Geophysical Research Abstracts
Vol. 17, EGU2015-6421, 2015
EGU General Assembly 2015

Using a data-assimilation system to assess the influence of fire on simulated carbon fluxes and plant traits for the Australian continent

Jean-François Exbrayat (1,2), T. Luke Smallman (1), A. Anthony Bloom (3), Mathew Williams (1,2)

(1) School of GeoSciences, University of Edinburgh, Edinburgh, UK, (2) National Centre for Earth Observation, University of Edinburgh, Edinburgh, UK, (3) Jet Propulsion Laboratory, California Institute of Technology, Pasadena, California, USA

Natural disturbances, such as fire, play an important role in the carbon balance of terrestrial ecosystems. Both burned emissions and the impact of fire on plant growth must be considered to quantify the magnitude of the current and future terrestrial carbon sink. However, fire is rarely represented in Earth System Models, and the usual classification of ecosystems in a limited number of global plant functional types does not take into account local adaptations to fire regimes that enable resilience of ecosystems.

We show the importance of these mechanisms with a terrestrial model-data fusion scheme applied to the fire-prone Australian continent. We use the CARbon DAta-MOdel fraMework (CARDAMOM) to assimilate time series of MODIS LAI and GFED burned area and use the Harmonized World Soil Database and remote-sensing based estimates of Above-Ground Biomass as prior knowledge for initial conditions. In each pixel, a Markov Chain Monte-Carlo algorithm is used to optimise parameters according to observations. Meanwhile, ecological and dynamical constraints representative of real world processes constrain parameter inter-dependencies and long-term pool dynamics. CARDAMOM outputs maps of ecosystem carbon fluxes and parameters as well as their uncertainty sampled from the posterior distribution provided by the MCMC.

We perform two data-assimilations over Australia. The first experiment is a control run that includes fire drivers while the second experiment does not consider the occurrence of fires. Results of the first experiment are comparable to previous estimates and show that Australian ecosystems have most likely been acting as a carbon sink since the year 2000 with a large fire-driven inter-annual variability (best estimate of 264 $\pm$ 172 Tg C yr^{-1}). However, our results indicate that the most intense fire seasons may temporarily turn the continent into a net source of carbon offsetting the natural carbon sink of the same year.

Comparing the parameter maps generated with and without fire clearly indicates that frequently burned ecosystems tend to optimise their net carbon uptake through different means (higher NPP:GPP ratio, higher canopy efficiency, etc…) to cope with the repeated removal of above ground biomass. Our parameter maps, which are comparable to plant traits maps, show that the plant functional type concept currently used in Earth System Models is likely not adapted for ecosystems that experience frequent disturbances. Considering ecosystem disturbances and going beyond the plant functional type concept are two urgent requirements to improve terrestrial carbon models and projections of the terrestrial carbon-climate feedback.