*Title: Correcting for forecast bias in soil moisture assimilation with the ensemble Kalman filter*

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*Abstract:*


*Land surface models are usually biased in at least a subset of the simulated variables even after calibration. Bias estimation may therefore be needed for data assimilation. Here, in situ soil moisture profile observations in a small agricultural field were merged with Community Land Model (CLM2.0) simulations using different algorithms for state and forecast bias estimation with and without bias correction feedback. Simple state updating with the conventional ensemble Kalman filter (EnKF) allows for some implicit forecast bias correction. It is possible to estimate the soil moisture bias explicitly and derive superior soil moisture estimates with a generalized EnKF that uses a simple persistence model for the bias and assumes that the a priori bias error covariance is proportional to the a priori state error covariance. For the case of bi-weekly assimilation of the entire profile of soil moisture observations, bias estimation and correction typically reduces the RMSE in soil moisture (over the standard EnKF without bias correction) by around 60 percent. However, under the above assumptions, significant improvements are limited to state variables for which observations are available. Therefore, it is crucial to measure the state variables of interest.*
*The best variant for state and bias estimation depends on the nature of the model bias and the output of interest to the user. In a model that is only biased for soil moisture, large and frequent increments for soil moisture updating may be required, which in turn may negatively impact the water balance and output fluxes. It is then better to post-process the soil moisture with the bias analysis without updating the model state.*


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