Geophysical Research Abstracts
Vol. 12, EGU2010-7929, 2010
EGU General Assembly 2010

Does canopy mean N concentration explain differences in light use efficiency in 14 eddy-covariance sites?

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Production efficiency models aim at explaining variation of vegetation productivity with climatic input and information on vegetation cover often obtained from satellite observations. It has been acknowledged that different plant species differ in their potential to assimilate carbon dioxide per unit of PAR (i.e light use efficiency, LUE). Subsequently, some LUE-based models apply different LUE-coefficients for different plant functional types.

Leaf N concentrations differ between plant species, and related differences in light saturated photosynthesis rate (A_max) have been detected. How much these differences affect the ecosystem production or LUE is more obscure. Canopies acclimate to prevailing environmental conditions, which causes variation e.g. in the proportion of leaves exposed to direct sunlight, leaf morphology, structure,orientation, and vertical N distibution. Furthermore, a fair proportion of photosynthesis occurs during cloudy days, in which case high A_max is unessential, and number of these days differs by location.

We studied if canopy mean N concentration could explain differences in LUE derived for 14 forest sites using eddy-covariance measurements. The largest actual LUE was estimated for each site directly as an upper percentile of the ratio of Gross Primary Production (GPP) to absorbed PAR. Potential LUE for each site, on the other hand, was estimated by parameterising a LUE-based production efficiency model (Prelued), which accounts for daily changes in weather (temperature, VPD, PAR). In this model structure, the LUE-parameter for each site, can be interpreted as the potential LUE under optimal environmental conditions, i.e when the environment is not limiting production at all.

Averages of the largest actual LUE and potential LUE were higher in deciduous sites than in conifer sites. Canopy mean N correlated weakly with both the largest actual and potential LUE, and the correlation was also significant in conifer subset in the former case. Mean growing season VPD was the only climatic variable which correlated significantly with the largest actual LUE; none of them correlated with potential LUE. Inclusion of nitrogen in the Prelued-model structure did not improve the goodness of fit of the model.

According to our results LUE correlates with mean canopy N concentration. The correlation of mean VPD with the largest actual LUE can also be explained with the model accounting for daily variation in climate, as was made with Prelued-model for the potential LUE. Further studies utilising seasonal values of canopy N are called upon.

*Acknowledgements:
Eero Nikinmaa, Pertti Hari, Timo Vesala, Tuomas Laurila, Fredrik Lagergren, Meelis Mölder, Anders Lindroth, Thomas Grünwald, Christian Bernhofer, Denis Loustau, Paul Berbigier, Beverly Law, Alison Dunn, Steve Wofsy, Torbjörn Johansson, Torben Christensen, Terry Callaghan, Hans Verbeeck, Remko Duursma, Leonardo Montagnani, Dario Papale, Andreas Ibrom, Ebba Dellwik, Kim Pilegaard, Kentaro Takagi, Eva van Gorsel, Heather Keith, Sonia Wharton, Matthias Falk, Kya Tha Paw U, Matt Schroeder, Jon Lloyd