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Use of satellite data for soil moisture analysis at ECMWF

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Soil moisture initialisation is of crucial importance for Numerical Weather Prediction (NWP). It influences the land-atmosphere exchange processes, which determines the partition of energy between latent and heat fluxes, and it has a strong influence on forecast screen level temperature and relative humidity. NWP systems initialisation relies on data assimilation approaches which have been using satellite data to analyse atmospheric state variables since several decades. Land surface initialisation is generally independent from the atmospheric system and based on ground measurements of screen level variables at 2 meters as a proxy for soil moisture.

New generations of satellites, such as ASCAT (Advanced Scatterometer) and SMOS (Soil Moisture and Ocean Salinity) provide highly suitable data from active or passive microwave sensors for soil moisture remote sensing. In order to improve land surface initialisation in NWP applications, ECMWF recently developed and implemented and Extended Kalman Filter (EKF) surface analysis. The EKF surface analysis makes it possible to combine use of satellite, in situ and proxy observations to analyse soil moisture.

This paper presents the ECMWF land surface analysis system and its recent developments to use active (ASCAT) and passive (SMOS) microwave satellite data to analyse soil moisture. Any satellite data used (or in development to be used) in the ECMWF Integrated Forecasting system is monitored. Monitoring provides a continuous evaluation of observations and first guess departures values at global and regional scales. It also allows to identify systematic features in the data set. The paper presents near real time monitoring of SMOS brightness temperature data and operational monitoring of ASCAT surface soil moisture data. The EKF based ECMWF surface soil moisture data assimilation system is presented for SYNOP and ASCAT data assimilation, as well as current developments to include SMOS data. ASCAT data bias correction is presented as well as observation operator based on ERS long time series and ECMWF re-analysis. Results of combined proxy information and ASCAT soil moisture data data assimilation are shown. Surface and atmospheric impacts of the EKF analysis are shown with and without ASCAT surface soil moisture data assimilation.

The ECMWF land surface data assimilation system is designed to combine different sources of information, from SYNOP ground data and from satellite sensors, to correct the model state variables. It is well suited to use future satellites data such as Soil Moisture Active and Passive (SMAP) data.