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Ensemble based Assimilation of SMOS Surface Soil Moisture into the Surfex 11-layer Diffusion Scheme

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The Soil Moisture and Ocean Salinity (SMOS) satellite samples soil moisture at a spatial scale of $\sim 40\,km$ and in the top $\sim 5\,cm$ of the soil, depending on land cover and soil type. Remote sensing products have a limited spatial and temporal cover, with a re-visit time of 3 days close to the Equator for SMOS. These factors make it difficult to monitor the hydrological cycle over e.g., Northern Areas where there is a strong topography, fractal coastline and long periods of snow cover, all of which affect the SMOS soil moisture retrieval. Until now simple 3-layer force and restore models have been used to close the spatial (vertical/horizontal) and temporal gaps of soil moisture from remote sensing platforms.

In this study we have implemented the Ensemble Transform Kalman Filter (ETKF) into the Surfex land surface model, and used the ISBA diffusion scheme with 11-vertical layers. In contrast to the rapid changing surface layer, the slower changing root zone soil moisture is important for long term evapotranspiration and water supply. By combining a land surface model with satellite observations using data assimilation we can provide a better estimate of the root zone soil moisture at regional scales. The Surfex model runs are done for a European domain, from 1 July 2012 to 1 August 2013. For validation of our model setup, we compare with in situ stations from the International Soil Moisture Network (ISMN) and the Norwegian Water and Energy Authorities (NVE); we also compare against the ESA CCI soil moisture product v02.2, which does not include SMOS soil moisture data.

SMOS observations and open loop model runs are shown to exhibit large biases, these are removed before assimilation by a linear rescaling technique. Information from the satellite is transferred into deeper layers of the model using data assimilation, improving the root zone product when validated against in situ stations. The improved correlation between the assimilated product and the in situ values, even though at different spatial scales, indicates the importance of combining remote sensing information (observations) with land surface models to improve our representation of the land surface state at high resolution.