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Hydrology and Earth System Sciences
Discussions

Interactive comment on "Data assimilation of GRACE terrestrial water storage estimates into a regional hydrological model of the Rhine River basin" *by* N. Tangdamrongsub et al.

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General comments :

This manuscript focuses on the possible improvement of hydrological simulations by assimilating Grace derived Terrestrial Water Storage into a large scale hydrological modelling framework. Two forcing data quality are selected to test this improvement: a high resolution and high quality meteorological input data (local datasets) and a low quality (global datasets). The modelling approach and the manuscript itself are off good quality and should be published in HESS.

Nevertheless, there is a gap between the results analysis and the conclusions: Page 11857, line 3: "Though it is encouraging that GRACE assimilation improved the estimated streamflow, these results demonstrate that it clearly cannot replace high quality forcing data or good model calibration" P11859, line 3: in conclusion "GRACE assimilation is clearly beneficial. . ." From my point of view, there is no clear evidence of improvement between ENOL and ENKF. The small to really small differences between both cases shown in Figure 11 should be used to demonstrate that there is not much improvement in this specific study.

Specific comments: The abstract does not reflect the results presented in this study. Âń The analysis showed a noticeable improvement in groundwater estimates when GRACE data were assimilated, with an overall improvement of up to 71% in correlation coefficient (from 0.31 to 0.53) and 35% in RMS error (from 8.4 to 5.4 cm) compared to the reference (ensemble open-loop) case. Âż

Groundwater results are presented in abstract but Figure 7 does not give a clear idea of the stream flow improvements with GRACE assimilation. On the contrary, ENKF simulation of the TWS is really closed to the GRACE derived TWS. This indicates that the assimilation process reach good results but the model is not able to take advantage of this to simulate better the water cycle. "Only a slight overall improvement was observed in streamflow estimates when GRACE data were assimilated. Âż Even not any improvement. I doubt this could be explained only by the forcing data errors. One major water flux that is not taken into account is the water withdrawal for human and agriculture consumption. A recent study has used GRACE derived TWS to validate the calibration of an agro-hydrological model by taking irrigated water withdrawal into account (Ferrant et al., 2014, in Nature Scientific Report; http://www.nature.com/srep/2014/140115/srep03697/full/srep03697.html). This part of the water consumption has a huge impact on the TWS anomaly derived from GRACE, and is not taken into account in this study. This should be discussed as the Rhine river basin is highly inhabited and include high industrial and agricultural activities.

Page 11850, line 2. The calibrated model is calibrated on spatial soil moisture whereas averaged soil moisture is used for the non calibrated model. Please detail. This is not obvious for the reader. What kind of soil moisture data is used? Is it remote sensing soil moisture products? In that case, it is difficult to get an idea of the soil water storage from a surface soil moisture estimate. Section 5.2 Here the improvements of the TWS assimilation on groundwater are not obvious and are discussed in details. It seems that calibrated soil moisture does not lead to appropriate groundwater during the assimilation process. Groundwater data should be discussed regarding the accuracy or representativeness of piezometric data. Local fluctuations of the water table cannot often be considered as representative of the basin average.

Page 11858 line 19, "GRACE could be combined with a hydrological model in a data-sparse region to yield additional insight into the variations in terrestrial water storage." I doubt this study demonstrates this. GRACE could be used as an extra observation to validate model, especially in a data-sparse region where any additional observations are welcome. Furthermore, TWS from GRACE is highly correlated to climate variables that are not always representative of a region in the case of global meteorological forcing data. The assimilation process will lead to redirect water fluxes between soil, groundwater and river to compensate the lack or the excess of water.

This paper should be published as the method and results presentation is of good quality, but conclusions and recommendations behind this test should be more clearly presented and should be more consistent with the findings presented in the results.

Finally I thank authors for sharing the results of this study, that is of interest for the hydrologist community.

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