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Considering Model and Forcing Uncertainties in EnKF Calibration and Assimilation of WGHM using Gridded GRACE Data

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Large uncertainties in hydrological models persist due to the simplified representation of hydrological processes and imperfect input data, including empirical model parameters, climate forcing, and information about anthropogenic water use. To adapt the model outputs to reality, in-situ measurements and remote sensing data have been used for parameter calibration or data assimilation. For the first time, the Gravity Recovery And Climate Experiment (GRACE) mission provides global observations of the Earth's time variable gravity field. Methods have been developed to separate the column-integrated sum of terrestrial water storage (TWS) changes. Therefore, these global measurements can be used to improve the performance of hydrological models. Here, an ensemble Kalman filter approach has been implemented to calibrate the parameters of the WaterGAP Global Hydrology Model (WGHM), and simultaneously, assimilate gridded TWS data into the model. The method uses the model-derived states and satellite measurements and their error information to determine updated water storage states.

Since hydrological models do not provide error information, an empirical covariance matrix needs to be estimated. Since both model parameters and climate forcing represent a significant influence on model derived TWS outputs, their uncertainties have to be introduced to ensure realistic model error estimation. In this study, we analyse the sensitivity of the modelled water storage to changes in 22 control parameters and climate input field uncertainties (e.g. precipitation). In addition, data assimilation and calibration runs considering different types of input uncertainties are performed to assess the influence of the introduced error information on the assimilation and calibration results.