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Towards a robust evaporation-based disaggregation method of SMOS soil moisture by combining high-resolution shortwave/thermal and available meteorological data

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The majority of hydrological and agricultural applications require high-resolution soil moisture (SM) information. To improve the spatial resolution of SMOS (Soil Moisture and Ocean Salinity) SM, a downscaling algorithm is applied to the 40 km resolution SMOS level 3 product using 1 km resolution MODIS (MODerate resolution Imaging Spectroradiometer) shortwave and thermal data. The DISPATCH (DISaggregation based on a Physical and Theoretical Scale CHange) algorithm converts soil temperature data into SM data using a soil evaporative efficiency (SEE) model and a first order Taylor series expansion. The current version of DISPATCH is contextual, meaning that the MODIS-derived SEE is a function of temperature endmembers (Tends), which are determined from the image-based trapezoid method. However, limitations concerning the estimation of Tends arise when fully dry and fully wet conditions are not met within the scene at the observation resolution. Therefore, in order to improve DISPATCH's robustness in such conditions, the aim of this paper is to estimate Tends independently of shortwave/thermal data using an energy balance model forced by meteorological data. As a mean to evaluate the new algorithm, results are analyzed in terms of both disaggregated SM with respect to in situ 0-5 cm measurements and DISPATCH-derived SEE with respect to theoretical models. The approach is tested over a mixed irrigated and dry land area located in Catalunya, Spain, spanning 2011 and 2012. When comparing 40 km SMOS and 1 km disaggregated SM data with the in situ measurements, results indicate that DISPATCH improves the spatio-temporal correlation with in situ measurements. Moreover, disaggregation results are further improved by integrating the energy balance model in the methodology. The representation of SEE is also enhanced, proving that meteorological data foster the physical link between shortwave/thermal and SM data within the disaggregation method. The synergy between SEE modeling and SM data could be exploited at different levels. For instance, a more robust SEE model would improve the DISPATCH downscaling relationship (partial derivative of SM with respect to SEE), would improve again DISPATCH SM at fine scale, and would improve the capacity of DISPATCH to monitor SEE at integrated spatial scales. Last, but not least, high-resolution SEE and SM data would be key for better constraining the partitioning of evapotranspiration into soil evaporation and plant transpiration from space. Such information is crucial for better quantifying crop water needs and managing water resources over semi-arid areas.