A Dual-pass Microwave Land Data Assimilation System for Estimating Soil Moisture and the Surface Energy Budget

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Low-frequency microwave brightness temperature is strongly affected by near-surface soil moisture; therefore, it can be assimilated into a land surface model to improve modeling of soil moisture and the surface energy budget. This study presents a new variational land system used to assimilate AMSR-E brightness temperature of vertical polarization of 6.9 GHz and 18.7 GHz. The system consists of a land surface model (LSM) used to calculate surface fluxes and soil moisture, a radiative transfer model (RTM) to estimate the microwave brightness temperature, and an optimization scheme to search for optimal values of soil moisture by minimizing the difference between modeled and observed brightness temperature. The LSM is an improved simple biosphere model for sparse vegetation modeling and the RTM is a Q-h model that can account for the effects of surface roughness and vegetation. Several parameters in the LSM and RTM can significantly affect the outputs of the land data assimilation system but their values are either highly variable or unavailable. To solve this problem, we developed a dual-pass assimilation technique. Pass 1 inversely estimates the optimal values of the model parameters with long-term (~months) forcing data and brightness temperature data, while Pass 2 estimates the near-surface soil moisture in a daily assimilation cycle. This system is driven by well-established reanalysis data and global data sets of leaf area index, precipitation, and surface radiation, and was tested at a Tibetan Plateau site and a Mongolian site. The system led to robust and reliable soil moisture estimates and significant improvements in modeling of the surface energy budget.

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