**Hydrology and
Earth System
Sciences
Discussions**

Interactive comment on "GRACE water storage estimates for the Middle East and other regions with significant reservoir and lake storage" *by* L. Longuevergne et al.

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This study provides a novel perspective on the information content of GRACE time-variable gravity data for estimating continental water storage variations. The study analyzes the effect of spatially concentrated mass variations such as water storage change in lakes, reservoirs or rivers on the GRACE signal. A similar dedicated analysis has not been published before. The paper very nicely combines a comprehensive synthetic experiment with real-world applications. The results, highlighting the considerable effect on GRACE data of position and extent of concentrated mass variations

within the area of interest, will have a high impact on future analyses of GRACE for hydrological applications. Also, results of several previous publications on the use of GRACE data for estimating water storage variations at regional scales may need to be reconsidered in the light of the outcomes of the present paper. I highly recommend publication of this study in HESS, given moderate revisions that should mainly help improving the quality of presentation, in particular with regard to the main findings of this study in terms of GRACE signal content with respect to concentrated mass variations.

Major comments:

1) With the synthetic experiment (Chapter 3) (Figures 1, S1, S2) the study presents a highly valuable but complex analysis of the impacts of scale and location of mass variations and study area on the apparent GRACE signal. A condensed summary of the three main findings as given in Chapter 3 is commendable. Nevertheless, in addition to improved wording and explanation of figures, a slightly extended discussion of the results will help to better illustrate the wealth of outcomes of the analyses condensed in the figures 1, S1, S2 and their impacts for future studies (see also my minor comments below for details).

2) The applications to real-world examples in Chapter 4 take an inverse view as compared to the synthetic experiments. In the real-world example, one has a GRACE signal and tries to interpret it in terms of water storage variations, including in terms of concentrated mass such as reservoirs (the synthetic experiment provides a mass distribution and estimates its effect on GRACE).

2.1) It will be very helpful to make it crystal clear how to explain the GRACE signal when having some a-priori information on the distribution of mass within the study area. For example, the sentence in page 11142, line 13, "If the mass is assumed uniformly distributed ,... then estimated storage is twice that actually determined from GRACE ..." is misleading. What is the true value, what does GRACE see, in which case do we overestimate or underestimate with GRACE data, how to relate GRACE

data to the point masses?

2.2) Similarly, the phrase in page 11141, line 27, is not fully clear. "Simple GRACE estimates will over-estimate average basin storage if the distribution is uncorrectly assumed to be uniform ...". What exactly does this mean? What is a "simple GRACE estimate"? Is it true if one says that that the real mass variations are smaller than those derived from GRACE if the spatial distribution is not uniform?

2.3) Similary, conclusions, page 11147, lines 16-18: "... the simple sum of reservoir storage underestimates their actual impact on GRACE by nearly 50%." Not clear. Isn't it rather that GRACE overestimates by 50% (the observed reservoir storage should be the truth?)

2.4) Similarly, page 11144: " Reservoir storage appears to explain about 50% of mass variations on GRACE ..." But we want to know the true storage variations?! Following Table 2, the true value is <30% when considering altimetry data.

3) The supplementary material is partly not self-explaining and references to it in the main test are rare. In my opinion, it will be helpful to include some paragraphs of text explaining the main approaches and findings, instead of (or in addition to) very condensed figure captions that do not provide enough information to grasp the overall message (in particular figures S3 and S4).

Minor / detailed comments: 1) page 11135, line 7: "observable" instead of "observability" 2) page 11135, line 19: Rodell et al. 2009 3) There is some confusion throughout the paper what ΔSMS stands for. It is introduced as soil moisture storage (page11139, line 6-7), later on defined as soil moisture + snow (page11139, line 17). For the Tigris-Euphrat, ΔSMS is considered as an important storage compartment (Chapter 4.2). Does it include snow, a storage compartment which will be relevant in this basin? Table 2: Does ΔSMS include snow? Which GLDAS model is used in table 2? 4) page 11141, line 8: "Masses outside the basin yield a similar ABS to point masses inside the basin ..." Where can this be seen? Up to which distance does this hold? 5) page

11141, line 11: Why does the degree 60 case lead to a decreasing ABS relative to the degree 50 case? Isn' t it the reverse (more smoothing / more strict truncation for the 50 case)? 6) page 11142, lines 3-4: Following my major comment 1), the authors may add some more explanations how location and spatial extent interact in the synthetic examples. 7) page 11142, lines 13-15: Assuming point and uniform distribution of mass among the basin, isn't it experiment 2 to refer to instead of experiment 1? 8) Can the leakage from southern parts of the Nile basin be specified (page 11143, line 15)? 9) page 11143, line 23: what is the "reduced area"? 10) page 11144, line 13: "reservoir storage" instead of "reservoir storage management" 11) page 11146, line 22: " water storage" instead of "water level" 12) page 11144, line 23: "reservoirs" 13) Table 1 and others: column "Variability". Is it mean seasonal variability? 14) Fig. 1, Fig S1, S2: Specify that in each plot a mass of 1 km3 is used. 15) Fig. 2: other (and less favourable) symbols for CSR and GRGS data (replace by error bars as in the other figures) 16) Fig. 2: Why has a 2.7 m water layer be used for the analysis? 17) Figure S1 caption: Delete twice "Experiment 1" 18) Figure S1 caption:" as reduced to..." (?) "... normalized to ..."? 19) Figure S3: suggestion to show SH spectra for area without point masses for comparison (and to illustrate the "signature of concentrated masses".

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