Comparison of the Biomass Production Efficiency (BPE) seasonal evolution for a forest, a crop and a grassland under similar soil and climatic conditions

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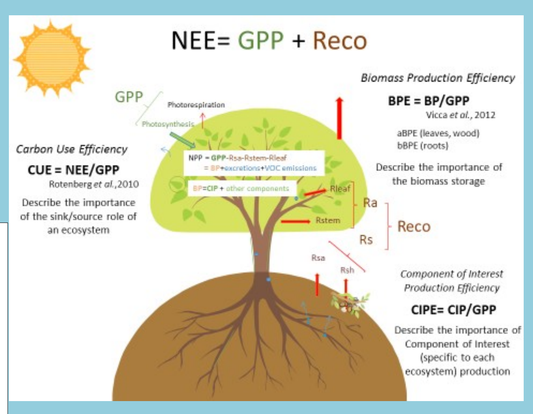
Context

- Uncertainties in spatiotemporal variability of C allocation models within ecosystems (Campioli *et al.,* 2013)
- Better understanding of C allocation would help to predict the strategies adopted by ecosystems to adapt to climate change
- Long term ecosystem C emissions depends indeed of where the C assimilates goes (i.e. deciduous tree leaves having a life span shorter than the woody part,…) (Trumbore, 2006)

Ecosystem Efficiencies



Acronyms:
NEE: Net Ecosystem Exchange
GPP: Gross Primary Production
Reco: Ecosystem's respiration
Ra: aerial Respiration
Rs: soil Respiration
Rsa: soil autotrophic respiration
Rsh: soil heterotrophic respiration
NPP: Net Primary Production
BP: Biomass Production
CIP: Component of Interest Production

VOC: volatile organic compounds

Component of interest (CI) to analyze

CI : Component that we thought are interesting for the ecosystem manager

General objectives

- Obtain BPE for a weekly to monthly scale
- Compare the BPE of a forest, a crop and a grassland under almost identical climatic and pedological conditions
  - Study relationship with climate and management
  - Analysis of adaptability to climate change (if large climate variability)
- Compare the temporal evolution of CIPEs for the 3 ecosystems

Biomass Production Efficiency (BPE)

Vicca *et al.,* 2012

- Introduced to distinguish the BPE from the ratio NPP/GPP (which also includes VOCs and root exudates) as BP is often used as proxy for NPP
- Show the part of C assimilated through photosynthesis used by plant for biomass production

State of the art

Potential determining factors:

Authors	Ecosystem type, caracteristics	BPE
Malhi et al., 1999 Vicca et al., 2012	Boreal forest	0.1-0.4
Granier et al., 2000 Vicca et al., 2012 Wu et al., 2013	Temperate deciduous forest	0.1-0.4
Barford et al., 2001 Curtis et al.,2005	Temperate mixt forest	0.1-0.6
Malhi et al., 1999	Tropical forest	<0.1
Aubinet et al., 2009	Crop (wheat)	0.5-0.6
	Crop (beet)	0.7
	Crop (seedling potato)	0.6
Ammann et al, 2007	Temperate grassland (intensive, fertilised)	0.2 (aBPE)
	Temperate grassland (extensive)	0.16 (aBPE
Klumpp et al, 2007	Temperate grassland (1 cut, 4 ovine grazing)	0.26
	Temperate grassland (1 ovine grazing	0.34

- Nutrient availability (Vicca *et al*., 2012, Sheriff *et al*., 1986)
- Age (controversial: De Lucia *et al*., 2007; Vicca *et al*., 2012)
- Species (Ryan *et al*., 1997; Aubinet *et al*., 2009)
- Atmospheric CO2 concentration (Matamala *et al*., 2003)

Experimental Sites

<u>Forest:</u>
→ Study zone spread on a 133 ha – toposequence, even-age stand of Beech (88%)
<u>Grassland:</u>
→ 8ha, cut then grazed
<u>Crop</u>:
→ 16ha, Canola (2013-2014)

<u>Studied soil type:</u> Calci-brunicol (AFES, 1998)

Growth follow-up

- Tree growth increment
- Crop, Grassland monthly sampling

Biochemical analysis

- Tree monthly micro-coring, Crop and Grassland monthly sampling
- Forest CI: gravimetric determination (Schädel *et al*., 2010)
- Crop, grassland CI: chemical, IR determination (Cesar laboratory, France)

Method

Flux tower/mast

- Wind speed
- Wind direction
- Radiation
- Precipitation
- Eddy covariance
- CO2/H2O profile (forest only)

} NEE

<u>EC system</u>: IRGA (LI 7200) coupled with a 3D sonic anemometer (CSAT3)

Obtaining GPP

- u* filtering (Reichstein *et al*., 2005)
- Gap filling (Reichstein *et al*., 2005; Falge *et al.,* 2002)
- NEE partitioning (Reichstein *et al*., 2005)

(use of bgc-jena online tool?

References

Aubinet, M. *et al.* (2009) Agricultural and Forest Meteorology 149, 407–418.
Bonan, G.B. (2008) Ecological Climatology: Concepts and Applications, 2nd ed. Cambridge University Press.
Campioli, M. *et al.* (2013) Ecological Modelling 263, 42-55
DeLucia, E.H. *et al.* (2007) Global Change Biology 13, 1157–1167.
Falge, E. *et al.* (2001) Agricultural and Forest Meteorology 107, 71-77
Matamala, R. *et al.* (2003) Science 302, 1385–1387.
Reichstein, M. *et al.* (2005) Global Change Biology 11, 1424-1439
Rotenberg, E., Yakir, D. (2010) Science 327, 451–454.
Ryan, M.G. *et al.* (1997) Journal of Geophysical Research: Atmospheres 102, 28871–28883.
Schädel, C. *et al.* (2010) Physiologia Plantarum 139, 241-255
Sheriff, D.W. *et al.* (1986) Tree Physiology 2, 73–88.
Trumbore, S (2006) Global Change Biology 12, 141-153
Vicca, S. *et al.* (2012) Ecology Letters 15, 520–526.
Waring, R.H., Running, S.W. (2010). Forest Ecosystems: Analysis at Multiple Scales. Elsevier.
Waring, R.H., Schlesinger, W.H., (1985). Forest ecosystems. Concepts and management.

Acknowledgments

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