Assimilation of L-band brightness temperatures in the ECMWF Land Data Assimilation System: advancements and future plans

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Since it was launched at the end of 2009, the Soil Moisture and Ocean Salinity (SMOS) mission [1] of the European Space Agency (ESA) is providing a unique and very valuable source of remote sensed information to accurately estimate the water content of soils. This information will soon be complemented with data from the future Soil Moisture Active Passive (SMAP) mission [2] of the National Aeronautics and Space Administration (NASA). SMOS observations (and the future SMAP observations) can be assimilated in Numerical Weather Prediction (NWP) models to adjust the soil moisture predicted by a land surface model. The accurate initialisation of soil moisture before a forecast run is crucial, due to the potential that it has to improve weather forecasts. As NWP centre, the European Centre for Medium-Range Weather Forecasts (ECMWF) is assimilating SMOS data in their Land Data Assimilation System [3], and is preparing the monitoring of the information that will be provided by SMAP.

This paper shows the current advancements in regards to the assimilation of SMOS brightness temperatures in the ECMWF version of the Extended Kalman Filter [4,5] and the plans for future developments. It also presents the preparations undertaken to accommodate SMAP data in the ECMWF system.

Several experiments have already compared different configurations of the assimilation system, with the aim of assessing the atmospheric impact of integrating SMOS data in the surface analysis. In particular, in this study the results obtained from three assimilation experiments are evaluated:
a) A control experiment, using the current configuration of the operational system. This means that only 2 m temperature and 2 m relative humidity observations of the SYNOP network are assimilated to correct the model soil moisture estimates,
b) An experiment assimilating only raw SMOS brightness temperatures,
c) An experiment combining screen level variables and SMOS brightness temperatures.

These experiments are run over a 4 month period, from May to end of August 2010 (when evaporation rates are higher), using the entire month of May as spin-off period to reach the hydric equilibrium, as strong gradients of soil moisture can occur when a new type of data is assimilated to adjust the soil moisture states. To increase the quality of the SMOS observations that are assimilated, only those localized in the alias free field of view of the satellite footprint are used. Radio Frequency Interference is filtered out through the SMOS data product flags. Only incidence angles at 30°, 40° and 50° and at pure XX or YY polarisations are assimilated.

These experiments show that SMOS has a great impact in soil moisture, mostly producing better estimates than if no SMOS data were assimilated, with particular positive results over semi-arid areas. The validation of soil moisture analysis is conducted by using in-situ data from the International Soil Moisture Network (ISMN) [6]. The impact of the previous experiments in the forecasts of air temperature and air humidity show some positive results, but also degradations, depending on the geographical location of the forecasts. These results are very useful as they point towards possible compensation for model errors, but they also highlight the need for fine tuning the use of SMOS data in the soil moisture analysis. The results obtained from a series of short experiments will also be shown, with the aim of obtaining an optimized configuration for an operational use of SMOS data.

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