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Using a bias aware Ensemble Kalman Filter to predict soil moisture in a layered field

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When modeling and predicting flow in the unsaturated zone, one problem are the strong heterogeneities in the system that occur on all scales and have in principle to be accounted for in the flow model. In general, however, our knowledge of subsurface structure often is poor and the internal structure of the model may be subject to strong simplifications. When modeling flow, models may have an inherent modeling error.

In this work, we consider external bias corrections to account for unresolved subsurface structure within an Ensemble Kalman Filter (EnKF) state and parameter estimation process. We assimilate and predict local spatially distributed data from a heterogeneous soil using a homogeneous flow model. We apply the data assimilation scheme to a set of TDR observations taken over a long series in a layered plot (published in Wollschlaeger et al, 2009). Different assimilation and prediction intervals are tested as well as different parameter models.

It is shown that the homogeneous model itself cannot be used to make prediction with the EnKF. When the bias corrections are introduced, however, the result clearly improves and the resulting model can be used to make reasonable predictions of local water content. It is also shown that in the proposed assimilation setup, the commonly used van Genuchten parameter model does not result in a better performance than the much simpler Russo-Gardner model, hence suggesting that the simpler model should be used for the assimilation. It will also be demonstrated that models that include the layering explicitly, might not lead to improved predictions, if the heterogeneous structure is not implemented correctly.

Literature:

Wollschlaeger, U., T. Pfaff and K. Roth (2009). Field-scale apparent hydraulic parameterisation obtained from TDR time series and inverse modelling, Hydrol. Earth. Sci., 13, 1953-1966.