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Inflation Method for Ensemble Kalman Filter in Soil Hydrology

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Representations of soil water movement contain uncertainties and errors in all model components. Data Assimilation methods combine information from uncertain models and measurements into an optimal estimate of the state. They can be extended to additionally estimate parameters. They are, at least in principle, capable of considering all uncertainties during their estimation, but rely on a quantitatively good description of these uncertainties.
The Ensemble Kalman Filter (EnKF) is such a data assimilation method, based on the assumption of Gaussian error distributions. Due to the convergent nature of the process, unrepresented model errors, and a limited ensemble size, state and parameter uncertainties become too small during the assimilation. Inflation methods are used to counteract this and increase state and parameter uncertainties, but typically struggle with soil hydrological applications. We propose a multiplicative inflation method specifically designed for the needs in soil hydrology. It employs a Kalman Filter within the EnKF to estimate inflation factors based on the difference between measurements and mean forecast state within the EnKF. We demonstrate its capabilities on a small soil hydrologic test case. The method is capable of adjusting inflation factors to spatiotemporally varying model errors and it successfully transfers the inflation to parameters in the augmented state, which leads to an improved estimation.