Geophysical Research Abstracts
Vol. 15, EGU2013-9052, 2013
EGU General Assembly 2013

Assimilation of NEE and CO_2-concentrations into the land-surface scheme of the MPI Earth System Model

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Uncertainties of land surface models are to a large extent a consequence of uncertainties in their parametrisation and parameter values. Understanding and reducing these uncertainties is important to reduce the spread in global carbon cycle and therefore climate change projections. For this purpose, we developed a Carbon Cycle Data Assimilation System (CCDAS) for the land surface scheme (JSBACH) of the MPI Earth system model as a tool to systematically confront observations with the model. Observations representative for different temporal and spatial scales and processes, such as plant trait observations, point scale flux measurements, and globally integrating CO_2 abundance monitoring, can be incorporated into this CCDAS to estimate net land-atmosphere carbon fluxes that are consistent with the observations and the model structure.

Here we present the latest results of the MPI-CCDAS using observations of net ecosystem exchange of CO_2 (NEE) and atmospheric CO_2 concentrations. Eddy-covariance based measurements of NEE constrain the modelled carbon cycle on the scale of the flux measurement footprint at hourly time scale. The assimilation of CO_2-concentration requires an observational operator that links modelled NEE with observed CO_2-concentrations, provided by the the atmospheric transport model TM3. The concentrations are observed at a network of atmospheric monitoring stations and provide a large-scale integrated view of the terrestrial carbon cycle at seasonal and inter-annual time scales.

Given the data streams complementarity, we evaluate its individual role in constraining the net land-atmosphere carbon exchange and discuss the benefits of its simultaneous assimilation. Additionally, we explore the importance of parameter priors, model and measurement uncertainties in the assimilation procedure to assess the robustness of NEE estimates. Our results emphasize the importance of integrating multiple data streams towards more comprehensive assessments of modelling structures.