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Advancing the characterisation of global hydrological droughts (2003-2017) by merging GRACE data and a 0.125° resolution water balance model

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Hydrological drought is caused by an abnormal decrease in precipitation, and it is influenced comprehensively by environmental and hydrological conditions such as land surface temperature, evapotranspiration rate, and soil property. In recent years, index-based drought monitoring approach is often adopted to represent the evolution of hydrological drought, which mainly relies on the simulation of hydrological models to generate soil and groundwater storage estimations and finally to estimate their related indices. Recent studies, however, indicate that the seasonal and long-term trends of model derived water storage simulations need to be improved. In this study, we apply a Data Assimilating (DA) approach to merge global terrestrial water storage (TWS) data from the Gravity Recovery And Climate Experiment (GRACE) with the output of a daily 0.125° resolution water balance model. The modified DA derived soil moisture and groundwater storage estimates are then used to estimate globally covered standardized soil moisture and groundwater drought indices. Our numerical implementation covers the assimilation period of 2003-2012, from which we find that the GRACE DA introduces a decadal trend to the soil moisture and groundwater storage changes. DA also modifies variability of soil moisture due to the El Niño Southern Oscillation and the seasonality of groundwater. Considerable increase in the extension of hydrological droughts, mainly severe and extreme droughts, are found globally.