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An Integrated Variational Framework for Mapping Evapotranspiration by Assimilating GOES LST and SMAP data

Leila farhadi and Abedeh Abdolghafoorian
United States of America (lfarhadi@gwu.edu)

Evapotranspiration (ET) is a key component of terrestrial water cycle that plays an important role in the Earth system. Aaccurate estimation of ET is crucial in various hydrological, meteorological, and agricultural applications. In situ measurements of ET are costly and cannot be readily scaled to regional scales relevant to weather and climate studies. Therefore, there is a need for techniques to make quantitative estimates of ET using land surface state observations that are widely available from remote sensing across a range of spatial scales.

In this work, A variational data (VDA) assimilation framework is developed to estimate ET by assimilating Soil Moisture Active Passive (SMAP) soil moisture and Geostationary Operational Environmental Satellite (GOES) land surface temperature data into a coupled dual-source energy and water balance model.

The VDA framework estimates the key parameters of the coupled model, which regulate the partitioning of available energy (i.e., neutral bulk heat transfer coefficient (CH_N) and evaporative fraction from soil (EF_S) and canopy (EF_C)). The uncertainties of the retrieved unknown parameters are estimated through the inverse of Hessian of cost function, obtained using the Lagrangian methodology. Analysis of the second-order information provides a tool to identify the optimum parameter estimates and guides towards a well-posed estimation problem.

The VDA framework is implemented over an area of 21780 km^2 in the U.S. Southern Great Plains (with computational grid size of 0.05 degree) during a nine-month period. The maps of retrieved evaporation and transpiration are used to study a number of dynamic feedback mechanisms between the land and atmosphere, such as the dependence of evapotranspiration on vegetation and soil moisture.