Geophysical Research Abstracts
Vol. 15, EGU2013-3019, 2013
EGU General Assembly 2013

Carbon cycling of European croplands: A framework for the assimilation of optical and microwave Earth observation data

Andrew Revill (1), Oliver Sus (2), and Mathew Williams (1)

(1) School of GeoSciences and National Centre for Earth Observation, University of Edinburgh, Edinburgh, United Kingdom (a.revill@sms.ed.ac.uk), (2) CREAF, Universitat Autònoma de Barcelona, Spain (o.sus@creaf.uab.es)

Croplands are traditionally managed to maximise the production of food, feed, fibre and bioenergy. Advancements in agricultural technologies, together with land-use change, have approximately doubled World grain harvests over the past 50 years. Cropland ecosystems also play a significant role in the global carbon (C) cycle and, through changes to C storage in response to management activities, they can provide opportunities for climate change mitigation. However, quantifying and understanding the cropland C cycle is complex, due to variable environmental drivers, varied management practices and often highly heterogeneous landscapes. Efforts to upscale processes using simulation models must resolve these challenges. Here we show how data assimilation (DA) approaches can link C cycle modelling to Earth observation (EO) and reduce uncertainty in upscaling.

We evaluate a framework for the assimilation of leaf area index (LAI) time series, empirically derived from EO optical and radar sensors, for state-updating a model of crop development and C fluxes. Sensors are selected with fine spatial resolutions (20-50 m) to resolve variability across field sizes typically used in European agriculture. Sequential DA is used to improve the canopy development simulation, which is validated by comparing time-series LAI and net ecosystem exchange (NEE) predictions to independent ground measurements and eddy covariance observations at multiple European cereal crop sites.

Significant empirical relationships were established between the LAI ground measurements and the optical reflectance and radar backscatter, which allowed for single LAI calibrations being valid for all the cropland sites for each sensor. The DA of all EO LAI estimates results indicated clear adjustments in LAI and an enhanced representation of daily CO_2 exchanges, particularly around the time of peak C uptake. Compared to the simulation without DA, the assimilation of all EO LAI estimates improved the predicted at-harvest cumulative NEE for all cropland sites by an average of 69%. The use of radar sensors, being relatively unaffected by cloud cover and sensitive to the structural properties of the crop, significantly improves the analyses when compared to the combined, and individual, use of the optical LAI estimates. When assimilating the radar derived LAI only, the estimated at-harvest cumulative NEE was improved by 79% when compared to the simulation without DA. Future developments would include the spatial upscaling of the existing model framework and the assimilation of additional state variables, such as soil moisture.