Assimilation of SMOS data for improving surface water management

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Abstract: The overall objective of this research is to demonstrate the potential use of Soil Moisture Ocean Salinity (SMOS) data for operational surface water management. A particular focus is made on discharge predictions. Therefore, two large-scale basins have been identified. For these basins, radio frequency interference does not present a problem, the land cover allows for accurate soil moisture retrieval, floods occur relatively frequently, and initial catchment storage is known to be important in discharge generation. These basins are the Upper Mississipi in the USA and the Murray Darling Basin in Australia. The Variable Infiltration Capacity (VIC) model has been calibrated for both basins using available discharge records.

The first part of the paper focuses on soil moisture assimilation. A data assimilation algorithm has been developed, in which the mismatch between the spatial resolutions of the model grid (10 km) and the satellite observations (25 km) have been taken into account. This is performed through the observation operator, which also takes into account the spatial weighting function (the average antenna pattern) in the determination of the large scale average. Bias between the soil moisture observations and the model predictions has been removed through cdf-matching. A spatial downscaling procedure has also been applied, in which the SMOS products are interpolated to the VIC grid prior to assimilation. An offline bias removal algorithm is applied in this case. Both approaches (use of the observation operator and prior downscaling) have been thoroughly intercompared. Furthermore, the impact on discharge generation is assessed.

The second part of the paper focuses on brightness temperature assimilation. For this reason, the radiative transfer model (which links the surface soil moisture to the top of atmosphere brightness temperature) has been calibrated, in order to remove the bias between the modeled and observed brightness temperatures. Similar to soil moisture assimilation, the mismatch in scale between the model simulations and the satellite observations has been taken into account through the use of the observation operator, using the antenna pattern as spatial weighting function. The HH and VV brightness temperatures are assimilated. As a first step, all brightness temperatures (angle binned at 6 fixed incidence angles at the surface reference frame) are assimilated. The differences between the results obtained by soil moisture and brightness temperature assimilation are investigated. Finally, only the incidence angle corresponding to the SMAP configuration are retained for assimilation. The advantages and disadvantages of assimilating all available brightness temperatures versus only one single channel are discussed.

Overall, the results of this study are expected to provide a detailed overview of the opportunities and challenges for the use of SMOS observations for operational water management, with a focus on flood prediction.

Keywords: *Data assimilation, downscaling, water management, soil moisture, brightness temperature*