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Multi-variate spatial explicit constraining of a large scale hydrological model

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Increased availability and quality of near real-time data should target at better understanding of predictive skills of distributed hydrological models. Nevertheless, predictions of regional scale water fluxes and states remains of great challenge to the scientific community. Large scale hydrological models are used for prediction of soil moisture, evapotranspiration and other related water states and fluxes. They are usually properly constrained against river discharge, which is an integral variable. *Rakovec et al (2016)* recently demonstrated that constraining model parameters against river discharge is necessary, but not a sufficient condition. Therefore, we further aim at scrutinizing appropriate incorporation of readily available information into a hydrological model that may help to improve the realism of hydrological processes. It is important to analyze how complementary datasets besides observed streamflow and related signature measures can improve model skill of internal model variables during parameter estimation. Among those products suitable for further scrutiny are for example the GRACE satellite observations. Recent developments of using this dataset in a multivariate fashion to complement traditionally used streamflow data within the distributed model mHM (www.ufz.de/mhm) are presented. Study domain consists of 80 European basins, which cover a wide range of distinct physiographic and hydrologic regimes. First-order data quality check ensures that heavily human influenced basins are eliminated. For river discharge simulations we show that model performance of discharge remains unchanged when complemented by information from the GRACE product (both, daily and monthly time steps). Moreover, the GRACE complementary data lead to consistent and statistically significant improvements in evapotranspiration estimates, which are evaluated using an independent gridded FLUXNET product. We also show that the choice of the objective function used to estimate model parameters leads to considerable changes in the partitioning of precipitation into runoff components, while maintaining total runoff estimates unaltered. Objective functions that take into account the spatial patters of GRACE estimates perform better than those constrained only against discharge. Improvements in parameter estimation based on multiple data sources will enhance the community efforts towards spatially consistent large scale seamless predictions.

Reference: Rakovec, O., Kumar, R., Mai, J., Cuntz, M., Thober, S., Zink, M., Attinger, S., Schäfer, D., Schrön, M., Samaniego, L. (2016): Multiscale and multivariate evaluation of water fluxes and states over European river basins, *J. Hydrometeorol.*, **17**, 287–307, doi: 10.1175/JHM-D-15-0054.1.