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Joint assimilation of GRACE satellite and in-situ discharge observations into a global hydrological model

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Global hydrological models simulate water storages and fluxes of the water cycle which is important for e.g. water management decisions and drought/flood predictions. However, the models include many uncertainties due to the model inputs (e.g. climate forcing data), model parameters, and model structure resulting in disagreements with observations. To reduce these uncertainties, the models are typically calibrated against in-situ discharge observations or GRACE-derived total water storage anomalies (TWSA) are integrated into the model by data assimilation.

In this study, we introduce a framework for jointly assimilating multiple observations into the WaterGAP 2.2d model over the Mississippi River Basin for 2003-2018. We do not only assimilate GRACE-derived TWSA but also in-situ discharge observations from gauge stations. In addition, we vary the number as well as the location of the considered discharge stations to derive information about e.g. the influence of assimilating down- or upstream stations.

Our results show a strong influence of the GRACE data and that the assimilation of multiple discharge stations resembles the results of a traditional calibration approach. We expect the most downstream stations to have a larger impact on the assimilation results than the more upstream stations (as the downstream stations already include the information of the upstream stations). The gained insights of this study show a great potential to better assess and understand the global freshwater system and become even more relevant in view of the Surface Water and Ocean Topography (SWOT) satellite. SWOT will be launched in 2022 and is expected to allow the derivation of discharge observations globally for rivers wider than 50-100m.