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Assimilation and Calibration Approach for WGHM Using Gridded GRACE Observations: Validation for the Mississippi, Amazon and Danube Basin

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Global hydrological models describe the terrestrial water cycle with detailed spatial and temporal resolution; e.g. the WaterGAP Global Hydrology Model (WGHM) simulates the vertical and horizontal water fluxes on a 0.5°x0.5° grid with daily resolution. On the other hand, the column-integrated sum of total water storage (TWS) changes can be derived from Gravity Recovery And Climate Experiment (GRACE) observations. An assimilating hydrological model that combines the advantages of detailed model resolution and accurate water storage measurements would be of great benefit for geophysical applications. Daily GRACE assimilated model outputs have the potential for being used for de-aliasing of GRACE products, replacing missing GRACE solutions or providing trends to separate GIA and perform ice mass corrections.

In our group, a new ensemble Kalman filter approach has been developed to improve WGHM. The method assimilates GRACE-derived gridded TWS changes and calibrates WGHM parameters. The model-derived states and satellite measurements and their error information are used to determine updated water storage states. Since hydrological models do not provide error information, an empirical covariance matrix needs to be estimated. In this study, we focus on the validation of the performance of our approach. Therefore, GRACE data is assimilated into WGHM and its parameters are calibrated over a certain period of time. Afterwards, a free model run, considering the calibrated parameters and assimilated states, is performed for the following years. The predicted TWS values are then compared with those of GRACE observations and the original model outputs. We also validate the assimilated model outputs against independent discharge measurements. We applied our method to the Mississippi and Amazon basin, which exhibit a strong TWS signal, and the Danube basin, which represents a moderate signal.