

EGU2020-7196

<https://doi.org/10.5194/egusphere-egu2020-7196>

EGU General Assembly 2020

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Analyzing different ways of assimilating volume change estimates for surface water bodies into a hydrological model

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To better understand global freshwater resources, we combine the state-of-the-art global hydrological model WGHM with Total Water Storage Anomalies (TWSA) derived from the Gravity Recovery and Climate Experiment (GRACE) satellite mission in an ensemble-based calibration and data assimilation (CDA) framework. However, when dealing with GRACE data, their limited horizontal resolution represents a major challenge. Filtering and/or 'destriping' is the usual approach for suppressing GRACE-specific spatial noise, which causes spatial leakage and in turn attenuation of signal and reduction of spatial resolution. In GlobalCDA project, we derive altimetry-based storage variations along with corresponding uncertainties of surface water bodies, such as lakes and reservoirs, that feature significantly higher spatial resolution compared to GRACE-based TWSA. These can, additionally, be incorporated into the CDA framework.

In this study, we investigate several possibilities on how to use the additional remote sensing observations within the CDA over the Mississippi basin for the time span 2003 - 2016. For this, we run the CDA (i) using GRACE-based TWSA only, (ii) removing altimetry-based storage variations of surface water bodies from GRACE-TWSA, (iii) removing and restoring altimetry-based storage variations for GRACE-TWSA, and (iv) directly using altimetry-based storage variations. New observation operators are constructed for (ii) and (iv). The results are validated against independent discharge observations.