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Earth System Dynamics
Discussions

Interactive comment on "Groundwater storage dynamics in the world's large aquifer systems from GRACE: uncertainty and role of extreme precipitation" *by* Mohammad Shamsudduha and Richard G. Taylor

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The authors present a manuscript on GRACE-based terrestrial and groundwater storage changes in 37 major aquifer systems across the globe. I must say, the authors have done a commendable job to compare huge amount of data in all of those major global aquifers. My major comments are provided below:

1. The surface water storage was used from GLDAS estimates of surface runoff. How do the authors comment on surface water storage variations in natural structures such

as, rivers, lakes and artificial structures like dams? I believe, the influence of surface water storage in natural and artificial structures can provide erroneous disaggregation of TWS. The smaller fraction of surface water storage is clearly visible in the figures on comparing the soil moisture and groundwater storages. 2. Lines 304-316: I am not totally agreeing with the arguments provided by the authors. They have not provided sufficient factual evidences in support of these arguments. There can be multiple reasons behind that. Surface water storage in the reservoirs can also play crucial role here, which is not considered in this study. 3. Please include a limitation section mentioning all the limitations in this study. For soil moisture storage, one of the major limitations is that the simulated values are up to 3.4 m at max, soil moisture at deeper layers are not used. This is particularly important in arid, semi-arid regions where vadose zone thickness is much deeper. "Uncertainty is generally higher for aquifers systems located in arid to hyper-arid environments (Table 2, see supplementary Fig. S79)." This observation can be linked with the non-representation of deeper soil moisture. 4. Sections 3.5, 4.2 and elsewhere: In general, while describing extreme precipitation, researchers normally use precipitation per day time-scale. The authors seem not to use the daily precipitation data. Please change the discussion topic to mention precipitation only. 5. Section 3.5: Observing non-significant, low correlation between precipitation and groundwater may indicate human interference. Central valley (16) is a clear exception here. This shows correlation analysis is not properly reflecting the observation. 6. Figure 3: Show the scale of variance. 7. "For example, centennial-scale piezometry in the Ganges-Brahmaputra aquifer system (no. 24) reveals that recent groundwater depletion in NW India traced by GRACE (Fig. 5 and supplementary Fig. S23) follows more than a century of groundwater accumulation through leakage of surface water via a canal network constructed primarily during the 19th century (MacDonald et al., 2016)." Centennial-scale data are not present in the manuscript. Please include them in SI. This is not only from the recharge of canal irrigation, groundwater resources in this area got benefited also from a significant rate of annual rainfall. The present decline is clearly linked to irrigation-linked withdrawal. Please mention these. 8. Figure

8: Continuous rise in GWS observed in several basins including Amazon, where precipitation rates even show declining trends (Figure S18). Please discuss the probable reasons. 9. Line 137: surface runoff or surface water storage (ΔSNS)

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