

Ensemble Data Assimilation for Soil-Vegetation-Atmosphere Systems

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There are many open research questions in the relatively new field of data assimilation for land surface models. We know that all models are imperfect and are probably biased. We also know that our knowledge of the initial conditions and forcing for those models is imperfect. The observations of interest may not be represented explicitly in the model and both the models and the observations have uncertainties and differences in representativeness. An effective data assimilation system must address all of these while producing a model state that contains the information that may be derived from those observations.

The main focus of an ensemble data assimilation system is to produce a collection of model states – the ensemble – that are indistinguishable from the modeled system. Land surface processes are challenging in this regard given the tremendous heterogeneity of the land surface and the range of scales of interest; from individual plants to watersheds to continental-scale responses. Furthermore, the equations governing ecological processes are not nearly as well-defined as those for atmospheric modeling, for example. Our goal is to produce an ensemble of land surface states that can be used to produce a forecast. The accuracy of this forecast is our measure of the success of our ensemble system. A good forecast is believed to depend on a good initial state and accurate model dynamics and so is a challenging measure of success.

This talk will focus only on a method that directly informs and updates the model state with the information content of the observations. The Data Assimilation Research Testbed (DART) is a community facility for ensemble data assimilation developed and maintained at the National Center for Atmospheric Research (NCAR). DART[1] is a software environment that makes it easy to explore a variety of data assimilation methods and observations with different numerical models and is designed to facilitate the combination of assimilation algorithms, models, and real (as well as synthetic) observations to allow increased understanding of all three. Land surface models supported by DART are the Community Land Model (CLM) and the uncoupled mode of the Noah Land Surface Model (Noah LSM). This talk will present an overview of three very different experiments and summarize the challenges and future direction of research. CLM is used to assimilate MODIS snow cover fraction observations to improve daily estimates of snow water equivalent. Noah LSM is used at a single site to assimilate hourly soil moisture estimates from a neutron probe and verified against (withheld) in-situ soil moisture estimates. CLM is also used at a single site to assimilate flux tower observations and is compared to open-loop simulations.

References

[1] J. L. Anderson, et al. "The Data Assimilation Research Testbed: A Community Facility", *Bulletin of the American Meteorological Society*, vol. 90, no. 9, pp. 1283-1296, September 2009. (Journal Article) doi: <http://dx.doi.org/10.1175/2009BAMS2618.1>