Downscaling remotely sensed soil moisture observations to hillslope scales with physically based distributed models through data assimilation

Alejandro N. Flores[1], Rafael L. Bras, and Dara Entekhabi
Ralph M. Parsons Laboratory, Department of Civil and Environmental Engineering, Massachusetts Institute of Technology

Abstract. Soil moisture is a critical land surface variable that exerts significant influence on the exchange of water, energy, and CO2 at the land-atmosphere interface. Knowledge of the spatial distribution and time evolution of the soil moisture field at high spatial (10 to 100 m) and temporal (hourly) resolutions is valuable to hydrologic and geomorphic applications. In particular, high resolution estimates of soil moisture would aid in rainfall-runoff modeling for flood forecasting and event-scale landslide hazard forecasting. Current and planned passive space-borne microwave radiometric satellites provide remotely sensed observations with global coverage at 2-3 day intervals. However, due to antenna size constraints these data typically have resolutions of 10 km and greater and are uncertain due to instrument sensitivity. We outline how ensemble-based data assimilation can be used to downscale remotely sensed observations to resolutions consistent with applications of interest. The TIN-based Real-time Integrated Basin Simulator (tRIBS) is a distributed parameter physically-based model that is used to evolve an ensemble prediction of the soil moisture field under uncertain initial conditions and environmental forcings. The Ensemble Kalman Filter (EnKF) provides an estimation framework through which the spatial distribution of soil moisture and its uncertainty may be estimated: (1) at resolutions consistent with applications of interest and (2) conditioned on remotely sensed observations with coarser resolutions. The posterior estimate is obtained by combining the model forecast and remotely sensed observation, weighting each according to its associated uncertainty.

[1] Ralph M. Parsons Laboratory
Department of Civil and Environmental Engineering
Massachusetts Institute of Technology
77 Massachusetts Ave.
Cambridge, MA 02139
lejo@mit.edu