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Hydrology and Earth System Sciences Discussions

Interactive comment on "Interpretation of GRACE data of the Nile Basin using a groundwater recharge model" *by* H. C. Bonsor et al.

Anonymous Referee #1

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General comments

The manuscript aims at explaining the total water storage variations derived from GRACE satellite measurement fort he Nile basin using a hydrological model. However, the manuscript does not contribute significant new knowledge abouth the Nile Basin hydrology, makes unfounded claims regarding the advantages of the applied model (also by not presenting correctly the capabilities of other macro-scale hydrological models) and draws some unfounded conclusions, in particular regarding moisture recycling within the basin. Thus, the manuscript does not reach its aim at all.

Specific comments

1) Throughout the manuscript, the author repeatedly claim that their hydrological model, which they call "recharge model", is better suited than what they call "bulk water balance models", as these "models are unable to accurately modele each component of terrestrial water storage. Soil moisture and groundwater are often simply calculated as a remainder in the the water balance models, leading to the conclusion that a major limitation of the models is their inability to model changes in groundwater storage" (p. 4504, l4-7). As an example for such a "bulk water balance model" they mention the WaterGAP Global Hydrology Model WGHM. First, macro-scale hydrological models like WGHM, and land surface models, all compute soil moisture storage explicitly and not as a "remainder". Secondly, WGHM also includes groundwater recharge and groundwater storage. The authors even compare their model results of groundwater recharge with the results of WGHM (p. 4515, l 28). Therefore, there already exist models that are applied for the interpretation of GRACE observations that have the capabilities of the model ZOODRM that was used in the presented study. Güntner et al. (2007) showed, at the global scale, how the diverse water storage compartments modeled in WGHM (canopy, soil, river, lakes, wetlands, man-made reservoirs, groundwater) behave.

ZOODRM does not appear to have more advanced modeling approaches than other models. For example, monthly groundwater discharge is assumed to be equal to long-term average monthly recharge, such that the interannunal variation of groundwater storage might be overestimated. Why not assume that groundwater discharge is proportional to groundwater storage? Evapotranspirative losses by irrigation are not taken into account, but are at least important in the Northern part of the basin and a reason fort the low outflow of the basin.

2) Moisture recycling within the Nile basin (p. 4516/17 is essentially a repetion of what is said on p. 4509/10). Only based on the difference between GRACE data with and without atmospheric correction, which is 5-10%, they conclude that there is not a significant input of atmospheric water into the Nile basin, but that the relatively small

variation of atmospheric water means that most of the precipitation stems from evapotranspiration within the basin. However, 1) to my knowledge, atmospheric correction of GRACE data also includes the impacts of changing pressure and not only atmospheric moisture, and 2) a small variation in a storage compartment does not allow any conclusions regarding the source of the inflow into that compartment (whether the water comes in laterally by atmospheric transport, or from evapotranspiration).

3) What is the difference between Figs. 6 and 7?

4) ZOODRM also simulates surface water variations (lakes, wetlands). It would be useful to show, in Fig. 6, all water storage compartments that are modelled by ZOODRM, not only soil and groundwater, to see model results that could be compared directly to the total water storage variations of GRACE.

5) Please show how well ZOODRM computes the seasonal variability of discharge at the 10 gauging stations after calibration. Which parameters where modified during calibration, only modify overland losses during calibration? It seems that due to the non-overlapping time periods for which you had climate data and discharge data, a real calibration is difficult.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 7, 4501, 2010.