Geophysical Research Abstracts
Vol. 16, EGU2014-14216, 2014
EGU General Assembly 2014

Parameter Estimation In Ensemble Data Assimilation To Characterize Model Errors In Surface-Layer Schemes Over Complex Terrain

Joshua Hacker, Jared Lee, and Lili Lei

National Center for Atmospheric Research (NCAR), Research Application Lab (RAL), Boulder, United States (hacker@ucar.edu)

Numerical weather prediction (NWP) models have deficiencies in surface and boundary layer parameterizations, which may be particularly acute over complex terrain. Structural and physical model deficiencies are often poorly understood, and can be difficult to identify. Uncertain model parameters can lead to one class of model deficiencies when they are mis-specified. Augmenting the model state variables with parameters, data assimilation can be used to estimate the parameter distributions as long as the forecasts for observed variables is linearly dependent on the parameters. Reduced forecast (background) error shows that the parameter is accounting for some component of model error. Ensemble data assimilation has the favorable characteristic of providing ensemble-mean parameter estimates, eliminating some noise in the estimates when additional constraints on the error dynamics are unknown.

This study focuses on coupling the Weather Research and Forecasting (WRF) NWP model with the Data Assimilation Research Testbed (DART) to estimate the Zilitinkevich parameter (C_{ZIL}). C_{ZIL} controls the thermal "roughness length" for a given momentum roughness, thereby controlling heat and moisture fluxes through the surface layer by specifying the (unobservable) aerodynamic surface temperature.

Month-long data assimilation experiments with 96 ensemble members, and grid spacing down to 3.3 km, provide a data set for interpreting parametric model errors in complex terrain. Experiments are during fall 2012 over the western U.S., and radiosonde, aircraft, satellite wind, surface, and mesonet observations are assimilated every 3 hours. One ensemble has a globally constant value of C_{ZIL}=0.1 (the WRF default value), while a second ensemble allows C_{ZIL} to vary over the range [0.01, 0.99], with distributions updated via the assimilation.

Results show that the C_{ZIL} estimates do vary in time and space. Most often, forecasts are more skillful with the updated parameter values, compared to the fixed default values, suggesting that the parameters account for some systematic errors. Because the parameters can account for multiple sources of errors, the importance of terrain in determining surface-layer errors can be deduced from parameter estimates in complex terrain; parameter estimates with spatial scales similar to the terrain indicate that terrain is responsible for surface-layer model errors. We will also comment on whether residual errors in the state estimates and predictions appear to suggest further parametric model error, or some other source of error that may arise from incorrect similarity functions in the surface-layer schemes.