

ABSTRACT

Inferring land surface model parameters for the assimilation of satellite-based L-band brightness temperature observations into a soil moisture analysis system

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The Soil Moisture and Ocean Salinity (SMOS) satellite mission provides global measurements of L-band brightness temperatures at horizontal and vertical polarization and a variety of incidence angles that are sensitive to moisture and temperature conditions in the top few centimeters of the soil. These L-band observations can therefore be assimilated into a land surface model to obtain surface and root zone soil moisture estimates. As part of the observation operator, such an assimilation system requires a radiative transfer model (RTM) that converts geophysical fields (including soil moisture and soil temperature) into modeled L-band brightness temperatures. At the global scale, the RTM parameters and the climatological soil moisture conditions are still poorly known. Using look-up tables from the literature to estimate the RTM parameters usually results in modeled L-band brightness temperatures that are strongly biased against the SMOS observations, with biases varying regionally and seasonally. Such biases must be addressed within the land data assimilation system. In this presentation, the estimation of the RTM parameters is discussed for the NASA GEOS-5 land data assimilation system, which is based on the ensemble Kalman filter (EnKF) and the Catchment land surface model.

In the GEOS-5 land data assimilation system, soil moisture and brightness temperature biases are addressed in three stages. First, the global soil properties and soil hydraulic parameters that are used in the Catchment model were revised to minimize the bias in the modeled soil moisture, as verified against available in situ soil moisture measurements. Second, key parameters of the “tau-omega” RTM were calibrated prior to data assimilation using an objective function that minimizes the climatological differences between the modeled L-band brightness temperatures and the corresponding SMOS observations. Calibrated parameters include soil roughness parameters, vegetation structure parameters, and the single scattering albedo. After this climatological calibration, the modeling system can provide L-band brightness temperatures with a global mean absolute bias of less than 10 K against SMOS observations, across multiple incidence angles and for horizontal and vertical polarization. Third, seasonal and regional variations in the residual biases are addressed by estimating the vegetation optical depth through state augmentation during the assimilation of the L-band brightness temperatures. This strategy, tested here with SMOS data, is part of the baseline approach for the Level 4 Surface and Root Zone Soil Moisture data product from the planned Soil Moisture Active Passive (SMAP) satellite mission.