Geophysical Research Abstracts
Vol. 16, EGU2014-12933, 2014
EGU General Assembly 2014

Improved modelling of the global terrestrial carbon cycle by application of a Carbon Cycle Data Assimilation System (CCDAS)

Gregor Schürmann (1), Christoph Köstler (1), Thomas Kaminski (2), Ralf Giering (2), Marko Scholze (3), Wolfgang Knorr (3), Jens Kattge (1), Nuno Carvalhais (1), Michael Voßbeck (2), Christian Rödenbeck (1), Christian Reick (4), and Sönke Zaehle (1)

(1) Max-Planck-Institute for Biogeochemistry, Germany, (2) FastOpt, Germany, (3) Lund University, Sweden, (4) Max-Planck-Institute for Meteorology, Germany

Uncertainties of land surface models are to a large extent a consequence of uncertainties in process representations and associated parameter values. Understanding and reducing these uncertainties is important to reduce the spread in projections of the global carbon cycle and climate change. 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 the model with observations.

In a first step, the phasing and magnitude of the modelled vegetation activity has been improved. We used satellite observations of the Fraction of Absorbed Photosynthetically Active Radiation (FAPAR) derived by the Two-stream Inversion Package (TIP) to constrain phenology parameters for 7 different plant functional types. The result was a notable improvement of the model's capacity to reproduce the observed temporal and spatial dynamics of FAPAR for the period of 2005 to 2011, which is a prerequisite to modelling the seasonal and inter-annual variability of the land-atmosphere net CO_2 flux.

In a second step, processes controlling the biosphere's photosynthesis and respiration have been constrained by CO_2 mixing ratios observed at a network of atmospheric monitoring stations. Those observations provide a large-scale integrated view of the terrestrial carbon cycle at seasonal and inter-annual time scales and have been widely used by atmospheric inversion studies to constrain the net land-atmosphere CO_2 fluxes. We coupled JSBACH with the Jacobian of the atmospheric transport model TM3 to constrain model parameters affecting the photosynthetic and ecosystem respiration rate.

The application of the CCDAS provides an improved, data-constrained and process-based estimate of the contemporary global land carbon cycle. The remote-sensing constraints of vegetation activity were especially important in dry climatic regions, where the optimised parameters lead to a better representation of drought-related phenology. But also in boreal regions, the phenology was improved by reducing the total leaf area, leading overall to a reduced global productivity. In addition to this, the constraints given by the CO_2 data further reduce the productivity of boreal needleleaf forests, thereby further correcting biases in the seasonal amplitude of the CO_2 mixing ratio at high-latitude stations. In general, both the improvements in phenology and in photosynthesis lead to a reduction of the overall global gross productivity of the model by about 20 %. Several experiments with various observational station densities and different prior uncertainties were preformed to assess the robustness of these findings.