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High resolution soil moisture mapping using Distributed Temperature Sensing

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Distributed Temperature Sensing (DTS) can measure high resolution (spatial < 1 m, and temporal < 1 min) soil temperature at multiple depths at scales up to kilometers. This study presents a data assimilation framework for robustly estimating soil moisture using DTS observed soil temperature data. The combination of advanced data assimilation techniques and DTS produces a tool for high spatial and temporal resolution soil moisture mapping. To robustly extract soil moisture information from the evolution of soil temperatures, we use a new data assimilation algorithm, particle batch smoother (PBS). Synthetic, as well as real point and DTS data were use develop the data assimilation framework. In addition to estimating soil moisture, the PBS was also used to estimate soil thermal and hydraulic properties by assimilating soil temperatures. The improved soil hydraulic properties fundamentally benefit the forward model in the data assimilation framework, which leads to the most robust soil moisture estimates. Finally, we applied the proposed data assimilation frame work to a real transect of DTS cable. The estimated soil moisture and soil properties are validated using data observed at a nearby site. The DTS mapped soil moisture shows that the soil moisture spatial variability is a strong function of the areal mean soil moisture, which is consistent with previous studies. Results so far indicate that we can finally use DTS to understand intermediate scale soil moisture spatial variability, and link soil moisture measurements at different scales.