Geophysical Research Abstracts
Vol. 19, EGU2017-19001, 2017
EGU General Assembly 2017

Catchment tomography - An approach for spatial parameter estimation

Dorina Baatz (1,2), Wolfgang Kurtz (1,2), Harrie-Jan Hendricks Franssen (1,2), Harry Vereecken (1,2), Stefan Kollet (1,2)

(1) Forschungszentrum Jülich GmbH, Institute of Bio- and Geosciences, IBG-3 (Agrosphere), Germany, (2) Centre for High-Performance Scientific Computing in Terrestrial Systems (HPSC-TerrSys), Geoverbund ABC/J, Jülich, Germany

Complexity of hydrological models has been increasing. Thanks to increasing computational possibilities, distributed and physically based models became feasible and can be coupled for simulating hydrological processes across compartments. The number of unknown parameters of these large models is a major challenge: Parameter estimation is difficult, because there are usually more parameters than observations. The parameter estimation problem is thus mathematically underdetermined. This study presents a tomographic approach to mitigate this equifinality problem in estimating distributed parameters of a catchment model with data assimilation.
The model is forced with radar based precipitation estimates in high resolution (500m, 5min) which serve as moving transmitter. The precipitation water forms runoff and stream discharge along different paths and time frames, depending on the spatio-temporal precipitation pattern and the hydrologic properties of the catchment. The resulting stream water level, measured at several stream gauges which serve as receiver, is therefore an integrated signal comprising information on upstream catchment parameters. The stream water level observations are assimilated into a 2D catchment model and used to estimate the Manning's roughness coefficient with a joint state-parameter update with the Ensemble Kalman Filter. The model used for these synthetic experiments is TerrSysMP to which the Parallel Data Assimilation Framework is coupled. The continuous integration of new information into the model constrains the parameter space and simultaneously accounts for uncertainties due to observation errors.
Estimating the Manning's coefficient, distributed to two and four zones, in synthetic, 2 dimensional experiments resulted in good estimates. The initially strongly biased Manning's coefficient was estimated with errors of less than 3% (2 parameter zones) and less than 16 % (4 parameter zones) with only 64 ensemble members. The realistic, distributed precipitation forcing is shown to be essential for this catchment tomography approach: The ensembles of Manning's parameter estimates rapidly converge towards the reference values with the start of distributed precipitation.
Experiments were performed with deterministic and perturbed precipitation forcing. Precipitation was perturbed with a multiplicative temporally and spatially correlated log-normally distributed error with a standard deviation of 0.5 and mean of 1 to generate the ensemble. Parameter estimates had slightly larger errors (3 to 5 %) with perturbed precipitation forcing. The overall impact of perturbed compared to deterministic precipitation was small. Increasing the observation error did not reduce the estimation accuracy but only resulted in a larger ensemble spread of the estimated parameters, representing the larger uncertainty.