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Soil moisture and snow assimilation in a regional model at the Met Office

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The Met Office operational UKV (UK Variable grid) forecast system couples the Unified Model (UM) for the atmosphere with the Joint UK Land Environment Simulator (JULES) for the land surface. The UKV regional domain has 1.5km horizontal resolution in the regularly spaced interior domain that reduces to 4km at the edges. Initialisation of the atmosphere is by 4D-VAR data assimilation with hourly cycling. UKV soil moisture is initialised daily by interpolating a soil moisture analysis from the 10km global UM. Snow is not initialised, but snow accumulation and snow melt are both represented in the model. Although this approach has proven skilful, it prevents the UKV from imposing its own dynamics, such as the effect of high resolution precipitation, onto the soil moisture fields. Additionally, it cannot benefit from the various observations of snow cover and depth which are now available.

Recently, the Met Office has put significant effort into improving its regional land surface data assimilation. A Simplified Extended Kalman Filter (SEKF) scheme has been implemented to assimilate screen observations on an hourly cycle into the soil moisture. Similarly to de Rosnay (2012, QJRMS) the observation operator at the Kalman gain is estimated by running JULES several times from slightly perturbed initial conditions and calculating the Jacobians with respect to a control forecast. Trials run for 3 different periods show that assimilating screen level observation data to initialise the soil moisture improves forecasts of both screen temperature and humidity.

At the same time, an Optimal Interpolation scheme for snow has been developed to assimilate 'in situ' snow depth observations and satellite snow cover data, from the European Organisation for the Exploitation of Meteorological Satellites
(EUMETSAT) Satellite Application Facility on Support to Operational Hydrology and Water Management (H-SAF). This scheme analyses snow depth to initialise the UKV model and is being tested in case studies of recent UK snow events and in longer assimilation trials.