Improving estimates of UK soil moisture using the JULES land surface model with COSMOS-UK measurements in the LaVEnDAR data assimilation framework

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Soil moisture predictions are increasingly important in hydrological, ecological and agricultural applications. In recent years the availability of wide-area assessments of current and future soil-moisture states has grown, yet few studies have combined model-based assessments with observations beyond the point scale. Here we use the JULES land surface model together with COSMOS-UK data to evaluate the extent to which data assimilation can improve predictions of soil moisture across the United Kingdom.

COSMOS-UK is a network of soil moisture sensors run by UKCEH. The network provides soil moisture measurements at around 50 sites throughout the UK using innovative Cosmic Ray Neutron Sensors (CRNS). Half hourly measurements of the meteorological variables that the Joint UK Land Environment Simulator (JULES) requires as driving data are also recorded at COSMOS-UK sites, allowing us to run JULES at observation locations. This provides a unique opportunity to compare soil moisture outputs from JULES with CRNS observations; these measurements have a footprint of up to 12 ha (approx 30 acres) and are therefore better scale matched with JULES outputs than those from point sensors.

We have used the Land Variational Ensemble Data Assimilation Framework (LaVEnDAR) to combine soil moisture estimates from JULES with daily CRNS observations from one year at a number of COSMOS-UK sites. We show that this results in improved soil moisture predictions from JULES over several years. This has been achieved by optimising parameters in the pedo-transfer function used to derive JULES soil physics parameters from soil texture information. Using data assimilation with LaVEnDAR in this way allows us to explore the relationships between soil moisture estimates, soil physics parameters and soil texture, as well as improving the agreement between JULES model outputs and observations.