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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.

H. C. Bonsor et al.

helnso@bgs.ac.uk

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We acknowledge the comments of the anonymous reviewer, and value the opportunity to discuss and state our case.

Firstly our paper has set out to examine the role of groundwater recharge in the mass changes observed from GRACE. This is a highly recognised weakness in many of the interpretations of GRACE data (Schmidt et al. 2006), and one that we have sought to address from a position of strength as hydrogeologists, groundwater modellers and geodesists.

The moisture recycling issue needs the attention of an atmospheric physicist, an av-

enue that we shall vigorously pursue. However, we believe any naivety on our part does not detract from the main message of the paper and is no greater than many of the discussions of groundwater within many highly cited papers using land surface models (e.g. section 1 of the discussion paper). The moisture recycling is not the major message of our paper (and is a side issue for the groundwater perspective), but something which we were encouraged to comment on by BGS internal peer review, given the great differences in precipitation and mass change. A possible option for the paper is to remove all discussion to moisture recycling, particularly if this is distracting from the main message of the paper.

The reviewer mentions several areas they are unhappy with:

1. Water balance concept. We are happy with our concept of terrestrial water balance although as stated above we are maybe naive about atmospheric lateral flow of moisture. As groundwater modellers and hydrogeologists we have a good understanding of the role of groundwater which is often misused in hydrological models. Groundwater in a poorly exploited system such as in the Ethiopian highlands and in Uganda is generally in quasi-equilibrium, and should be treated as such.

2. Modelling approach. We have set out our reasons in the paper and our subsequent reply to reviewer 1 for using a groundwater recharge model. Groundwater models often take a different approach to calibration than hydrological models. Further to the reply for point 5 of referee #1, the model was not calibrated in the same way that hydrological models are, i.e. changing parameters automatically within a predefined range to produce a fit with the observed data regardless of the physical meaning. Rather we used the modelling process to gain an understanding of how the system worked and to aid the quantitative interpretation of the GRACE data. It was, therefore, an iterative and interactive approach aimed at gaining an appreciation of the meaning and value of the GRACE data.

3. Validation. The Nile River is a difficult area to model. River flow data are difficult

to come by along the entire river, and we have used what data were available. The annualised flows for the available years are used for validation and, as shown in Table 1, provide a plausible match. The few available estimates of groundwater recharge are also shown and also show a plausible match (Figure 5). The various stores of water from the model are compared to the GRACE data and also give a plausible explanation for the mass changes.

We hope these comments are helpful in explaining our approach.

Helen Bonsor, Majdi Mansour, Alan MacDonald, Andrew Hughes, Roger Hipkin and Tulu Bedada

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