Enhanced Surface Water and Energy Flux Calculation through the Integration of Thermal Remote Sensing Retrievals with Land Surface Models

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The treatment of aerodynamic surface temperature in soil–vegetation–atmosphere transfer (SVAT) models can be used to classify approaches into two broad categories. The first category contains models utilizing remote sensing (RS) observations of surface radiometric temperature to estimate aerodynamic surface temperature and solve the terrestrial energy balance at a given snapshot in time. The second category contains combined water and energy balance (WEB) approaches that simultaneously solve for surface temperature and energy fluxes based on observations of incoming radiation, precipitation, and micrometeorological variables. WEB-SVAT models are currently being widely applied to globally monitor/predict surface water and energy fluxes for a variety of applications and are attractive in that they purport to solve for all major flux and storage components within the terrestrial water and energy cycles. However, WEB-SVAT predictions are degraded by a large number of known modeling shortcomings including: parameterization uncertainties, error in required model forcings (primarily rainfall) and inadequate vertical physics. These limitations typically severely limit the accuracy, and thus overall utility, of WEB-SVAT model predictions.

Two recent advances provide a potential strategy for addressing these WEB-SVAT modeling shortcomings. First, recent inter-comparison studies are shown that surface energy flux calculations made by RS-SVAT and WEB-SVAT models possess mutually independent errors - opening up the possibility that optimized surface and water flux analysis products can be created via the assimilation of diagnostic RS-SVAT predictions into prognostic WEB-SVAT model simulations. Second, new advances with the Atmosphere Land Exchange Inversion model (ALEXI) RS-SVAT model have demonstrated that, in addition to surface energy flux calculations, RS-SVAT modeling approaches can provide operational estimates of surface and root-zone soil moisture variability. This suggests that RS-SVAT estimates can help constrain both the energy and water balance components of WEB-SVAT models.

This talk will attempt to seize on both opportunities by presenting results that illustrate the potential of utilizing RS-SVAT observations (derived from thermal-based remote sensing) to address each of the fundamental shortcomings of WEB-SVAT models (uncertain parameterization, error-prone forcing data and inadequate model physics). Integration techniques will be based on a range of strategies including Ensemble Kalman filtering and multi-objective model calibration. These strategies will be applied to data sets collected at the USDA OPE3 site, the 2002 Soil Moisture–Atmosphere Coupling Experiment (SMACEX) and WEB-SVAT modeling from the North American Land Data Assimilation System (NLDAS).

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