Higher-resolution mapping of regional aquifer storage parameters using a GRACE spherical harmonic inversion method

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The aquifer storage parameter, i.e. the specific yield (storativity) for unconfined (confined) aquifers, is crucial for estimating groundwater storage changes, and for hydrological and land surface model simulations. Despite that it can be quantified through pumping test or ground gravity measurement at local scale, obtaining distributed values at large scale is still of great challenge. In this study, we propose a GRACE (Gravity Recovery and Climate Experiment) spherical harmonic inversion (SHI) method, which reconciles GRACE and in situ groundwater level observations and enables distributed estimation of the storage parameters with higher-resolution at large scales. Through a case study in the plain area (346, 000 km^2) of the Yellow River basin, Huaihe River basin, and Haihe River basin (YHH), with a validation dataset of 120 pumping test data, we demonstrate that the overall performance (the R between SHI and pumping test) can reach 0.75 at the resolution of 1 km×1 km, though major limitations still exist in the uncertainties associated with selecting the best (true) one from multiple inversion results. Our study provides a potential new solution for estimating aquifer storage parameters at large scale, and highlights the additional value of spherical harmonic data on higher-resolution studies related with groundwater storage changes.