Title: **The impact of land model structural, parameter, and forcing errors on the characterization of soil moisture uncertainty, *Hydrology and Earth System Sciences* (European Geosciences Union)**

Author list w/ email addresses:

Viviana Maggioni	Viviana.Maggioni@uconn.edu
Emmanouil N. Anagnostou	Manos@engr.uconn.edu
Rolf H. Reichle	Rolf.Reichle@nasa.gov

Abstract:

A sensitivity analysis is conducted to investigate the contribution of rainfall forcing relative to the model uncertainty in the prediction of soil moisture by integrating the NASA Catchment Land Surface Model (CLSM), forced with hydro-meteorological data, in the Oklahoma region. This study depicts different sources of uncertainty, namely, errors in the model input (i.e. rainfall estimates from satellite remote sensing observations) and errors in the land surface model itself. Specifically, rainfall-forcing uncertainty is introduced using a stochastic error model that generates reference-like ensemble rainfall fields from satellite rainfall products. The ensemble satellite rain fields are propagated through CLSM to produce soil moisture ensembles. Errors in CLSM are modeled with two different approaches: either by perturbing model parameters using the generalized likelihood uncertainty estimation (GLUE) technique or by adding randomly generated noise to the model prognostic variables. While the first method only addresses parametric uncertainty, the second one addresses both structural and parametric uncertainty. Despite this, a reasonable spread in soil moisture is achieved with relatively few parameter perturbations through GLUE, whereas the same ensemble width requires stronger prognostic perturbations with the standard random perturbation method. The probability of encapsulating the reference soil moisture simulation increases when the rainfall forcing uncertainty and the model uncertainty approaches are combined (compared with using only rainfall uncertainty). This improvement is more significant when using the GLUE technique to perturb CLSM parameters as opposed to perturbing the CLSM prognostic variables.

Popular Summary:

A standard approach to estimating soil moisture globally is to use numerical models of land surface processes (so-called land surface models) to convert precipitation estimates, obtained from a variety of observational and model-based information, into soil moisture estimates. Obviously, uncertainty in the input precipitation estimates is a major source of error in the land surface fields (such as soil moisture) obtained from such land surface models. Additional uncertainty in soil moisture estimates is due to errors in the structure and the parameters of the land surface model itself. The uncertainty in modeled soil moisture is particularly important in so-called land data assimilation systems that merge model-based information with independent satellite estimates of soil moisture to provide

optimal soil moisture estimates based on both sources of information. This paper investigates the soil moisture errors that are due to errors in rainfall forcing relative to those that are due to errors in model structure and model parameters. Various approaches are explored on how best to represent these errors within a land data assimilation system.