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Earth System Dynamics
Discussions

Interactive comment on "Climate-groundwater dynamics inferred from GRACE and the role of hydraulic memory" *by* Simon Opie et al.

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This study presents an interesting analysis that examines the relationship between climate forcing and groundwater response on 17 major aquifers globally. The results are important, indicating strong relationships between groundwater storage and monthly precipitation in humid settings and with annual precipitation in more semiarid regions. These results have important implications for management, indicating the importance of seasonal variations in storage in humid regions and much longer-term variability in semiarid regions and time to recover from extreme events. The findings are consistent with results of the authors previous studies on episodicity of recharge in semiarid regions in Africa. The finding that recharge events in dryland aquifers occur during negative cumulative PCPA is very interesting and coincidence with

extreme rainfall is very important. The linkage to ENSO is also very valuable (L. 460 – 470). I agree with the use of the JPL mascons solution for GRACE data and the use of NOAH land surface model considering the large variability among the GLDAS models. The following includes some minor comments: In the abstract the authors refer to ENOS as seasonal; however, I think of ENSO as more interannual with 3 – 5 yr timescales. The authors refer to baseflow from groundwater sustaining rivers and wetlands being fundamentally important, especially in semiarid and arid regions; however, one should recognize that in many semiarid regions surface water recharges groundwater. L. 45: The authors suggest that future management of freshwater resources will be a critical issue linked to climate change but I think it is already a critical issue because of climate extremes (droughts and floods). L. 63 – 65: In contrast to the statement from Wada et al., 2014; recent reports suggest that water use has been stable or decreasing in past decades in the U.S. and China. Zhou, F., et al. (2020), Deceleration of China's human water use and its key drivers, Proceedings of the National Academy of Sciences, 117(14), 7702-7711. https://www.usgs.gov/special-topic/water-science-school/science/trends-water-use-united-states-1950-2015?qt-science_center_objects=0#qt-science_center_objects L. 90: This is a good point on sources of uncertainty with application of GRACE data to groundwater storage. L. 175 – 180: GRACE uses a baseline from 2004 – 2009; however, I think it would be better to calculate anomalies for your data based on your entire record. It is not clear why you don't combine JPL and CSR mascons? JPL relies on models to process the GRACE data whereas CSR does not. The combination should be more robust. L. 237: It would be good to use a consistent time period for calculating all anomalies throughout the paper. L. 310: I think it is important to indicate the uncertainties in these global datasets. For example, the water table depth map developed by Fan differs markedly from that developed by the British Geological Survey for Africa. L. 423: Long and Mahler (2013) applied the analysis to karst aquifers, which are similar to surface water drainage systems. These systems differ markedly from many aquifer systems.

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