RSHS18-42
Remote Sensing and Hydrology Symposium (ICRS-IAHS)

How influential is the optimal T parameter on ASCAT based Soil Water Index assimilation results?

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Soil moisture content in the surface layer (SSM) of a catchment plays a critical role on the activation of the different runoff mechanisms. Thus, in order to obtain precise streamflow predictions through hydrological modeling, an accurate SSM simulation is required. To avoid any systematic errors on the SSM simulation provided by hydrological models, remotely sensed SSM observations can be used to correct those predictions. Correcting the modeled SSM content is expected to improve streamflow simulations.
SSM observations are integrated with hydrological models through data assimilation techniques (DA). One of the main limitations for a successful application of DA techniques is the difference in the depth of the observed and simulated SM: i.e. while ASCAT sensor is a C-band scatterometer that observes the moisture content in the upper 2 cm of the soil, hydrological models usually simulate the moisture content of deeper root zone layers (RZ).
A method, commonly used to transform the shallower SSM observations into a deeper Soil Water Index (SWI), is the recursive exponential filter proposed by Albergel et al. (2008). This filter is based on the one initially proposed by Wagner et al. (1999) to predict RZSM from SSM measurements. This recursive filter depends on one single parameter, which is the characteristic time length parameter (T). Parameter T, which is expressed in days, remains somehow uncharacterized, and its relation with different catchment-related factors remains also unclear, being in many cases used as a fitting parameter.
In this study, SWI data derived from ASCAT were assimilated into TOPLATS model, considering an upper soil layer 5 cm deep. The assimilation was performed for two catchments of similar size (≈750 km2), located in northern Spain (Arga) and central Italy (Nestore). In order to find its optimal value (Topt), parameter T was calibrated by optimizing the correlation between the generated SWI and the model simulated SSM value, exploring a variation range from T=1 day to T = 200 days. Optimal values were found with T= 24 days for Arga catchment and T = 45 for Nestore. DA was also performed by applying lower T values, identified as local minima (T=2 for Arga and T =1 for Nestore). All the evaluated scenarios offered improvements in terms of streamflow simulation efficiency, and differences were minimal despite the very different Topt values applied.
These results indicate, that regardless of the interesting discussion on the factors that control Topt value (e.g., modeled soil depth, soil texture or climatology), the actual optimal value might not be as crucial as expected, since observed streamflow simulations showed a low sensitivity to Topt. This possibly suggests that it is the information contained in the observation what matters, to a larger extent, rather than the specific SWI parameterization.