Seasonal comparison of carbon flux estimates from C-TESSEL model and Moderate Resolution Imaging Spectroradiometer (MODIS) over several biomes

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Text of the abstract (max. 400 words)

Carbon dioxide exchange between vegetation and the atmosphere is determined by absorption of solar radiation by plant leaves and by turbulent transfer in the surface layer. This led to two different streams of methods to estimate carbon flux density: A) models based on parameterizations of aerodynamic resistance, and B) modeling of radiative transfer processes in vegetation canopies. We present here a comparison of one approach of type A (the C-TESSEL model) and one approach of type B (the MODIS gross primary production, i.e. GPP data product). The C-TESSEL model is the extension of the ECMWF land surface scheme TESSEL (Van den Hurk et al., 2000), in which a photosynthesis-based canopy resistance (Jacobs, 1994; Jacobs et al., 1996) and a carbon allocation scheme (Calvet et al., 1998) that represents leaf growth in response to photosynthesis is included. The MODIS GPP is estimated based on the radiation use efficiency logic proposed by Monteith (1972; 1977), which links net primary productivity (NPP) to the absorbed photosynthetically active radiation (APAR). The latter can be obtained by inverting spectro-radiometric data using a radiative transfer model.

To provide an independent reference, the comparison was done for 12 experimental sites equipped with tower-based continuous measurements of CO_2 flux density. Comparison of CO_2 flux densities is complex because of different physical basis of parameterizations used in each case and of the tower based measurements. The latter provide observations of instantaneous CO_2 flux (net ecosystem exchange, i.e. NEE) and a combination of parameterization of ecosystem respiration and integration over time provides estimates of daily GPP (daytime

integral) and NPP (daily integral). The C-TESSEL model provides estimates of CO_2 flux exchange at leaf level and estimations based on parameterizations of GPP and NEE in a half-hour interval over a model grid much larger than the tower footprint. The MODIS data product, at a spatial resolution of 1km, is based on a singular observation of spectral reflectance of vegetation canopies during daytime, from which both daily GPP and NPP are estimated.

We have compared the carbon fluxes from the three methods (C-TESSEL, MODIS and tower CO2 flux) in terms of GPP over several biomes (e.g. grass, crops, coniferous, deciduous and tropical forests). The focuses were paid on the differences of parameterizations of CO2 flux estimates in the two products. The comparison of the three sets of GPP estimates at 12 sites gave conflicting: the MODIS data product is in good agreement with tower observations most of time, but C-TESSEL performs better in some instance. These results provide insights into the validity of parameterizations, rather than on the accuracy and reliability of a specific data product.