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Hydrology and Earth System Sciences
Discussions

Interactive comment on "Using GRACE in a streamflow recession to determine drainable water storage in the Mississippi River Basin" *by* Heloisa Ehalt Macedo et al.

Anonymous Referee #1

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General Comments This manuscript describes a method of relating streamflow measurements and terrestrial water storage anomalies (TWSA) from GRACE data products to estimate the drainable storage of several Mississippi River sub basins. This research is current, relevant, and of interest to the readers of HESS. The manuscript was well written and organized, and I enjoyed reading it. I have a couple of concerns with the fundamental concepts that underpin this research that require further explanation from the authors, as described under 'specific comments' below. In addition, I have further minor/editorial comments provided under 'technical corrections' below. Overall, I think this manuscript should be returned to the authors for major revisions.

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Discussion paper

Specific Comments First of all, the methodology estimating Qb is not clear. The authors state that the Qo-S pairs are ordered by size of S, then Qb is the 'forward-looking minimum' of Qo. Is this forward in time, or just in this ordered pairing from low to high S? I assume forward in time, because you can't simply ignore the order of events (a low S cannot be the result of a low Qo that won't occur for several months). In addition, the text says that Qb is estimated as a fraction of Qo using equation 1, yet equation 1 contains no metric for this fraction. Either this is the incorrect equation, or the term 'fraction' is used in error. The second concern is related to the temporal resolution of the data with respect to equation 1. GRACE data represent the TWSA on the particular day(s) the measurements were taken, and not the monthly high/low/average. Qo is defined as the mean monthly observed discharge. Thus, equation 1 is dependent upon pairing of an instantaneous value with a mean value. While some work indicates that TWSA variability is largely not due to surface water storage (storage that can fluctuate greatly with time), some evaluation of the variability of Q throughout each month should be considered before applying equation 1. Thirdly, while only considering non-winter storage variability simplifies the analysis with respect to snow accumulation and events, it does complicate the issue with respect to vegetation growth. The Mississippi basin is a large agricultural area, and a change in mass due to the increase in vegetation over the growing season should be addressed in this work. Along similar lines, I would be interested to know how much groundwater pumping takes place within each sub basin, and if that contributes significantly to changes in TWSA. Finally, while the authors address the issue of reservoir storage and releases and their influence over Q I think further work is needed to discuss how the Q-S relationships can still hold in these environments. If the flow of the stream is dependent upon reservoir releases they would not necessarily reflect the basin's storage (e.g. we can have a large reservoir release when groundwater levels (a reflection of baseflow) and drainable storage, are low), so how can the Q-S relationship still hold? Many reservoirs in the Mississippi basin are driven by downstream user demands and are not a reflection of what the natural flow conditions would be.

Technical Comments P3 L2: You provide an estimate of drainable basin storage, not total basin storage. P3 L16: ‘smaller size’ not ‘inferior size’ P3-4, L31-1: This sentence is redundant P4 L2: Recent research supports the conclusion that TWSAs are not due to surface anomalies, but also indicates that TWSAs are not related to water availability (drainage) in basins within the Mississippi. Areas with large vadose zones can have changes in the vadose zones dominate the changes in TWSA. P4 L5: Perhaps indicate that you focus on storage anomalies because it is not possible to quantify absolute storage with GRACE data. P5 L4-5: This should not be a surprise since you derived S from TWSA. P7 L6-11: This is a summary not conclusion. The conclusions need to be bolstered, at the moment they are quite weak. P7 L13: You didn’t just use TWSA, you used Q as well. Figure 3: Are these regressions significant? Include axis labels. Figure 4 (and within text): This insinuates that drainable storage didn’t change with time. How do you justify this in such a dynamic basin?

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