An Auto-calibration System to Assimilate AMSR-E data into a Land Surface Model for Estimating Soil Moisture and Surface Energy Budget

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Abstract: Low-frequency microwave brightness temperatures are strongly affected by near-surface soil moisture, and thus they can be assimilated into a land surface model to improve soil moisture and surface energy budget modeling. However, parameter values in both the land surface model and the used radiative transfer model may significantly affect the outputs of a land data assimilation system. This study presented a new variational data assimilation system, which intends to solve this problem. The system consists of a land surface model (LSM) to calculate surface fluxes and soil moisture, a radiative transfer model (RTM) to estimate microwave brightness temperatures (T_b) from surface temperature and soil moisture, and an optimization scheme to search for optimal values of key model parameters and soil moisture by minimizing the difference between modeled and observed brightness temperatures. The AMSR-E brightness temperatures of 6.9 GHz and 18.7 GHz vertical polarization are assimilated into the land model. The land surface model is an improved simple biosphere model for sparse vegetation modeling, and the radiative transfer model is a Q-h model for estimating microwave brightness temperature. Three global data sets were utilized to provide parameters required in the LSM and the RTM: soil parameters (thermal and hydraulic properties) are given by the 1°×1° ISLSCP Initiative II soil data, vegetation parameters (classification and coverage) are given by the 1°×1° ISLSCP Initiative II vegetation data, and leaf area index is provided by the MODIS 0.25°×0.25° gridded 8-day products. However, ISLSCP soil data can only provide a background value for soil texture and soil parameters, because of their high spatial variability. Also, the surface roughness parameters and vegetation optical parameters in the RTM are usually unavailable. Therefore, a two-pass technique is embedded in this system to overcome this problem. Pass 1 inversely estimates the optimal values of these model parameter using forcing data and brightness temperature data during a long period (~months), and Pass 2 only estimates the near-surface soil moisture in a daily assimilation cycle. This system is driven by the GPCP precipitation and NCEP reanalysis data with some corrections based on in situ data. This system was tested at a CEOP reference in the Tibetan Plateau, which not only reproduced surface energy budget observed at a plateau reference site, but also detected precipitation events that were missed in the forcing data. We applied this system to the whole plateau, and the produced soil moisture and surface energy budget show an apparent seasonal march in the Tibetan Plateau and contrast distributions between the west plateau and the east plateau.