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Evaluation of Soil Moisture Downscaling Algorithms for the SMAP Mission

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The Soil Moisture Active Passive (SMAP) satellite is scheduled for launch by NASA in November 2014, with the aim to provide a medium-resolution soil moisture product at the global scale and with 2-3 days revisit frequency. The rationale behind this mission is that the synergy between 3 km resolution active (radar) and 36 km resolution passive (radiometer) observations can be used in a downscaling approach to overcome the individual limitations of each observation, ultimately providing soil moisture data at a resolution suitable for hydro-meteorological applications, on the order of $\sim$9 km. Two soil moisture downscaling approaches were tested in this study: i) the baseline downscaling algorithm proposed for SMAP, which is based on an assumption of linear relationship between radiometer and radar observations, with the downscaled radiometer data then converted to a soil moisture product using the passive microwave retrieval method; ii) the optional downscaling algorithm for SMAP, which is based on an assumption of a directly linear relationship between soil moisture and the radar observations. Data used to evaluate these two approaches were collected from the Soil Moisture Active Passive Experiments (SMAPEx) in south-eastern Australia, which closely simulate the SMAP data stream using airborne observations for a single SMAP radiometer pixel over a 3-week interval. Both approaches were compared to a reference soil moisture map retrieved from 1 km resolution radiometer data. Results indicated that radar observations at *vv*-polarization had the best correlation with radiometer observations or soil moisture data than *hh*- or *hv*-polarization, thus having best performance during downscaling procedure. These two downscaling approaches showed similar performance in terms of accuracy, with a Root-Mean-Square Error (RMSE) in downscaled soil moisture data around 0.02 cm^3/cm^3, when downscaled to 9 km resolution. This increased to 0.043 cm^3/cm^3 when applied at 1 km resolution. Results indicated both downscaling methods had the ability to fulfill the error target of SMAP, with a RMSE less than 0.04 cm^3/cm^3 at 9 km resolution.