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# Setup assessment for assimilating GRACE observations into the Australian Water Resource Assessment (AWRA) model

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Hydrological models have usually been used to simulate variations in water storage compartments resulting from changes in fluxes (i.e. precipitation, evapotranspiration) considering physical or conceptual frameworks. In an effort to improve the simulation of storage compartments, this research investigated the benefits of assimilating the Gravity Recovery and Climate Experiment (GRACE) derived terrestrial water storage (TWS) anomalies into the AWRA (Australian Water Resource Assessment) model using an ensemble Kalman filter (EnKF) approach in 2009. The Murray–Darling Basin (MDB), which is Australia's biggest river system, was selected to perform the assimilation. Our investigations address (i) the optimal implementation of the EnKF, including sensitivity to ensemble size, localization length scale, observational errors correlations, inflation and stochastic parameterization of forcing terms, and (ii) the best strategy for assimilating GRACE data, which are available at different spatial resolutions (few hundred kilometres).

Our motivation to select EnKF was due to its promising performance in previous studies to deal with the nonlinearity and high-dimensionality of hydrological models. However, the small size of ensembles might represent a critical issue for its success, since the statistical state of the system might not be well represented. Therefore, in this study, we analysed the relation between ensemble size and the performance of assimilation process. Previous studies have demonstrated that GRACE can be used to enhance the performance of models. However, it is very difficult to deal with its relatively low spatial resolution. Furthermore, assimilation of GRACE TWS measurements at different spatial resolution may result in different degree of improvements. Therefore, attempts were made here to find an optimal assimilation resolution of GRACE TWS observations into AWRA over MDB. Eventually, a localization approach was applied to modify the error covariance matrices of TWS observations for the effect of distant observations.

Our results showed a significant improvement in ground water estimates after assimilation of GRACE TWS data into AWRA in compare with GRACE observations. In the best-case improvement results, correlation coefficient between model outputs and data have changed from 0.73 to 0.87. Overall, this study highlights the benefit of EnKF as well as the effects of GRACE on hydrological model during assimilation.