Multi scale assimilation of sentinel-1 radar and Landsat 8 optical data for soil moisture and Leaf Area Index predictions using an Ensemble Kalman Filter based assimilation approach

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Data assimilation techniques allow to merge optimally remote sensing observations in ecohydrologic models, guiding them for improving land surface fluxes predictions. Nowadays freely available remote sensing products, like those of Sentinel 1 radar and Landsat 8 and Sentinel 2 optical sensors, allow to monitor land surface variables (e.g., radar backscatter for soil moisture and NDVI for LAI) at unprecedent high spatial and time resolutions, even appropriate for heterogenous ecosystems, typical of semi-arid ecosystems, characterized by contrasting grass and tree vegetation components competing for water use.

A multiscale assimilation approach that assimilates radar backscatter and grass and tree NDVI in a coupled vegetation dynamic - land surface model, based on the Ensemble Kalman filter (EnKF), is developed. It is not limited to assimilate backscatter data for soil moisture predictions and NDVI for LAI predictions, but it also uses the assimilation for updating key model parameters (ENKFdc), like the saturated hydraulic conductivity and the maintenance respiration coefficients, which are highly sensitive parameters of soil water balance and biomass budget, respectively. The proposed EnKFdc assimilation approach allowed to well predict soil moisture and grass and tree LAI in an heterogenous ecosystem in Sardinia, for a 3-year recent period with contrasting hydrometeorological (dry vs wet) conditions. The proposed EnKFdc approach performed well for the full range of hydrometeorological conditions and parameter values, even assuming extremely biased model conditions with very high or low parameter values compared to the calibrated ("real") values. The EnKFdc approach was crucial for soil moisture and LAI predictions in winter and spring, key seasons for water resources management in Mediterranean water-limited ecosystems.

The use of ENKFdc allowed to well predict evapotranspiration and carbon flux with errors less than 4% and 15%, respectively, even with extremely bias model conditions.