SMOS soil moisture data assimilation for operational numerical weather prediction and perspectives for climate reanalysis

Patricia de Rosnay
Pete Weston
Nemesio Rodríguez-Fernández
David Fairbairn
Joaquín Muñoz-Sabater
Heather Lawrence
Calum Baugh
Francesca Di Giuseppe
Hans Hersbach
Stephen English
Christel Prudhomme
Matthias Drusch
Susanne Mecklenburg

This paper presents an overview of the Soil Moisture and Ocean Salinity (SMOS) mission soil moisture data assimilation activities conducted at the European Centre for Medium-Range Weather Forecasts (ECMWF). SMOS brightness temperature data is used operationally in the ECMWF Integrated Forecasting System (IFS) for monitoring purposes. Long term monitoring based on observed and reanalysed forward SMOS brightness temperatures show a consistent improvement in the SMOS observations quality through the SMOS lifetime. In 2018, a new Neural Network (NN) SMOS soil moisture product was developed, which was trained on ECMWF soil moisture. The processor was implemented to produce near real time soil moisture from SMOS brightness temperature data. The SMOS-ECMWF NN soil moisture product captures the SMOS signal variability in time and space, while by design its climatology is consistent with that of the ECMWF soil moisture, which makes it suitable for data assimilation purposes. Preliminary investigations in offline land surface analysis systems demonstrated the potential of SMOS NN assimilation. More recently, SMOS NN soil moisture data assimilation was developed in the coupled land surface analysis of the IFS and its impact on assimilation and NWP was evaluated. Results showed that SMOS soil moisture data assimilation in the IFS slightly improves root zone soil moisture and independent verification against aircraft humidity profiles also shows that SMOS data assimilation improves humidity in the northern hemisphere during summer. These results, which led to operational implementation in IFS cycle 46r1 in June 2019, are presented in this paper. They illustrate the value of the SMOS soil moisture observations for operational NWP. They open perspectives for future climate reanalyses as well as for environmental forecasts such as fire and flood forecasting, in the context of ECMWF activities with the Copernicus Climate Change and Emergency Management Services (C3S and CEMS).