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Spatio-temporal variations of plant mediated exchange - diurnal and seasonal changes of the function status of plant canopies measured by sun-induced fluorescence

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Fluxes of plant mediated exchange processes are large and substantially influence patterns in atmospheric CO2 concentrations and water vapor. Plant canopies are not constant, but continuously adapt their physiology to the ever changing environmental conditions. Structural changes of plant canopies mainly occur on the time scale of weeks and seasons and are generally parametrized in regional and global carbon and water models. Changes of the physiological status of plant ecosystems, however, may occur within hours or a few days and are often not accounted for in models. Nevertheless, a reduction of photosynthesis because of e.g. stress may greatly reduce carbon and water exchange below the theoretical optimum. Such physiological changes are often are not correctly parametrized in spatially explicit and high resolution carbon and water models.

For a better understanding of the diurnal and seasonal variations of soil-vegetation-atmosphere exchange processes, the structure and function of two main agricultural crops were monitored over two years in the frame of the collaborative research consortium Transregio TR32. Seasonal development of the two main crops of the region, winter wheat and sugar beet, has been characterized during diurnal courses using non invasive methods ranging from leaf to canopy level including gas exchange, PAM fluorometry and eddy correlation measurements. The day course of photosynthetic capacity varied between the two species by being constant during the day for winter wheat whereas sugar beet showed a constant decrease over the day. The highest photosynthetic electron transport rates appeared before solar noon. Additionally the region was scanned by an airborne high-resolution spectrometer that allowed the extraction of sun-induced fluorescence. Sun-induced fluorescence is currently evaluated to serve as a direct measure of photosynthetic efficiency from air- and spaceborne platforms.

In this presentation we present the first conceptual view how passive remote sensing of sun-induced fluorescence can be used together with eddy covariance measurements and leaf-level characterization of the photosynthetic apparatus, to better parametrize local and regional CO2 and water fluxes. We aim to derive a quantitative map of GPP that includes physiological changes of the photosynthetic machinery n green and structurally unaffected canopies.

Selected Publications

[1] Rascher U. & Nedbal L. (2006) Dynamics of plant photosynthesis under fluctuating natural conditions. Current Opinion in Plant Biology, 9, 671-678.
[2] Rascher U. & Pieruschka R. (2008) Spatio-temporal variations of photosynthesis ¬ The potential of optical remote sensing to better understand and scale light use efficiency and stresses of plant ecosystems. Precision Agriculture, 9, 355-366.
[3] Rascher U., and 35 others (2009) CEFLES2: The remote sensing component to quantify photosynthetic efficiency from the leaf to the region by measuring sun-induced fluorescence in the oxygen absorption bands, Biogeosciences, 6, 1181-1198.
[4] Damm A., Elbers J., Erler E., Gioli B., Hamdi K., Hutjes R., Kosvancova M., Meroni M., Miglietta F., Moersch

A., Moreno J., Schickling A., Sonnenschein R., Udelhoven T., van der Linden S., Hostert P. & Rascher U. (2010) Remote sensing of sun induced fluorescence to improve modeling of diurnal courses of gross primary production (GPP). Global Change Biology, 16, 171-186.