Validate LDAS-estimated soil moisture and land fluxes in Tibetan Plateau and Mongolian Plateau

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The estimation of continuous regional soil moisture and the surface energy budget is crucial for studies of agricultural, hydrological, and atmospheric processes, as well as applied research. 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 two CEOP (Coordinate Enhanced Observing Period) reference sites, respectively on the Tibetan Plateau and Mongolian Plateau.

The application in the Tibetan Plateau shows that simulations of soil moisture and the surface energy budget were improved compared with the case with no assimilation. In particular, the soil moisture and energy partition simulated using the assimilation system is less contaminated by negative biases in input precipitation data than the case with no assimilation. This result is encouraging in terms of producing reliable surface-energy budgets in remote regions such as Tibet where precipitation-monitoring networks are sparse and input precipitation data are prone to large errors.

The application in the Mongolian Plateau focused on the validation of soil moisture estimates in semi-arid regions, where soil moisture is very heterogeneous. Validation data of soil moisture were collected in a semi-arid region. Results show that (1) the LDAS-estimated soil moistures are comparable to areal averages of in situ measurements, though the measured soil moistures were highly variable from site to site; (2) the LSM-simulated soil moistures show less biases when the LSM uses LDAS-calibrated parameter values instead of default parameter values, indicating that the satellite-based calibration does contribute to soil moisture estimations; (3) compared to the LSM, the LDAS produces more robust and reliable soil moisture when forcing data become worse; the lower sensitivity of the LDAS output to precipitation is particularly encouraging for applying this system to regions where precipitation data are prone to errors.

This system will be applied to developing a long-term dataset of soil moisture and land fluxes for the Tibetan Plateau and Northwest China.

Publications:

1. Yang, K., T. Koike, I. Kaihotsu, and J. Qin, 2009: Validation of a dual-pass microwave land data assimilation system for estimating surface soil moisture in semi-arid regions, ***Journal of Hydrometeorology*** (DOI: 10.1175/2008JHM1065.1), in press.

   (http://ams.allenpress.com/perlserv/?request=get-pdf&doi=10.1175%2F2008JHM1065.1)

2. Yang, K., T. Watanabe, T. Koike, X. Li, H. Fujii, K. Tamagawa, Y. Ma, and H. Ishikawa, 2007: An auto-calibration system to assimilate AMSR-E data into a land surface model for estimating soil moisture and surface energy Budget, ***Journal of the Meteorological Society of Japan***, 85A, 229-242.

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