professional relationship with LE STUDIUM® Loire Valley Institute for Advanced Studies.

Ary Bruand

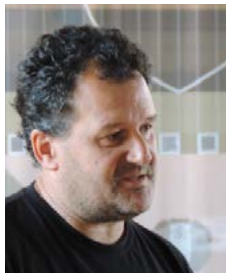
Chairman
LE STUDIUM®

SUMMARY

POSTERS

Natural and human-assisted adaptation of forests to climatic constraints: the relevance of interdisciplinary approaches

CONVENORS



Dr Alejandro Martinez-Meier

LE STUDIUM® FELLOW

Dr Philippe Rozenberg

INRA Orléans, UR0588 (Unité d´Amélioration Génétique et Physiologie Forestières)

Pr Sally Aitken

University of British Columbia
Department of Forest and Conservation Sciences, 3041-2424 Main Mall, Vancouver, BC V6T 1Z4 CANADA

Tel.: +01 604 822 6020
Email: Sally.Aitken@ubc.ca

Sally Aitken is a Professor in the Department of Forest and Conservation Sciences the University of British Columbia. Her work is focussed on the capacity of tree populations to adapt to or tolerate a range of climatic conditions, and implications of climate change for forest management. Dr. Aitken completed her PhD at the University of California, Berkeley and was a faculty member at Oregon State University prior to UBC. She received the Canadian Forestry Scientific Achievement Award in 2009 and the International Union of Forest Research Organization's Scientific Achievement Award in 2014. She is Project Leader of AdapTree, a large-scale project investigating the genomic basis of adaptation of tree populations to climate, evaluating their capacity to adapt to new climates, and developing reforestation policy recommendations.

Is the adaptive portfolio of current reforestation stocks adequate for new climates?

Climate change is creating a mismatch between tree populations and the climates they inhabit. Assisted gene flow, the practice of changing seed sources to better match genotypes to future climates, has the potential to mitigate this maladaptation. To better plan for reforestation for new climates, the AdapTree Project is characterizing the extent of local adaptation in two widespread conifers in western Canada, lodgepole pine (Pinus contorta) and the interior spruce species complex (Picea engelmannii, P. glauca, and their hybrids). Seedlings from hundereds of populations have been phenotyped for climate-related traits including growth, bud phenology, cold hardiness, and heat and drought stress. These individuals have also been genotyped through sequencing and assessing variation in ~25,000 genes. Relationships among provenance climate, phenotypes and genotypes are being used to characterize local adaptation in both species.

In recognition of the importance of socioeconomic as well as biological constraints to adaptation of forest management strategies to new climates, this project has assessed the values and perception of professional foresters, community leaders, and the public in western Canada. Recognition of the threat of climate change to forest health is high in all groups, but opinions vary on the acceptability of different reforestation strategies. Acceptance of assisted gene flow is moderately high among foresters, but somewhat lower in the general public. While foresters distinguish changing seed sources for a species from changing species, the general public does not seem to recognize this distinction. Results are being used to design climate-based seed transfer policies for future climates, to evaluate the capacity of natural populations to rapidly adapt to new climatic conditions, and to develop communication tools to translate genetic knowledge to stakeholders.

LE STUDIUM® **CONFERENCES** | 18-19 November 2014
Natural and human-assisted adaptation of forests to climatic constraints: the relevance of interdisciplinary approaches

Adrià Barbeta

Global Ecology Unit (CREAF-CSIC)
Building C, Faculty of Sciences, Autonomous University of Barcelona.
08193, Cerdanyola del Vallès, Barcelona, Catalonia, Spain.

Tel.: +34 935814221
Email: a.barbeta@creaf.uab.es

I am a PhD student in the last year of my doctoral thesis entitled "Effects of global change on Mediterranean forests: Drought and Fragmentation", under the guidance of Prof. Josep Peñuelas. My research focus is on the effects of the predicted increase in frequency, duration and intensity of droughts on Mediterranean forests. More particularly, I am interested in investigating the stabilizing and acclimation processes that may help plants to buffer against the negative effects of climate change. To date, I have mostly conducted my research in a long-term drought experiment installed in a Holm Oak forest. The duration of the study (established in 1998) allowed us to assess the temporal stability of the response to drought of the different species. During my training, I have used different approaches and techniques, including foliar-level measurements (IRGA chambers), sap flow sensors, stable isotopes, dendrochronology and demography. Though currently focused in plant water use, I am broadly interested in plant ecophysiology and the effects of global change on forests.

Forest acclimation to drought: Structural, functional and epigenetic changes following a long-term drought experiment

Long-term manipulation experiments of precipitation are a necessary approach to assess how the drought effects on vegetation change over time. Particularly, it has been hypothesized that the effect of a drought experiment may not be stable over time as a consequence of structural changes at the community level and of physiological, morphological and genetic changes at the individual level. In this talk, we will present the results of a 15 year long drought experiment in a Holm Oak forest in Prades Mountains (NE Iberian Peninsula). The negative effect of drought treatment on stem growth in Quercus ilex and Arbutus unedo was attenuated as the study progressed, providing evidence of a certain acclimation capacity. The drastic effects of an extreme drought event were added to the chronic water stress imposed by the drought treatment and caused higher mortality rates in the drought plots. That produced higher reductions of stem density in the drought plots and led to a resource-release effect, probably involving an increase of water availability per individual. Furthermore, water stable isotopes revealed that plants subjected to the long-term experimental drought shifted water uptake towards deeper soil layers during the wet season, indicating that there is plasticity in fine root functional distribution. However, the droughted plants showed reduced access to groundwater during the dry season. We also investigated the capacity of Q. ilex to produce rapid acclimation responses based on epigenetic modifications, using the methylation-sensitive amplified polymorphism (MSAP) technique to assess patterns and levels of methylation. The percentage of hypermethylated loci increased, and the percentage of fully methylated loci clearly decreased in plants exposed to drought. Altogether, the observed structural, functional and epigenetic changes, although unable to prevent the decreased growth and higher mortality associated with the experimental drought, seem to dampen to some extent the initially higher effects of the drought treatment and thus warrant further attention.

Dr Marta Benito-Garzon

CIRED
45bis, Av de la Belle Gabrielle F-94736 Nogent-sur-Marne

Email: marta.benito@gmail.com

Assisted migration scenarios for *Pinus halepensis* and *Pinus pinaster* in Western Europe

Marta Benito Garzón[1,2,3,4] & Juan Fernández Manjarrés[1]

[1] CNRS, Laboratoire d'Ecologie, Systématique et Evolution (ESE), UMR 8079, Université Paris-Sud, Orsay Cedex, France

[2] CNRS, Centre International de Recherche sur l'Environnement et le Développement (CIRED), Nogent-sur-Marne Cedex, France

[3] Université de Bordeaux, UMR 1202 BIOGECO, F-33400, Talence, France

[4] INRA, UMR 1202 BIOGECO, Cestas, France

One adaptation option to compensate forests for climate change and protect biodiversity is assisted migration (AM), by which biological units are intentionally relocated in climatically suitable areas to compensate for observed or expected climate change. Yet, tools for evaluating the sensitivity of target sites and identifying potential seed sources have not been developed. We used the National Forest Inventories of Spain and France to analyze Pinus halepensis Miller and Pinus pinaster Aiton sensitivity to climate change and design AM scenarios between and within both countries. Sensitivity to climate change was characterized as the expected changes in volume and mortality between the present and 2050. We selected seed zones from provenances with low sensitivity and target zones from provenances with high sensitivity to climate change. This design allows us to define three plausible scenarios for translocating biological material to the target zones on the basis of volume simulations calibrated with different planting strategies: 1) biological material coming only from foreign provenances; 2) biological material coming from foreign and local provenances; and 3) only biological material from local provenances. The results suggest that planting foreign resources alone or in combination with local seeds (cases 1 and 2) always increase the standing volume at the target zone if climate change is within the tolerance of the species. Interestingly, seed

sources coming from provenances with the highest volume in the southern populations are those that perform better in the target provenance as well. In these cases, AM would be beneficial for production in areas that are not so exposed to climate stress as the northern range of Mediterranean species.

Keywords (4-6): translocation, National Forest Inventory, Pinus pinaster, Pinus halepensis, climate change adaptation, Europe, production, management.

Dr Guillermina Dalla-Salda

Forest Ecology Group-INTA, Bariloche ARGENTINA
Modesta Victoria 4450, (8400) Bariloche, ARGENTINA

Tel.: +54 2944422731
Email: gdsalda@hotmail.fr

I live and work in Patagonia; Argentina. I am a Forest Engineer working in the research field since 1998 at INTA (National Institute of Agricultural Technology of Argentina), Bariloche in the Forest Ecology Group. My interests are focused on aspects related to plant ecophysiology: water relations in tree species, drought resistance and in the influence of the weather on the characteristics of wood by analyzing the hydraulic conductivity, vulnerability to cavitation, wood density and wood anatomy of different tree species. I am working now on the functional and adaptive role of wood in Douglas-fir trees.

Tree-ring study of cavitation and adaptation to drought in Douglas-fir

Water stress submits trees to strong functional and physiological adjustments, by limiting not only growth but also affecting their survival. It is expected that limitations in the availability of water during the growing season of the trees become more intense and frequent, raising many questions on the adaptation of forest ecosystems. In order to assess Douglas-fir's adaptation potential to drought we studied the phenotypic and genetic variation of xylem hydraulic properties, the relationship of these variables with wood density (microdensity) and the dynamics of conductivity loss within the tree-rings. Our results show the existence of significant genetic variability for the parameters describing the vulnerability to cavitation curves. Significant relationships were found between these parameters and the wood microdensity variables: high earlywood density confers Douglas-fir ring higher resistance to cavitation (P_{50}) while high latewood density is associated to a higher resistance to air entry (P_{12}). Cavitation was found to start in the latewood portion of the ring and would continue to propagate in the earlywood portion while transition-wood remains conductive at higher pressures. These results show that Douglas-fir has an adaptive potential to face drought and that wood density could be used as a tool that can eventually lead to the identification of genotypes with desirable characteristics to withstand drought.

Dr Sylvain Delzon

INRA, UMR BIOGECO, Bordeaux, France
Allée Geoffroy St-Hilaire, CS 50023, 33615 Pessac Cedex, France

Tel.: +33 5 40 00 38 91
Email: sylvain.delzon@u-bordeaux.fr
Website : http://sylvain-delzon.com

Sylvain Delzon is a Senior Researcher in Forest Ecology at the French National Institute for Agricultural Research (BIOGECO Unit, Biodiversity, Genes and Communities). He works at the crossroads of plant ecology, physiology, and evolutionary biology. His primary research interest is the understanding of plant ecophysiological responses to environment changes.

Evolution of ecophysiological traits and tree population adaptation

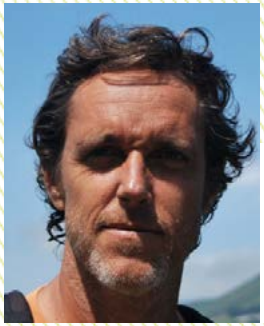
I will briefly present two examples

Phenological adaptive responses of trees to altitudinal gradients

I will report on experiments conducted in sessile oak (*Quercus petraea*) and beech (*Fagus sylvatica*) aiming at assessing the importance of both diversity and plasticity in the response to environmental changes generated by altitudinal gradients. The experiment consisted in a set of common garden and reciprocal transplantation experiments, and on the monitoring of bud burst and leaf coloration in situ and in the plantations.

Cavitation resistance and drought tolerance in conifers

In addition to being one of the most ecologically and economically important plant group, the Order Pinales is an appropriate size to examine the evolution of key functional traits across an entire plant Order, spanning >250My of evolution. Of particular interest given their longevity and stature, is the evolution of stress tolerance in the water-transport system. In the last four years, thanks to a new technology (CAVITRON), an extensive dataset has been developed for cavitation resistance, a fitness-related trait critical for plant survival during drought. We here analyzed the global variation in cavitation resistance and related traits (i) across 260 conifer species from the seven extant conifer families growing in the four main biomes and (ii) between populations across a species range.



Dr Martin De Luis

Department geography/university of zaragoza
C/Pedro Cerbuna 12, 50009 Zaragoza. Spain

Tel.: +34 976761000 (ext 4029)
Email: mdla@unizar.es

He obtained his degree in Biology at the Universidad de Alicante in 1994, where he also got his PhD in 2002. Subsequently, his research was conducted as postdoctoral researcher (2003-2004) in two international institutions: The laboratory of Tree-Ring Research in Tucson, Arizona (USA) and the Department of Wood Science and Technology at the Biotechnical Faculty in the University of Ljubljana (Slovenia). After that and from 2004 to 2009, he was a Ramón y Cajal Researcher at the Department of Geography of the Universidad de Zaragoza. Since September 2009 he is associate researcher in same institution. During 2013, he was visiting professor at University of Western Sydney (Australia). At present he is the research leader of a funded project of the Spanish National plan and acts as a leader of one of the research topics (TG5) of the EU COST Action FP1106, STReESS.

Phenotypic plasticity in cambial seasonality and xylem production of mediterranean species: results and challenges

Local adaptation and phenotypic plasticity in response to climate variability may play a decisive role in species persistence or expansion under future global warming.

Tree growth is a key fitness parameter for accurate predictions of responses to future climate instability and, in this context, dendro-sciences form a powerful and unique tool to assess the dynamics of tree growth in response to climate variability and change. However, despite such evidence, plasticity in species responses to climate variability has been poorly explored from a dendro- chronological perspective and variability in dendroclimatic response is more often considered as due to environmental noise in the tree-ring signal rather than a consequence of the plastic character of the species.

A substantial plasticity in the annual rhythms of cambial activity of different species in response to different climatic conditions has been recently well established. Similarly, recent results based on the analysis of dense dendrochronological networks, demonstrate that dendroclimatic relationships significantly vary across species distribution in accordance to underlying climate conditions suggesting that the acclimation of trees to the new environmental conditions through a plastic response may be playing an important role.

A more complex forest dynamics modeling approach considering genetic variation and phenotypic plasticity may contribute to resolve these uncertainties. Dendro-sciences will surely significantly contribute to this task but the reliability of some old principles and assumptions requires re-examination to provide a more realistic characterization of the biological processes that govern species responses to climatic changes.

Pr Annie Deslauriers

Université du Québec à Chicoutimi - Département des sciences fondamentales
555 Boulevard de l'Université

Tel.: +01 418 545 5011
Email: adeslaur@uqac.ca

Carbon coupling and uncoupling during wood formation depends on water availability and source of assimilates

Annie Deslauriers, Marilène Beaulieu, Lorena Balducci, Sergio Rossi

Non-structural carbohydrates (NSCs) represent the main constraint to plant growth, playing a crucial role in xylem formation. The amounts of NSCs for xylogenesis in black spruce saplings were assessed under high temperature and drought to determine the role of sugar mobilization for osmotic purposes and its consequences for secondary growth. We also assessed the coupling between the amount of differentiating cells during wood formation and the available NSCs in cambium and xylem in order to determine changes in source-sink relationships under different plant water status. Four-year-old saplings of black spruce were grown in greenhouses at different temperatures and submitted to a dry period of about one month in June. During two years, wood formation and NSCs concentration were monitored from May to September in cambium and xylem. Except for raffinose, the amounts of soluble sugars were not modified in the cambium even if gas exchange and photosynthesis were greatly reduced during drought. Raffinose increased more than pinitol under a Ψ_{pd} of less than -1 MPa because this compound is more apt than polyol at replacing water, capturing free radicals, and its degradation into simple sugar is easier. Warming decreased the starch storage in xylem as well the available hexose pool in cambium and xylem. Radial stem growth was reduced during drought due to the mobilization of NSC for osmotic purposes and the lack of cell turgor. In the absence of water stress, the number of cells in differentiation was positively correlated with NSCs in cambium, especially with sucrose and hexose, but these correlations decreased under water deficit. No coupling between NSCs in xylem and growth was observed except that between the amount of enlarging cells and hexose under water deficit. The variations in the correlations observed under water deficit represent an alteration of NSCs dependence on growth that is caused by changes in the source-sink relationships.

Dr Jean-François Dhôte

INRA
ADRESS

Tel.: +XX XXXXXX
Email: xxxxxx@xxxxx.com

Senior scientist (Directeur de Recherches) at INRA, Jean-François Dhôte (52 yr-old) graduated as an engineer from Ecole Polytechnique and Ecole Nationale du Génie Rural, des Eaux et des Forêts ; he has a PhD in Biometrics from University of Lyon.
Starting from an initial research topic on forest stand dynamics, he developed modeling approaches on several themes related to forest management : silviculture, wood quality, sensitivity to wind damages, long-term growth changes, site productivity mapping, regional resource dynamics, estimation and projection of carbon pools. Recently, to cope with climate change-induced challenges in public forest management, he put more emphasis on timber yield, biodiversity engineering and genetic resource management.
He created and managed two research units of ca 70 persons : at Nancy, the Laboratory of Forest and Wood Resources Studies (association of INRA and AgroParisTech, 2000-08), then at Fontainebleau the R&D Department of Office National des Forêts (2008-14). He supervised 14 PhD students, participated to 37 PhD defense committees and ≈ 15 evaluation panels. He authored (or co-authored) 65 scientific papers, 18 invited papers, 96 communications and ≈ 100 reports. !

Diversification options to address adaptation and mitigation objectives in forest management planning under climate change

Challenges on forest management under climate change are very high. This communication examines the field of objectives/constraints linked to adaptation and mitigation, in a context where society expects forests to provide very high levels of goods and services. Silvicultural diversification is a largely accepted principle in this context ; however, the diversification options currently discussed in Europe remain too narrow (in their scope) and naturalistic (in their philosophy). We propose to explore a broader range of diversification options, most of which imply *(i)* active management ; *(ii)* intentional and visible forest transformation ; *(iii)* a long-term, sustained commitment to monitor the efficiency and impacts of management change. We discuss the consequences on management planning decision-support, public perception and what would be expected from social science investigations on this topic.

Dr Patrick Fonti

Swiss federal research institute wsl
8903 BIRMENSDORF

Tel.: +41 44 739 22 85
Email: patrick.fonti@wsl.ch

Patrick Fonti graduaded in 1997 at the Swiss Federal Institute of Technology in Zurich (ETHZ) as a forest engineer. After few years in Bellinzona at the Sottostazione of the WSL working on the relaunch of chestnut forests management and the valorization of its wood, he defended is PhD at the ETHZ with his "Investigations into ring shake of chestnut". In 2006 he moved to Zurich at the Dendrosciences of the WSL starting his work in the fields of dendrochronology. Since then his research focuses on the use of tree rings for understanding the relationship tree-environment and its application to the study of environmental change. His field of activity is prevalently anchored in dendroecology, but strongly interacts with other disciplines as wood anatomy, tree physiology, and plant ecology.

Inside the ring: an interdisciplinary laboratory of growth responses

Tree-rings are usually seen as biological indicators of weather conditions and thus are specifically appreciated for reconstructing past climate. However, when looking inside the tree-rings it emerges a variegate structure composed by different type of cells fulfilling functions as water transport, mechanic support and storage of water and carbon assimilates. These cells are built at different time within the growing season and with varying structure according to the functional needs or the environmental constraints the tree was facing at time of ring-formation. In this context, an interdisciplinary approach could be beneficial to unravel these wealth of ecological information behind these complex connections between structure and function at varying spatial and temporal scales. The presentation will bring examples from high resolution monitoring of tree-growth to demonstrate that interdisciplinary approaches can be extremely rewarding in their contribution to a better mechanistic understanding of tree growth responses to changing climate.

Miriam Isaac-Renton

University of Alberta / University of Freiburg
ADRESS

Email: isaacren@ualberta.ca

I am currently a PhD student working in an international collaborative research project aimed at developing climate change adaptation strategies for lodgepole pine in western North America. My contributions in this project focus on tree growth and physiology; climate analysis and species distribution modeling; and risk management. When I finish my current program, I would be most interested in pursuing a post-doctoral research fellow position, and, eventually, a career in academia. As a Registered Professional Biologist, however, I wish to maintain my ties with other practicing Page 2 of 2: Bioclimatic Envelope Model & Douglas-fir Provenance Trials professionals to help solve pressing challenges across Canada and the world. My ultimate career goal is to provide a legacy of useful contributions in the fields of forestry and conservation and the adaptation of these disciplines to climate change. A recent research contribution of this nature was the outcome of a dual-degree MSc program through the University of Alberta (Canada) and the Albert-Ludwigs-Universität-Freiburg (Germany). I took advantage of this international connection by combining species distribution models developed in Canada with Douglas-fir field trials in Europe for validating growth and habitat projections under climate change. I hope that the resulting paper published in Global Change Biology will help forest practitioners both in Europe and Canada to develop climate change adaptation strategies for one of the most important commercial forest tree species. During my undergraduate degree in Natural Resources Conservation at the University of British Columbia (Canada), I took part in exchange and Co-op programs to study and work in New Zealand,South Africa and in various locations across Canada. These positions gave me my first scientific experiences in organizing field logistics, data collection and statistical analysis, and also led to a paper published in Écoscience (see: Isaac-Renton et al. 2010. Écoscience 17: 394-399).

Bioclimatic envelope models combined with genetic provenance trials indicate northward seed movement required for Douglas-fir in Europe under climate change

Miriam Isaac-Renton, David Roberts, Andreas Hamann, Heinrich Spiecker

To investigate the realism of climate envelope model predictions, we evaluate the introduction of North American Douglas-fir provenances to Europe as a retrospective experiment on how trees respond when subjected to novel environmental conditions. We conducted a meta-analysis of long term growth data of 2,800 provenance transfers to 120 European test sites, and examined whether a bioclimate envelope model developed for guiding assisted migration in North America can retrospectively predict the success of provenance transfers to Europe. The climate envelope model was generally well suited to predict the best performing provenances along north-south clines but failed to predict the superior provenance performance of coastal North American populations under continental climate conditions of eastern Europe. However, model projections appear appropriate when considering additional information regarding adaptation of Douglas-fir provenances to withstand frost and drought, even though the model partially fails in a validation against growth traits alone. We conclude by applying the partially validated model under climate change scenarios for Europe, and demonstrate that climate trends observed over the last three decades warrant changes to current usage of Douglas-fir provenances in plantation forestry throughout western and central Europe.

For more information see: Isaac-Renton et al. 2014. Global Change Biology 20: 2607-2617.

Sandra Karanitsch-Ackerl

University of Natural Resources and Life Sciences, Vienna

Tel.: +43 1 47654 4281
Email: sandra.karanitsch@boku.ac.at

Dendroecological response of softwood grown in eastern Austria to drought based on daily precipitation data

Sandra Karanitsch-Ackerl[1*], Konrad Mayer[1], Michael Grabner[1], Raphael Klumpp[1], Jan-Peter-George[2], Silvio Schüler[2]

[1] University of Natural Resources and Life Sciences – BOKU Vienna

[2] Federal Research and Training Centre for Forests, Natural Hazards and Landscape

For the current analysis, a subset of the data obtained within the project "Softwood for the Future" supported by the Austrian Science Fund (FWF TRP122-B16) – five eastern Austrian provenance trials including Norway spruce (*Picea abies*), larch (*Larix decidua, L. decidua x kaempferi*), fir species (*Abies alba, A. borisii-regis, A. bornmuelleriana, A. cephalonica, A. cilicica, A. nordmanniana*) and Douglas fir (*Pseudotsuga menziesii*) – was chosen to assess relationship to daily precipitation data of a Viennese station of the Austrian Central Institute for Meteorology and Geodynamics. The dataset consists of dendrodensitometric measurements of ring width and density, earlywood width and density as well as latewood width and density. As most of the sampled trees were young (20 to 35 years), the age trend in the time series of all measured parameters was removed with a 15-year cubic smoothing spline. From the daily precipitation data – sums were aggregated for 10, 20, 30, 40, 50, 60, 70, 80 and 90 consecutive days. For the same time slices, the number of days without any precipitation (= dry days) were counted. The trees' response to the meteorological situation was investigated with Spearman correlations for July prior to the growing season to November of the current year. First results for fir and spruce show that a 20-days-window is promising, although different window lengths seem to be suitable for different parameters. Highest correlation coefficients are obtained with earlywood density of fir and dry days from early July (r = up to -0,555 for single provenances) as well as dry days from early August (r = up to +0,618). The somewhat surprising results – e.g. positive correlation of spruce ring density with dry days of early July of the previous year, but negative correlation of fir ring density with dry days of early July of the current year – still need to be investigated in more detail.

Dr Antoine Kremer

INRA
69 Route d'Arcachon

Tel.: +33 6 63 11 51 26
Email: antoine.kremer@pierroton.inra.fr

Antoine Kremer is senior scientist at INRA Bordeaux (France). He received his phD in quantitative genetics and habilitation degree in population genetics at the University of Paris (Orsay). His research deals with the evolution of genetic diversity and differentiation between natural tree populations, at various hierarchical levels where diversity is expressed (from genes to phenotypic traits). Antoine Kremer initiated Europe-wide forestry research as early as the 1980s based on population genetics and evolutionary biology. His research has focused on the evolution of oaks across Europe, investigated by complementary approaches including paleobotany, population genetics and computer simulations. His current interest addresses future evolution in the context of environmental changes, using microevolutionary approaches by linking genetics, genomics and ecology.

Adaptation versus maladaptation under climate change

Along the current hot debate on adaptation of trees under climate change, the need for monitoring or predicting evolutionary change *in natura* has become of utmost importance. There is indeed experimental evidence that trees may undergo significant genetic change at contemporary time scales for various traits, based on the large body of experimental data demonstrating the wide genetic variation residing in natural tree populations. The main questions however remain as to which trait will actually be affected by climatic change, and how large the adaptive genetic change will be. I will extend traditional quantitative genetic approaches implemented under controlled experimental designs (progeny tests) and elaborate on the estimation of genetic parameters that would allow to make predictions of genetic changes in situ under so called natural conditions. Under directional selection driven by climate change, theoretical predictions of genetic changes will depend on the heritability of the trait and the selection gradient, but will be buffered by the amount of gene flow with neighboring populations. Depending on the direction of gene flow and the geographical location of the populations of interest, adaptation might be enhanced or hindered under climate change.

Ruth Martín-Sanz

Forest Research Center - INIA

Email: martin.ruth@inia.es

Ontogenetic and ecotypic effects on cone serotiny in Aleppo pine (Pinus halepensis Mill.).

Climent J, Martín-Sanz R, Santos L, Chambel MR, Notivol E.

In the Mediterranean basin, the increase of more frequent wildfires and severe droughts has raised concern about if the high colonizing ability of Mediterranean pines will be enough to cope with these challenges. As a fire-related trait, serotiny has being studied much lately. Aleppo pine seems to be a good model, probably because it shows a complex variation of cone serotiny. In previous studies we found that cone serotiny variation in Aleppo pine is due to genetic differences among and within populations (those from drier summers have greater serotiny) and to a significant plasticity effect among sites (dry episodes triggers cone opening). We also assume that cone serotiny depends on ontogeny (young/small individuals retain more closed cones) and ecotypic effects (this species may reveal different degrees of serotiny with different reproduction rates). That is, individuals could perpetuate after a fire by having enough aerial seed bank, but trees can choose for having many or few female cones, most of them closed, or having many cones, the most open. We examined the effect of tree size on cone serotiny and the extent of ecotypic differentiation on it. Analysing how different are the combinations of reproduction rate and serotiny degree among provenances and contrasting sites, considering also tree size effect. We measured serotiny (estimated through the percentage of closed cones) in an Aleppo pine common garden experiment replicated at three contrasted sites. Our analysis showed that tree size has a key influence on serotiny (it decreased with tree size) but this effect is site specific. As for ecotypic effects, we found that there are significant differences among provenances, being the ones from the harshest places those with higher reproduction and serotiny, while provenances with less reproduction have little serotiny. Moreover, intermediate reproductive provenances show variable behaviours, finding a high influence of site and tree size.

Pr Csaba Mátyás

University of West Hungary
H-9400 Sopron, P.o.b. 132, Hungary

Tel.: +36 99 518 395
Email: cm@emk.nyme.hu

In the field of impact of climate change on forest tree populations, Csaba Matyas is among the pioneers in research of the evolutionary ecological background of adaptation. He uncovered the value of common garden experiments for modeling and quantitative projection of climate change impacts, with the help of "ecological distance" calculation. His results indicated that genetically determined climate tolerance is especially decisive at the receding lower limits and introduced the concept of "xeric limits". This issue is especially ardent but insufficiently researched in the meeting zone of grasslands and closed forests, i.e. in the temperate forest steppe zone reaching from SE Europe to North China and to Western North America: a matter of global interest. Accordingly, the theme was taken up by numerous international workshops, consultations and conferences; the most prominent was organized by FAO at his University (FAO workshop "Climate Change Impacts on Forest Management in Eastern Europe and Central Asia" Sopron, 2010). With the support of NASA, NOAA1, and the Russian Academy of Science, he established in 2008 the NEESPI2 Regional Focus Center for Non-boreal Eastern Europe in Sopron (Hungary) to promote research in this field. He participated in various EU projects and COST collaborations, at present in the "FORGER" EU 7 project and the COST actions MaPS (marginal/peripheral populations) and STReESS (tree responses to extreme events). He had a decisive role in founding EUFORGEN in 1994/95, a network cooperation for genetic conservation in Europe. In IUFRO3 he has held various positions in genetics and breeding, lastly as coordinator for forest genetics. The professional achievement of Csaba Matyas was recognized by IUFRO with „Distinguished Services Award", he received visiting scholarships (Fulbright Scholarship, University Award/Canada) and honorary doctoral recognition from his University of West Hungary. At present he is initiator and coordinator of the "Agrarklima" joint EU/national integrative project to develop a decision support system to prepare for climate change impacts in forestry and in climate dependent agrarian sectors, with the participation of numerous universities and agrarian/forest companies on national level.

Envisioning forest reproductive material choice for uncertain times

The greatest current challenge to forestry is the fact that considering the projected magnitude of climate shifts, adaptation has to be mastered within one single generation of forest trees, against diverse limitations in species and genetic resources.

Increasing the share of nature-close forestry is often seen as a remedy to projected upheavals, based on the assumption that spontaneous adaptation processes may function sufficiently rapidly and effectively. Field and historic analyses of distribution shifts prove however that species migration needs human support, first of all on plains. Considerate species enrichment will be obstructed by the shortage of proper information and of certified reproductive material (FRM) and, moreover, by the respected principle of autochthony. On the within-species level of genetics, results similarly indicate that under significantly changing conditions, plasticity is a trait superior to autochthony: the assumed advantage of local populations may be questioned. Adaptability depends on extant adaptive genetic diversity, including genetically determined (!) plasticity; having, however, also definite limitations primarily vs. moisture stress (droughts).

The presented practical experiences from field tests imply the reviewing of presently valid regulations and laws of FRM use, of nature conservation and probably, even of the traditional interpretation of sustainability; all sensitive scientific and communication issues. Options for species and genetic diversity adjustment to future conditions should become integral part of decision support systems. Sources for future FRM demand have to be identified and established (e.g. seed orchards). Species envisaged for future introduction should be carefully tested for their fitting into ecosystems (e.g. invasiveness). Valuable populations, gene conservation units at lower range limits should be considered for evacuation.

Dr Sylvie Oddou-Muratorio

URFM-INRA
Domaine Saint Paul, Site Agroparc 84000 Avignon, FR

Tel.: +33 4 32 72 29 04
Email: sylvie.oddou@avignon.inra.fr

I am a population geneticist interested in understanding how microevolution can help tree populations to mitigate the effect of climate change. The originality of my research relies on estimating «real time» eco-evolutionary processes contributing to adaptation, using an inter-disciplinary approach, and combining experimental and modeling approaches. I develop innovative methods based on genetic markers to characterize plant mating system and gene flow by pollen and seed across a generation. I also investigate how these methods can be combined with quantitative genetic and ecophysiology approaches to measure the available genetic variability and ongoing selection gradients. Finally, I develop mechanistic simulation models to integrate eco-physiological, demographic and genetic processes, and predict future dynamics of trees population in response to climate change.

Past and ongoing adaptive response of fagus sylvatica along a short-scale climatic gradient

Understanding how and how fast populations can adapt to heterogeneous environment is a major issue of evolutionary ecology, which is currently gaining a renewed interest in the context of climate change. This study investigates adaptive differentiation and adaptive potential of three European beech (*Fagus sylvatica*) stands spanning across short elevational gradients (~1km long) in a mountain-Mediterranean ecosystem (Mont Ventoux, South-Eastern France). We first used indirect approaches based on the genetic differentiation of functional traits involved in climate response among stands at different elevation (measured in a common garden); this revealed a weak but significant imprint of past divergent selection on various phenological, growth, and physiological traits. Second, real time estimates of the available genetic variability and of the selection due to the abiotic environment on functional traits revealed a strong adaptive potential within population. Taken together, our results suggest that genetic adaptation can contribute to substantial phenotypic variation in response to environmental heterogeneity along the studied beech altitudinal gradient. However, some discrepancies between the observed patterns of adaptive differentiation and the real-time estimates of adaptive also suggest constraints to adaptive response.

Dr Ute Sass-Klaassen

Wageningen University, Forest Ecology and Management Group
P.O. Box 47, 6700 AA Wageningen, NL

Tel.: +31 317 486364
Email: ute.sassklaassen@wur.nl

Ute Sass-Klaassen has a background in wood science and technology and did her PhD on quantitative wood anatomy at Hamburg University, Germany. Since 10 years she is working at the Forest Ecology and Management Group at Wageningen University, The Netherlands where she heads the DendroLab. Besides teaching she is involved in projects in the field of temperate, arctic, and tropical dendrochronology. Her major interest concerns the relationship between tree physiology and environmental conditions by studying wood formation and wood anatomy. As chair of the COST Action STReESS she is currently organising a network of experts on wood anatomy, dendrochronology, ecophysiology, forest genetics and forest ecology to integrate knowledge on Stress response of European tree species.

Origin matters! –Insights from dendrochronology and wood anatomy of beech and douglas fir provenance trials to evaluate performance on moderate sites in the Netherlands

Authors: Ute Sass-Klaassen, Jan den Ouden & Britta Eilmann

Negative impacts of environmental changes are not restricted to forests on marginal sites but also affect tree populations growing under moderate site conditions. To evaluate the susceptibility to environmental change of local tree populations, but also to assess the possibility to speed up adaptation by planting other provenances of a given species, indicators for tree performance are needed. Tree rings form a valuable archive to study tree growth tree under varying environmental conditions across longer periods of time. Besides information on radial growth the anatomical structure of tree rings provides information on water-conducting capacity and drought susceptibility of trees and provenances. Two examples are presented where dendrochronology and wood anatomy together with information on mortality and leaf phenology are applied to assess growth performance and drought susceptibility of European beech and Douglas fir provenances growing under moderate site conditions in the Netherlands. Both species are important for Dutch forestry and are assumed to be affected by predicted changes in environmental conditions, especially summer drought. Differences in leaf phenology, radial growth, and wood-anatomical structure between provenances are evaluated regarding genetic and environmental control.

Dr Ivan Scotti

INRA

Email: ivan.scotti@paca.inra.fr

Microgeographic variation in tropical forests: do adaptive processes matter?

Tropical forest ecosystems are characterised by high biological diversity and spatially structured plant communities, with cohort replacement often occurring over very short geographical scales. These diversity patterns are associated with steep environmental gradients or habitat mosaics. Exploring the importance of adaptive processes to environmental gradients in the distribution of biodiversity is paramount for the development of predictive frameworks for ecosystem management and climate response. Are the observed patterns the result of adaptive processes? One way to answer this question is to look at species and species complexes that occur across habitats, and to test whether sub-populations of such groups show signs of microgeographic adaptation.

We have studied two tree genera, Eperua (Fabaceae) and Symphonia (Clusiaceae) and looked for signatures of genetic divergence at the microgeographic scale. We have found that spatial genetic structure within populations is associated with habitat patchiness. Molecular divergence is restricted to few, highly divergent loci, despite strong trait and metabolic divergence between subgroups within populations. Such incongruence between phenotype and expected genomic divergences raises questions about the mechanisms involved in divergence at the genomic level, and suggests a possible role of epigenetics in the maintenance of phenotypic diversity and adaptation.

Dr David Roberts

University of Alberta, Edmonton
751 General Services Building CA, T6G 2H1

Email: drr3@ualberta.ca

I am currently employed as a postdoctoral fellow at the University of Alberta, in Edmonton, Canada, working with the AdapTree project under Prof. Andreas Hamann at the University of Alberta and Prof. Sally Aitken at the University of British Columbia.
I have recently received an Alexander von Humboldt Postdoctoral Fellowship for a two year research term at the Albert-Ludwigs-Universität in Freiburg, Germany under the supervision of Prof. Carsten Dormann, to commence in December, 2014.

Applying newly-developed velocity of climate change algorithms to guide conservation and management decisions for forest trees

Climate change is often seen from a local perspective as the alteration over time of climatic variables at a given location. However, it can also be perceived from a regional or continental perspective as the movement over time of specific arrangements of climatic variables across the landscape. The velocity of climate change is an analytical concept that considers both the temporal and spatial variability of climate change on the landscape by dividing the rate of climate change by the rate of spatial climate variability or, more simply, by dividing the distance to analogous future climates by the interim years. Through this approach, it is possible to calculate the velocity at which organisms or species must migrate to maintain consistent climate conditions.

Such calculations, when run forward into the future, can provide valuable information for both conservation and management applications by identifying local populations for which climate velocities may exceed potential migration rates, helping prioritize genetic conservation action. However, such an analysis may also be calculated in reverse, identifying the distance to genetic source material for emerging future populations on the landscape, allowing managers to identify locations where actions to promote seed dispersal, such as assisted migration or assisted gene flow, may be beneficial.

As an ecological tool, climate velocities may also be paired with genetic information to evaluate the efficacy of current seed-transfer guidelines as well as to design effective seed-transfer boundaries into the future. In our research, we look specifically at two North American tree species, lodgepole pine (*Pinus contorta*) and interior spruce (*Picea engelmanii and P. glauca complex*), and find that migration demands on populations in topographic terrain are likely to be much less that on those in flat, open areas, necessitating different conservation and management strategies for different regions.

Dr Sabine Rosner

Institute of Botany, BOKU University, Vienna
Gregor Mendel Str. 33, A-1170 Vienna, AT

Tel.: +43 1 47654 3177
Email: sabine.rosner@boku.ac.at

1987-1995	*Study of Forestry at the University of Agricultural Sciences, Vienna (BOKU), Graduation to Diplom Ingenieurin of Forestry*
1998	*Graduation to Dr. nat. techn. (PhD in Forestry)*
1999-2002	*Post doc positions within the projects GENIALITY and LARCH financed by Shared Cost Action (EU)*
2003-2013	*Post-doc positions within three consecutive research projects at the Institute of Botany, BOKU University, Vienna, financed by FWF.*
	«Tradeoffs between structural, mechanical and hydraulic functions in Norway spruce – consequences for wood quality»
	Hertha Firnberg scholarship: «Wood dehydration analyzed by extraction of features of ultrasound acoustic emissions»
	Elise Richter Scholarship: «Analysis of acoustic emission from drought stressed plants»
2013	*Habilitation (Venia docendi) «Ecophysiology of Plants»*
*03.2013 - **	*Associate Professor at the Institute of Botany, BOKU, Vienna*

Growth and wood quality versus tree survival in conifers: What can we learn from plant physiology?

Global change is expected to increase the frequency of heat waves and drought periods. As a consequence, reduced water availability will directly affect tree survival in many areas. Evolution has optimized tree structure to maximize survival of the species, but not necessarily the quality properties needed for lumber. Structure of wood within and between trees differs due to changing demands on hydraulic efficiency, safety and mechanical performance. The optimum structures for achievement of biological functions will most likely differ, leading to conflicting demands on wood structure for physiological fitness. Superior wood quality such as high uniformity is not always paralleled by high hydraulic safety and mechanical performance. Breeding for wood quality or high growth without understanding the relationships between wood structure and tree survival may result in trees which meet the demands of wood industry but also in trees that have poor survival prospects in a changing environment. Moreover, knowledge about structure-function relationships enables selection of individuals or provenances with a lower sensitivity to drought.

Ignacio Sevillano

Teagasc - University College
Ashtown, Dublin 15

Email: ignacio.sevillano@teagasc.ie

Ecophysiological responses of Fagus sylvatica and Quercus robur seedlings to light intensity

Ignacio Sevillano[1,2], Ian Short[1], Conor O'Reilly[2], Olga Grant[2], Jerry Campion[1]

[1] Forestry Development Department, Teagasc, Ashtown, Dublin 15

[2] UCD Forestry, School of Agriculture&Food Science, University College Dublin, Dublin 4

Broadleaf planting has become increasingly important in Ireland in recent years, with European beech (*Fagus sylvatica L.*) and pedunculate oak (*Quercus robur L.*) being two of the most popular species planted. The ecophysiology of beech and oak seedlings grown in the open and under shadehouses (providing 100%, 62%, 51% and 28% of incident photosynthetically active radiation) conditions was studied in a simulated experiment during the summer of 2013 and 2014.

Results showed that during the first summer, beech and oak seedlings exhibited different physiological responses under shade, but there was no difference between the species at full sunlight. Oak showed greater values than beech for the physiological parameters studied during the summer of 2013. In contrast however, maximum photosynthetic rates were significantly higher in oak than in beech at full sunlight and minor differences were found under shade in 2014. Beech seedlings showed greater physiological plasticity than oak seedlings during 2013, but the opposite occurred in 2014.

Physiological responses during summer 2014 are closer to what might be expected for shade tolerant beech and the more light-demanding oak. This study suggests that beech and oak seedlings may require more than a full growing season before they can acclimate to different shade levels. Further work is required in order to gain a better understand of the physiological adaptations of these species to light availability.

Dr Michel Vennetier

EMAX (Ecosystèmes Méditerranéens et Risques) / Irstea
3275 Route de Cézanne, CS 40061, 13182 Aix en Provence Cedex 5

Tel.: +33 442 669 922
Email: michel.vennetier@irstea.fr

Michel Vennetier research fields since 1995 includes two main and related topics:

- *Forest ecology: dynamics of forest ecosystems and biodiversity with high levels of disturbances related to climate and global change: heat waves, drought, wildfires and urbanization.*
- *Forest and water engineering: sylviculture, forest site assessment, environmental management on dikes and in riparian forests.*

His position at Irstea aims at bridging research and society, by systematically coupling scientific results and papers with technical and dissemination papers and other practical outputs (technical guides, training sessions, teaching material, ...).
Before Irstea, he worked 7 years as forest manager in north-eastern France and 11 years in tropical forest research in India, Ivory Coast and the Caribbeans

Legacies of climate change and extreme events shape tree architecture: implications for forest decline and die-back

This presentation deals with the influence of climate change and extreme events on tree architectural development, its relations with reproduction, phenology and productivity, its consequences on tree leaf area dynamics, and finally its potential contribution to forest decline and die-back.

Fifteen species from Europe, USA and Canada were studied in natural forest stands and in experimental plots with rainfall exclusion and irrigation. Repeated droughts and extreme heat waves reduced branch vigor for all species, leading to low polycyclism and branching rates, short leaves and a small number of leaves per shoot, and thus to a significant leaf area deficit. The slow recovery from branch deficit holds back leaf area for many years after a prolonged or severe stress, limiting photosynthesis capacity and thus tree growth and reserve build up. Reproduction was severely affected as well. Phenology shifts were observed, related with both climate warming and drought. In the Mediterranean area, some trees showed a continuous growth during hotter winters, with sometimes dramatic frost damages as shoot abortion and leaf mortality. Increasing aridity led to a significant change in the response of ring width to climate, requiring the integration of up to 5 years of climate data to better assess tree diameter increase. Isotope analyses showed that trees had to look for water deeper in the soil.

Conclusion: Climate variability and extreme climate events have both short term and long lasting impacts on leaf area through their control of tree architectural development. Long lasting reductions of the potential leaf area, induced by branch deficits, limit forest productivity and has physiological effects that influence tree susceptibility to mortality, and may contribute to forest decline and dieback.

Pr Martin Weih

Department of Crop Production Ecology, Swedish University of Agricultural Sciences (SLU)
P.O. Box 7043 (visiting address: Ulls väg 16), SE-75007 Uppsala, SE

Tel.: +46 18672543
Email: martin.weih@slu.se

Martin Weih is a Professor of Plant Ecology at the Swedish University of Agricultural Sciences (SLU). Major research activities focus on the production ecology of agricultural crops - mainly perennial energy crops grown on agricultural land (Salix) and cereals (wheat) - and the genetic basis of production traits. He obtained his Diploma in Biology at the University of Erlangen-Nürnberg (Germany, 1990), and his PhD at the Uppsala University (Sweden, 1998). His current position is a full professor and the Head of Department of Crop Production Ecology, SLU (since 2010). More information is found at www.slu.se/weih.

Breeding of biomass willows for climate adaptation: integrating molecular genetics, eco-physiology and ecology

M. Weih, A-C. Rönnberg Wästljung, C. Björkman, J. Stenlid, G. Engqvist, S. v. Arnold

The culture of perennial biomass crops, such as willow (*Salix* spp.) on agricultural land is a viable alternative for the production of biomass for bioenergy. An increased use of bioenergy reduces the use of fossil fuels and thus contributes to mitigate climate change, which the EU committed to by signing the Kyoto protocol. Commercial short-rotation production systems with willow have been developed and put into practice in Sweden. However, breeding histories of the most promising perennial crops, among them *Salix*, are short and there is still a great potential for significant crop improvements. Apart from crop adaptation to the current climatic conditions in various parts of Europe, plant material needs also to be adapted to the environmental conditions expected in the future, e.g. as a consequence of climate change. Willows grown in short rotation are less sensitive to climate change than conventional forest species, especially because they are frequently replanted, making it possible to replace plant material to cultivars better adapted to a changed climate. Sustainable crop adaptation by a frequent change into better adapted plant material requires continuous and efficient plant breeding programmes, in which experts from various disciplines participate. A national Swedish willow breeding project integrates the disciplines molecular genetics, plant eco-physiology, plant protection and ecology with the practical breeding. The goal is to develop efficient breeding tools for rapid improvement of Salix grown for energy purposes under different climatic conditions. To reach this goal relevant plant characteristics for improved growth, drought and pest resistance are identified, molecular markers for those characteristics are developed, and marker-based information is introduced into the commercial breeding process. This will provide a basis for accelerated plant breeding and thereby sustainable adaptation to changing environmental conditions, including climate, of this fast-growing biomass crop.

Quinn BARBER

University of Freiburg

Email: qbarber@ualberta.ca

Quinn Barber, graduate student researcher at the University of Alberta (primary association) and the University of Freiburg (secondary association), working with Dr. Andreas Hamann and Dr. Scott Nielsen.

Prioritizing rare species conservation using climate change velocity, habitat connectivity and dispersal ability

Climate change generally requires species to migrate northward or to higher elevation to maintain constant climate conditions, but migration requirements and migration capacities of individual species can vary greatly. Species populations occupy different positions in the landscape that determine their required range shift to maintain similar climate, and likewise the migration capacity depends on habitat connectivity. Species-specific factors such as dispersal ability can greatly weaken or amplify migration capacity. Here, we demonstrate an approach to quantify species vulnerabilities and thus conservation priorities for 419 rare vascular plants in Alberta, Canada based on the velocity of climate change, local habitat fragmentation, and migration capacity from dispersal 'syndromes'. Multivariate climate change velocities indicated that future migration requirements ranged from 1 to 5 km/yr in topographically complex landscapes, such as the Alberta Foothills and Rocky Mountains. In contrast, migration requirements for maintaining similar climate in relatively flat Boreal Plains, Parkland and Grassland ranged from 4 to 8 km/yr. Habitat fragmentation was also highest in these flat regions, particularly the Parkland Natural Region. Of the 419 rare vascular plants assessed, 36 were globally threatened (G1 to G3 ranking). Three globally threatened species were ranked as extremely vulnerable and five species as highly vulnerable to the interactions between climate change velocity, habitat fragmentation and migration capacity. Incorporating dispersal characteristics and habitat fragmentation with local patterns in climate change velocity improves our ability to estimate climate change threats and to prioritize species for conservation actions such as managed relocation, while identification of stable populations and migration corridors will facilitate conservation of genetic resources.

Katline Charra-Vaskou

INRA

Email: katline.charra-vaskou@clermont.inra.fr

Water movement and embolism formation during freeze-thaw cycles: microdendrometer , NMR, X-ray microtomography, and Ultrasonic Acoustic Emissions analyses on Juglans regia

Katline Charra-Vaskou[*1,2], Eric Badel[1,2], Guillaume Charrier[3], Marc Bonhomme[1,2], Loïc Foucat[4,5], Stefan Mayr[3], Thierry Améglio[1,2]

[1] INRA, UMR PIAF, F-63100 Clermont-Ferrand, France

[2] Clermont Université, Blaise Pascal University, UMR PIAF, F-63100 Clermont-Ferrand, France

[3] Department of Botany, University of Innsbruck, A–6020 Innsbruck, Austria

[4] INRA, UR QUaPA, F-63100 Clermont-Ferrand, France

[5] current adress : INRA UR BIA, F-44316 Nantes, France

[*]corresponding author

Freezing events are a limiting factor for plants, particularly in the context of global climate change, and also water transport system of trees is affected by freezing stress. Freeze-thaw cycles may cause damage and lyses of living cells lyses and embolism in conduits, which impacts tree hydraulics.

We investigated water movements and embolism formation during freeze-thaw cycles on Juglans regia stems using four complementary methodical approaches: microdendrometer, Nuclear Magnetic Resonance Imaging (MRI), X-ray microtomography and Ultrasonic Acoustic Emissions (UEs) analysis. Therefore, stem samples were subjected to temperature cycles between +5°C and -40°C.

During temperature decrease, a drastic shrinkage of stems was observed, mainly due to dehydration of living cells in the bark. A higher content of free water was observed in the cambial and phloem zone, probably because ice nucleation occurred in these tissues and attracted water from the bark and xylem. UEs were strictly emitted during freezing indicating cavitation events in the xylem. During thawing, no UEs were recorded but the formation of embolism was observed via X-ray microtomography.

The experiments conducted with complementary methods clearly demonstrated that vessels embolism occurs during thawing without UEs. These results enabled new insights into the complex process of water movements and ice formation as well as its physiological consequences in stems of Juglans.

Keywords: cavitation, ice, xylem, water potential, walnut, tree.

HERVA Maria

University of Eastern FI

Email: mherva@student.uef.fi

Species distribution models predict suitability but not growth of lodgepole pine reforestation stock under climate change

Maria Herva[1,2,*], Andreas Hamann[1], Katharina Liepe[3], & Christer Karlsson[4]

[1] University of Alberta, Dept. Renewable Resources, 751 General Services Building, Edmonton, AB, Canada, T6G 2H1

[2] University of Eastern Finland, School of Forest Sciences, P.O.Box 111, 80101 Joensuu, Finland

[3] Thünen-Institut für Forstgenetik, Sieker Landstrasse 2, 22927 Großhansdorf Germany

[4] Swedish University of Agricultural Sciences, Unit for Field-based Forest Research

Siljansfors Experimental Forest, Box 74, SE-792 22 Mora, Sweden Abstract. Assisted migration of forest tree species in normal reforestation operations is a promising climate change adaptation strategy. Species distribution models could guide such prescriptions, but the modeling approach has been rightly criticized for making various assumptions that may lead to unreliable predictions of suitable habitat.

Our study contributes a retrospective test of the species distribution modeling approach by evaluating more than 2000 transfers of lodgepole pine (Pinus contorta Douglas ex Loud.) seed sources from North America to 61 European test sites. We quantify how tree populations respond when subjected to climate regime shifts, and we examine whether they can retrospectively predict the success of transfers to novel climate environments.

We found that at the species level, the predicted suitable niche space of lodgepole pine in Europe was not a good predictor of growth performance. Excellent growth was observed in test sites outside the projected habitat, while growth was comparatively poor where habitat suitability was predicted to be highest. However, projections of high habitat suitability correspond to regions where lodgepole pine grows well relative to native species, and projections were accurate at the population level. With few exceptions, the provenances predicted as the best climate match were also among the top performers at provenance trials for all regions.

Our research confirms a key criticism of the species distribution model approach to assess climate change impacts. Loss of habitat inferred from the realized niche space should not be interpreted as an imminent threat to species, although in the long-term they may be outcompeted or face other threats. However, we can nevertheless conclude that projections of the realized climate niche of species and their populations should be a useful approach to guide assisted migration under climate change, and to select well adapted planting stock for the future in reforestation programs.

KRAJMEROVA Diana

Technical University in Zvolen SK

Email: diana.krajmerova@tuzvo.sk

Is the heritable response of norway spruce to climate epigenetic rather than genetic?

Gömöry, Dušan[1] – Krajmerová Diana[1]– Longauer Roman[2]– Foffová Elena[2]– Pacalaj Marián[2]

[1] Technical University in Zvolen, TG Masaryka 24, 960 53 Zvolen, Slovakia, gomory@tuzvo.sk,

[2] National Forestry Centre, TG Masaryka 22, 960 92 Zvolen, Slovakia

Climatic clines of fitness-related phenotypic traits are usually attributed to divergent selection in environments gradually changing along latitudinal or altitudinal gradients resulting in gradually changing allelic structures. We analyzed responses of Norway spruce populations to climatic transfer, in terms of growth and survival, in a provenance experiment derived from the international provenance test IUFRO 1964/1968, which comprises a series of five trial plots situated at contrasting elevations ranging from 484 to 1,275 m a.s.l., with 11 provenances represented in all plots. Transfer rates were defined as differences in altitudes or climatic variables between the site of plantation and the site of origin. Optimal transfer rates were consistently negatively correlated with the underlying environmental variables whereas optimal climates were nearly the same for all provenances irrespective of the response traits and ecodistance variables. The results indicate that populations in different climates remain adapted to a common optimum and the extent of local adaptation is quite limited. In a nursery trial, we examined carryover effects provoked by climatic conditions during early growth. Twelve Norway spruce provenances were grown in two climatically contrasting nurseries and were reciprocally transplanted after the first year. Budburst phenology was scored 2 years after replanting. Plants grown during the first year at the warm site consistently flushed later in both nurseries than those grown under cold climate, the difference ranged between 2.6 and 7.1 days for different provenances. Plants also exhibited differences in budburst duration. Results give a strong indication for epigenetic basis of the observed shifts in spring phenology, which may be important for nursery management and reforestation.

KURJAK Daniel

Technical University in Zvolen SK

Email: kurjak@tuzvo.sk

Primary photosynthesis of ten beech provenances in response to heat-stress: connection with phenology, geographical and climatic condition

Kurjak Daniel[1], Gömöry Dušan[1], Macková Miroslava[1], Konôpková Alena[1], Frýdl Josef[2], Kmeť Jaroslav[1]

[1] Faculty of Forestry, Technical University in Zvolen, T.G. Masaryka 24, 960 53 Zvolen, Slovakia, e-mail: kurjak@tuzvo.sk

[2] Forestry and Game Management Research Institute, Strnady 136, 252 02 Jíloviště, Czech Republic

The increase of air temperature is one of the most important trait of global climate change and its impact on forests across the Europe is hard to predict. Therefore we tested the response of ten provenances originated from different countries and conditions to short-term heat stress. We used the water bath to simulate different temperatures ranged from 30°C up to 48°C and measured chlorophyll fluorescence of leaves (with the analysis of the OKJIP transient). All provenances were sampled from two international provenance plots in Slovakia (Tále) and in Czech Republic (Zbraslav). We tested for differences in the response among provenances and between two trial plots. Further we searched for relationship between primary photosynthesis response and original geographical and climatic characteristics as well as phenology. We found significant variability among provenances and between plots. We also found significant relationship between most of evaluated parameters and amount of precipitation during vegetation season on the plot Tále. However, this was not confirmed for the plot Zbraslav. We found consistent results for both plots in phenological response: chlorophyll fluorescence parameters correlated with day of flushing indicating lower thermostability for trees with later flushing. Further we found higher resistance to heat for individuals with longer vegetation period.

Key words: chlorophyll fluorescence, OKJIP-test, high temperature, Fagus sylvatica, provenance research

Anne LATREILLE

INRA, UR629 Ecologie des Forêts Méditerranéennes (URFM)
Domaine Saint Paul, Site Agroparc 84914 Avignon, FR

Email: anne.latreille@paca.inra.fr

Evaluation of the adaptive potential of silver fir (Abies alba) along altitudinal gradients using reciprocal transplants.

A. Latreille[1], C. Pichot[1], B. Fady[1]

anne.latreille@paca.inra.fr, christian.pichot@avignon.inra.fr, bruno.fady@avignon.inra.fr

Global changes, including global warming, alter ecological conditions and may compromise the persistence of ecosystems in their current habitat. Combining plasticity, migration and genetic adaptation processes, species will be able to adapt, to some extent. Although, population genetic differentiation and adaptation have frequently been estimated from common garden experiments at the scale of species distribution range, similar studies were more rarely conducted at local scale.

In this context, the INRA «Ecology of Mediterranean Forests» Research Unit focus its research on the dynamics of forest tree species such as beech (Fagus sylvatica) or silver fir (Abies alba) particularly exposed to climate change because of their long life cycle. Combining microdensitometry, association genetics (with SNP markers) and quantitative genetics on adaptive traits (growth, survival, budburst, leaf area, leaf/stem and root biomass) measured on reciprocal transplants and altitudinal gradients, we propose to analyse, at local scale, genetic differentiation and adaptation potential (genetic adaptation and plastic response to climate variation) of silver fir.

The evaluation of plastic and genetic components in phenotypic variability is based on two experimental strategies: (i) long term monitoring of adult trees along three altitudinal gradients (Mont Ventoux, Issole and Vésubie) located at southern limit of the species range in the French Alps and (ii) reciprocal transplants of seeds from 60 mother trees (20 from each gradient) collected at 3 elevations (low, mid and high) along the gradients.

Early trends from the analysis of survival and growth of 5 years-old seedlings in the reciprocal transplants did not reveal any genetic adaptation but showed strong diversity among families. Further analyses will provide information on adult trees adaptation and on the genetic control of the traits under selection, potentially key for adaptation under climate change.

[1] INRA PACA, UR629 Ecologie des Forêts Méditerranéennes (URFM) Domaine Saint Paul, Site Agroparc 84914 Avignon, France

MELLISHO Carmen

INRA

Email: cdmellisho@hotmail.com

Is the interaction between waterlogging and drought a worsening factor in oak (Quercus petraea and Quercus robur) decline?

Carmen Mellisho[1], Thierry Améglio[1], Philippe Balandier[2]

[1] UMR PIAF (INRA, Université Blaise Pascal), Site de Crouël, 5 chemin de Beaulieu, F- 63039 Clermont-Ferrand Cedex 02, France

[2] Unit Research on Forest Ecosystems (IRSTEA), Domaine des Barres, F-45290 Nogent-sur-Vernisson, France

Corresponding author: cmellishosa@clermont.inra.fr

The purpose of this study was to explain decline in vitality of even-aged oak (Quercus robur and Q. petraea) stand observed in three sites located in the county of Allier (Auvergne, Central France). Our analysis showed that microclimatic variables measured under tree cover (air relative humidity and temperature, rainfall, radiation, and calculated ETP) were very similar among the three sites. Records showed that no root growth occurred during waterlogging period (from January to June) in the three sites, because water excess led to hypoxia (oxygen deficiency) which probably caused a decay of the flooded fraction of the root systems. Waterlogging also affected the period of root active growth, i.e. the first flush of root growth did not occur, when oak normally has two flushes of root growth, one in late June and another in late July. After the water table decrease, root growth was observed in the three sites, but rooting profiles (0-180 cm below ground) were variable in the course of time, this fact is related to soil water content. As the soil surface horizons desiccated, root growth and plant water uptake may preferentially occur in deeper horizons in order to attenuate the duration and intensity of water deficit. These deep fine roots probably acted only during a short period (end of summer), when oxygen supply was sufficient, i.e., when water table fell. However, water deficit was strongest in one site, this fact may be due to its soil type, podzolic pseudogley, susceptible to dry out quickly and strongly in summer due to the coarser texture: the maximum water reserve is particularly low. Therefore, we can conclude than the root growth has two main issues in a one-year cycle. One is the temporary ground water table which stops the growth of the new roots during the waterlogging period, and the second issue is a low soil water content that becomes the main water limit for well root growth in a drought period.

Key words: climate change, drought, waterlogging, root growth, oak decline (Quercus robur and Q. petraea)

PSIDOVA Eva

Institute of Forest Ecology Slovak Academy of Sciences

Email: evkapsidova@yahoo.com

Drought-induces changes in physiological processes and recovery of beech and spruce seedlings from contrasting provenances.

Eva Pšidová*[1], Ľubica Ditmarová[1], Jana Majerová[1], Gabriela Jamnická[1], Daniel Kurjak[2]

Presenting author*

[1] Institute of Forest Ecology, Slovak Academy of Sciences, 960 53 Zvolen, Slovak Republic

psidova@sav.savzv.sk*, ditmarova@sav.savzv.sk, majerova@sav.savzv.sk, jamnicka@sav.savzv.sk

[2] Faculty of Forestry, Technical University in Zvolen, 960 53, Zvolen, Slovak Republic, kurjak@tuzvo.sk

The aim of the study was to deepen knowledge about physiological response to dry periods of beech (Fagus sylvatica L.) and spruce (Picea abies [L.] Karst.) and consequent monitoring of adaptive mechanisms and ability recovery of contrasting provenances. Beech seedlings from three provenances and spruce seedlings from two provenances were exposed to drought treatment in control condition. Seedlings water status was evaluated by measuring predawn water potential. We assessed mechanism on the photosynthetic level – gas exchange, stomatal conductance and accumulation of osmotic active substances (ABA). Water shortage caused changes in beech and spruce seedlings likewise, while the intensity of changes varied between studied provenances. Seedlings origin from dry climate responded relatively resistant to drought in both species. In spite of the most sensitive response of beech and spruce provenances from convenient conditions to water deficit we recorded the speedy recovery for them compared to provenances from drier climate.

Based on physiological approach and monitoring of adaptive mechanisms in recovery process we could observe different recovery ability of seedlings. We confirm that origin influences impact of water shortage as well capacities for recovery.

Key words: drought, recovery, physiological processes, provenance

RASZTOVITS Ervin

Institute of Environmental and Earth Sciences, University of West Hungary, Bajcsy-Zs. u. 4., H-9400 Sopron, HU

Email: raszto@emk.nyme.hu

The incorporation of extreme drought events improves modelling of beech persistence at its distribution limit in Hungary

Ervin RASZTOVITS, Imre BERKI, Csaba MÁTYÁS

Projections of species distribution models (SDMs) for future climate conditions are based on long term mean climate data. For management and conservation issues SDMs have been extensively used, but it is not tested whether models that are successful in predicting current distributions are equally powerful in predicting distributions under future climates.

Observations after 2003 confirms that extreme drought events played an important role in driving beech mortality at low-elevation xeric limits. The objective of this study was (1) to set up a simple extreme drought event based vitality model (EDM) using sanitary logging information as a proxy of vitality response of beech and (2) to compare the spatial pattern of the predicted vitality loss provided by the EDM with the distribution limits of the SDMs for three terms (2025, 2050 and 2100) in Hungary to assess model performance.

Prediction for vitality loss for 2025 obtained from the EDM was in agreement with those of the SDM, but for the end of the century the EDM predicted a more serious decline in almost all regions of Hungary. The result of the comparison suggests that the increasing frequency and severity of extremes might play a more important role in limiting the distribution of beech in the future near to the xeric limit than long-term means.

REZAEI Negar

University of Tuscia -CNR IBAF

Email: rezaie.negar@gmail.com

Climatic analysis of pointer years in beech tree-ring chronologies from Mediterranean mountains in Italy to temperate Germany

Negar Rezaei [1,2], Achim Brauning [3], Ettore D'Andrea [2], Pierluigi Bombi [2], Mario Cammarano [2], Giorgio Matteucci[2],[4]

[1] Dendrology lab, DAFNE, University of Tuscia, via San Camillo de Lellis, Viterbo, Italy

[2] CNR-IBAF, via Salaria Km 29.300, 00015, Monterotondo (Roma), Italy

[3] Institute of Geography, University of Erlangen-Nurnberg, Kochstrasse 4-4, Erlangen 91054, Germany

[4] CNR-ISAFOM, Via Cavour 4-6, 87036, Rende (CS), Italy

Trees have become increasingly valuable in providing long-term information on climate. In their annual rings, they hold signals from both local conditions of growth and global effect of atmosphere and climate. In years with extreme climatic condition, annual rings (pointer years) differ visibly and markedly from previous and subsequent rings.

This study is targeted to evaluate spatial and temporal distribution of pointer years in a latitudinal transect of the most important and drought-susceptible european broadleaf tree species (*Fagus sylvatica L.*). In order to do so, we sampled and established new chronologies of four beech forests from Mediterranean mountain in Italy (three sites, from Calabria to Veneto) to the temperate center of Germany (one site, north Bavaria). Pointer years were chosen according to "Cropper method". Climate data of Italian sites have been provided from a model created on data collected in last century from 1930 from weather stations nearest to the sampled sites (Brunetti, 2009). German climate data have been gained from the DWD climate data base.

The results indicate that from the beginning of the last century in all sites the temporal distribution of pointer years is homogenous, while the spatial distribution was very variable along latitude. For instance, Year 2003, that was critical for central Europe, did not have significant effects in the two sites located in central southern Italy. Among all the pointer years individuated in this study, Year 1957 can be considered a pointer year in all 4 sites of the transect. In addition, there were several common pointers years between two sites (e.g. 1935 in center and south of Italy, 1960 in north of Italy and Germany, 1902, 1949,1939, 1981,1987 and 1991 in center and north of Italy).

2014

Dr Magnus Williamson
Pr. Xavier Bisaro
Reconstructing Lost Spaces: acoustic, spatial, ceremonial contexts
30 - 31 October 2014

Dr. Edouard Asselin
Dr. Guylaine Poulin-Vittrant
Copper, a strategic metal? The present and future of resources, processing and recycling
14 - 15 October 2014

Dr. Christopher Oshman
Dr. Guylaine Poulin-Vittrant (GREMAN)
Piezoelectric micro and nano-structures and their applications
25-26 September 2014

Dr Eric Reiter
3rd International Congress on Gonadotropins & Receptors - ICGRIII
7-10 September 2014

Pr. Robin Beech
Dr Cédric Neveu
NemaTours: bringing worms together
17-18 July 2014

Pr. Gary Gibbons
Pr. Sergey Solodukhin
Gravitation, Solitons & Symmetries
20-23 May 2014

Dr Charles Sennoga
Dr Ayache Bouakaz
Targeted ultrasound contrast imaging and drug delivery
19-20 May 2014

Dr Igor Leontyev
Dr Louis Hennet
Heterogeneous catalysis : recent advances in preparation and characterization
31 March - 1 April 2014

2013

Pr. Chandani Lokuge
Pr. Trevor Harris
Postcolonialism now
4-5 February 2013

Dr Fabrizio Gherardi
Dr Pascal Audigane
Geochemical reactivity in CO2 geological storage sites, advances in optimizing injectivity, assessing storage capacity and minimizing environmental impacts
25-26 February 2013

Pr. Marcos Horacio Pereira
Pr. Claudio Lazzari
Vector-borne diseases : a multidisciplinary approach
8 -9 April 2013

Pr. Marc Hillmyer
Pr. Christophe Sinturel

Bottom-up approaches to Nanotechnology
29-30-31 May 2013

Dr Svetlana Eliseeva
Pr. Stéphane Petoud

Lanthanide-based compounds : from chemical design to applications
11-12 July 2013

Pr. Pietro Roccasecca
Pr. Philippe Vendrix

Vision and image-making : constructing the visible and seeing as understanding
13-14 September 2013

Pr. Reuben Ramphal
Pr. Mustapha Si-Tahar

Chronic inflammatory lung diseases : The next-generation therapeutic targets to consider
20-21 September 2013

Pr. Sergey Traytak
Pr. Francesco Piazza

Macromolecular crowding effects in cell biology : models and experiments
24-25 October 2013

Pr. Mourad Bellasoued
Pr. Jérôme Le Rousseau

Biology and mathematical inverse problems : a new wedded couple ?
14-15 November 2013

2012

Dr Lidewij Tummers
Pr. Sylvette Denèfle

Co-housing : born out of need or new ways of living ?
12-13-14 March 2012

Pr. Clive Oppenheimer
Dr Bruno Scaillet

Mount erebus, antarctica : an exceptional laboratory volcano
15-16 March 2012

Pr. Friedrich Wellmer

Life and innovation cycles in the field of raw material supply and demand — a transdisciplinary approach
19-20 April 2012

Dr Gerard Klaver, Dr Emmanuelle Petelet
Dr Philippe Negrel

Rare earth elements in our environment from ores towards recycling through the continental cycle
10-11 May 2012

Pr. Rosalind Brown-Grant
Pr. Bernard Ribémont

Textual and visual representations of power and justice in medieval manuscript culture
5-6 July 2012

Dr Agata Matejuk
Pr. Claudine Kieda

Defeating Cancer
Can non coding small RNAs be new players ?
24-25 September 2012

2011

Pr. Nicola Fazzalari
Pr. Claude-Laurent Benhamou

Osteocyte Imaging
13-14 January 2011

Pr. Nikolay Nenovsky
Pr. Patrick Villieu

Europe and the Balkans : economic integration, challenges and solutions
3-4 February 2011

Pr. Salvatore Magazù
Dr Louis Hennet

Cosmetics and Pharmaceutics : New trends in Biophysical Approaches
14-15 February 2011

Pr. Irène Garcia-Gabay
Dr Valérie Quesniaux

Inflammatory and infectious diseases
30-31 May 2011

Pr. Ali Chamseddine, Pr. Alain Connes et
Pr. Mickaël Volkov

Non commutative geometry, strings and gravity
25-26-27 May 2011

Pr. Jinglin You
Dr Patrick Simon

In situ Molecular Spectroscopic Technique and Application
20-21 June 2011

Pr. Valery Terwilliger
Dr Jérémy Jacob

Hydrogen isotopes as environmental recorders
15-16 September 2011

Pr. Philip Weller
Pr. Philippe Vendrix

Mystères des voix perdues – Polyphonies reconstituées, 1420-1520
24-30 October 2011

Pr. John Brady
Pr. Marie-Louise Saboungi

Water in biological systems
5-6 December 2011

2010

Pr. Alfredo Ulloa Aguirre
Dr Eric Reiter

New directions in gonadotropin hormones and their receptors
3-4 June 2010

Dr Yossi Maurey
Dr Christine Bousquet-Labouérie

Sacred space, sacred memory : bishop saints and their cities
10-12 June 2010

LE STUDIUM®
Loire Valley
Institute for Advanced Studies

www.lestudium-ias.com
1, rue Dupanloup • 45000 Orléans • France