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Interactive comment

Interactive comment on "On the use of GRACE intersatellite tracking data for improved estimation of soil moisture and groundwater in Australia" *by* Natthachet Tangdamrongsub et al.

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We would like to acknowledge the insightful comments and suggestions provided by reviewer 1. We will consider the reviewer's suggestions in our revised manuscript. Followings are the responses (R) based on the comments:

(1) The description of the GC approach appears to be somewhat ambiguous: While Sect. 2 is claiming to use L1B KBRR data only, it becomes clear from Sect. 3 that in fact L2 monthly normal equations from ITSG2016 are applied. Those NEQ, however, include not only KBRR but all GRACE sensor information (KBRR, ACC, GPS, attitude) and a priori background models (AOD1B, earth, ocean, and atmospheric tides, third

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Discussion paper

body effects).

R1: Reviewer is correct that the normal equation is built including measurements from all GRACE sensors, including KBR, and a priori background models. Therefore, we will rephrase lines 121-122 as follows: "... the observation vector containing various kinds of L1B data including the inter-satellite ranging"

I suggest that comparisons with the official ITSG2016 monthly solutions are included in order to demonstrate the added-value of the GC approach over the standard L2 data. Note that comparisons against GRGS or JPL monthly solutions as already (partly) included in the paper will not be sufficient since ITSG2016 is commonly perceived as a GRACE series of particularly high quality.

R2: We thank for reviewer suggestion. However, the official ITSG2016 solution is the unconstraint gravity field. Deriving TWS from the unconstraint SHC requires filtering, which might lead to the alteration of the GRACE signal. Comparing the GC result with the filtered GRACE data may lead to misinterpretation of the GC performance. Therefore, we do not compare our GC result with the ITSG2016 solution. Instead, we compare the GC result with the independent GRACE-derived TWS product such as the GRGS and Mascon that do not require further post-processing.

(2) The GC approach assumes that model errors are normally distributed with zero mean (eq. 1). Authors should provide more evidence that this assumption is indeed justified in their setting.

R3: The GC approach is developed based on the least-square combination, which assumes the uncertainty following the normal distribution with zero mean and covariance C. The derivation and setting of model uncertainty under the given assumption (e.g., zero mean) is described in Sect. 4.2 of the submitted manuscript.

(3) line 284: It is optimistic to assume that the model omission error can be fully accounted by just increasing the model covariance by 20%, in particular since this as-

sumes that omission errors do not contribute to biases (which is quite unlikely). More evidence need to be provided for the (approximate) validity of this assumption.

R4: It is difficult to acquire a precise omission error from CABLE. This might require an extensive experiment, which is a subject of independent study. Therefore, we simply assumed the omission error base on trial-and-error to be a good compromise between increasing of the model error (due to the omission error) and not exceeding the TWS error suggested by Dumedah and Walker (2014). Note that, this is one way to construct the error statistic and we understand the limitation of such an assumption. Therefore, we will consider including the statement regarding the limitation of this approach in the revised manuscript.

(4) The statement of line 212ff is unclear (and apparently not picked up again in the remainder of the paper). Please elaborate.

R5: In this section, we describe the reason and the usage of the independent GRACE solutions. The GC approach requires the knowledge of the \DeltaTWS outside the study area, and the GRGS is used for this purpose. This is clearly stated in lines 213 – 216: "To obtain the \DeltaTWS values outside Australia. As shown in Eq. (9), .. the GRGS solutions as the GRGS solution provides \DeltaTWS at a spatial resolution comparable to the normal equation data." The GRGS and mascon solutions are also used for the comparison purpose (lines 217 – 218), and the application of both solutions have been discussed in the paper e.g., Sect. 5.2.1, Sect. 6.1.

(5) Line 289: What does "cooperating" mean in that case?

R6: Replaced with "using" in the revised manuscript.

(6) The specific yield for the Queensland and Victoria networks differ by a factor of 2: Is there any geologic evidence/argument available for those very different yield factors?

R7: We obtained the specific yield values from the published literatures (Chen et al., 2016; Rassam et al., 2013, Welsh 2008). Unfortunately, there is no record about the geological structure reported in those references.

(7) Sect. 6.2 appears to be rather an outlook to a future study. Since no actual results are presented, I am wondering if this section should not be better removed entirely?

R8: We agree with reviewer. Section 6.2 will be removed from the manuscript.

(8) Major mining activities are currently taking place at the North West Plateau where GRACE picks up negative mass trends: What measures have been taken to reduce mass loss un-related to the terrestrial water cycle from the GRACE data in particular in that area?

R9: This has been discussed in the past few years. It is more likely that the negative mass trends is mainly caused by the declining rainfall after 2000 (van Dijk et al., 2011), and unlikely mining (please see also http://www.news.com.au/technology/environment/climate-change/nasa-study-says-the-canning-basin-in-wa-is-being-depleted-too-fast/news-story/9bf107b8299c19b57904ed719639a0ba). The hydrological signal tends to be much larger than the mining signal. This is supported by model's water storage estimate that describes more than 90-95% of GRACE signal (see e.g., TRMM in Fig. 2). Such a small signal (from mining) is unlikely picked up by GRACE. Therefore, we do not take the mining signal into our calculation.

Reference

van Dijk, A. I. J. M., L. J. Renzullo, and M. Rodell (2011), Use of Gravity Recovery and Climate Experiment terrestrial water storage retrievals to evaluate model estimates by the Australian water resources assessment system, Water Resour. Res., 47, W11524, doi:10.1029/2011WR010714.

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