Soil moisture retrieval using L-band SMAP radar data: forward model evaluations and inversion improvements

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The L-band radar on the Soil Moisture Active Passive (SMAP) Mission satellite provided multi-polarized (HH/VV/HV) normalized radar cross section (σ°) at 1-km resolution with 2-3 day interval from mid-April to early July, 2015. This paper presents the soil moisture estiamtes of a top 5-cm layer at 3-km spatial resolution (the highest resolution that has the adequate level of speckle noise). Forward scattering models were developed for 12 classes of the global land surface cover encompassing a wide range of soil and vegetation conditions, using ground- and aircraft-field campaign data sets. Soil moisture is retrieved by inverting the forward models in their look-up table forms through constraining surface roughness using time-series radar observations.

Initial evaluation of the forward model at 28 core-validation sites in the world reports discrepancy of several dBs. The ancillary inputs have uncertainties due to the climatological nature of vegetation amount and outdated knowledge of landcover classes. The forward models have limitations in correctly modeling vegetation scattering, topography surface, and heterogeneity of landcover classes. In the long term, the forward model and the ancillary data will be improved using data from core calibration/validation sites and field campaigns. Alternatively these error sources are corrected during the retrieval by estimating the bias, ajdusting the vegetation input, and modifying the landcover classification based on SMAP's σ° observations. Assessed over 28 core validation sites covering a wide range of biomass types, amount, and soil conditions, the soil moisure retrieval reaches an accuracy of to 0.056 cm^3/cm^3 unbiased-rmse, a bias of -0.005 cm^3/cm^3, and a correlation of 0.55 (0.06 cm^3/cm^3 unbiased-rmse was the accuracy goal for SMAP's radar soil mositure products).