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Potential of satellite surface soil moisture products for spatially calibrating distributed eco-hydrological models

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Calibration of distributed hydrological models needs to include spatial information of the hydrological processes in order to guarantee a robust spatial representation of the model state variables. Satellite remote sensing monitoring the Earth in a temporal and spatial comprehensive way stands out as a valuable resource of this kind of information. Surface soil moisture (SSM) plays a key role in the description of the hydrological cycle, especially in semi-arid areas. Nevertheless, the coarse resolution of available SSM products has restricted the use of SSM in the calibration of hydrological models to only the temporal approach. The current operational SSM estimates (1km) resulting from new sensor estimates or the application of downscaling methodologies pave the way for this spatial calibration approach. The present study explores the applicability of these spatially enhanced SSM estimates for distributed eco-hydrological modelling in Mediterranean forest basins. On one hand, it contributes to fill the existing research gap on the use of remote sensing SSM spatial patterns within the distributed hydrological modelling framework, in particular in medium/small basins. On the other hand, it serves as an indirect validation method for the spatial performance of satellite SSM products. TETIS eco-hydrological distributed model was implemented in three case studies, named Carraixet (eastern Spain), Hozgarganta (southern Spain), and Ceira (western Portugal), which were strategically selected to perform this research in the Mediterranean Region. The SSM estimates selected for evaluation were: Sentinel-1 SSM provided by the Copernicus Global Land Services (CGLS), SMAP SSM disaggregated using Sentinel-1 provided by the National Aeronautics and Space Administration (NASA), SMOS SSM provided by the Barcelona Expert Center (BEC), and SMOS and SMAP SSM disaggregated using the Dispatch algorithm provided by Lobelia Earth. The methodology employed involved a multi-objective and multi-variable calibration using the considering remote sensing SSM spatial patterns and in-situ streamflow, using the Spatial Efficiency Metric (SPAEF) and the Nash-Sutcliffe efficiency index (NSE) respectively. In spite of the spatial and temporal differences amongst products, the multi-objective calibration approach proposed increased the robustness of the hydrological modelling. Spatial and temporal agreement depends on the selection of the SSM product. The disaggregating methodology determined the spatial agreement to a greater degree than the sensor itself.