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Assimilation of Leaf Area Index and Soil Wetness Index into the ISBA-A-gs land surface model over France

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The development of a Land Data Assimilation System (LDAS) dedicated to carbon and water cycles is considered as a key aspect for monitoring activities of terrestrial carbon fluxes. It allows the assimilation of biophysical products in order to reduce the bias between the model simulations and the observations and have a positive impact on carbon and water fluxes. This work shows the benefits of data assimilation of Earth observations for the monitoring of vegetation status and carbon fluxes, in the framework of the GEOLAND2 project, co-funded by the European Commission within the GMES initiative in FP7.

In this study, the SURFEX modelling platform developed at Meteo-France is used for describing the continental vegetation state, surface fluxes and soil moisture. It consists of the land surface model ISBA-A-gs that simulates photosynthesis and plant growth. The vegetation biomass and Leaf Area Index (LAI) evolve dynamically in response to weather and climate conditions. The ECOCLIMAP database provides detailed information about the land cover at a resolution of 1 km. Over the France domain, the most present ecosystem types are grasslands (32%), C3 crop lands (24%), deciduous forest (20%), bare soil (11%), and C4 crop lands (8%).The model also includes a representation of the soil moisture stress with two different types of drought responses for herbaceous vegetation and forests.

A version of the Extended Kalman Filter (EKF) scheme is developed for the joint assimilation of satellite-derived surface soil moisture from ASCAT-25 km product, namely Soil Wetness Index (SWI-01) developed by TU-Wien, and remote sensing LAI product provided by GEOLAND2. The GEOLAND2 LAI product is derived from CYCLOPES V3.1 and MODIS collection 5 data. It is more consistent with an effective LAI for low LAI and close to the actual LAI for high values. The assimilation experiment was conducted across France at a spatial resolution of 8 km. The study period ranges from July 2007 to December 2010.

In the model simulation, the start of the growing season tends to occur later than in the observations. Similarly, the senescence phase is delayed. The assimilation is able to reduce this bias. The lack of detailed knowledge of the farming practices and other shortcomings of the model are compensated by the assimilation of the remotely sensed LAI. The analyzed seasonal LAI cycle across large cropland regions (north-eastern France) is closer to the observations.

A coherent impact of LAI and soil moisture updates on the carbon fluxes is noticed. Increased LAI values in the growing season due to data assimilation corrections trigger an increased photosynthetic activity. Similarly, lower LAI values corresponding to the senescence phase cause a decrease in the carbon dioxide uptake when compared to the original model simulations.