EGU22-10048
https://doi.org/10.5194/egusphere-egu22-10048
EGU General Assembly 2022

Multi Scale Assimilation of NDVI and radar data for soil moisture and Leaf Area Index Predictions in an Heterogeneous Mediterranean Ecosystem

Andrea Gaspa, Roberto Corona, and Nicola Montaldo
University of Cagliari, Engeneering, DICAAR, Italy (andreagaspa14@gmail.com)

In the presence of uncertain initial conditions and model parameters coupled land surface model (LSM)- vegetation dynamic model (VDM) performance can be significantly improved by the assimilation of periodic observations of certain state variables, such as the soil moisture and normalized difference vegetation index (NDVI) as observed from satellite remote platforms.

The possibility to merge grass and tree NDVI observations and radar data with the model optimally for providing robust predictions of soil moisture and grass and tree leaf area index (LAI) in heterogenous ecosystems is demonstrated. We propose an assimilation approach that assimilates backscatter data from radar and NDVI from optical sensors through the Ensemble Kalman filter (EnKF) and provides a physics-based update of soil moisture and grass and tree LAI predicted by VDM. We used Sentinel 1 radar data for soil moisture, and Landsat 8 and Sentinel 2 optical data for NDVI. Soil moisture is predicted by the LSM, while the VDM predicts the LAI, which is strictly related to NDVI, through a field-estimated empirical relationship.

This approach, as with other common assimilation approaches, may fail when key model parameters, e.g. the saturated hydraulic conductivity of LSM and the maintenance respiration coefficient (m_a) of VDM, are estimated poorly. This leads to biased model errors producing a violation of a main assumption (model errors with zero mean) of the EnKF. For overcoming this model bias an innovative assimilation approach was developed, which accepts this violation in the early model run-times and dynamically calibrates all the components of the model parameter ensembles as a function of the persistent bias in soil moisture and LAI predictions, allowing to remove the model bias, restore the fidelity to the EnKF requirements and reduce the model uncertainty.

The proposed multiscale assimilation approach was tested in a Sardinian field site, a typical Mediterranean ecosystem characterized by strong heterogeneity of the vegetation and water limited conditions. The site is also a case study of the SWATCH European Research Project, and in this field a micrometeorological eddy-covariance based tower is operating from 2003.

The positive impact of the proposed assimilation approach on the soil water budget, evapotranspiration and CO_2 uptake predictions in the heterogenous ecosystem is demonstrated finally.