General comments:

Reinecke et al. established a global gradient-based groundwater model (G3M) that would be integrated to the WaterGAP model. This advanced development should be greatly welcomed as currently there are still few global/large-scale groundwater models having ability to simulate groundwater heads. The geosciences field, particularly hydrology science community, would be benefited by this advanced modeling feature. This is my first time reading the manuscript (as I was not involved in reviewing the earlier version of manuscript) and I read it with great interest. The authors deserve huge credit in taking such huge modeling effort and producing a good manuscript with extensive analyses. I fully support the publication of this study and I have only few comments to the manuscript:

- P1L20-21, P2L40-P3L4 and other lines related to '… additional drainage above flood plain …' in PCR-GLOBWB-MODFLOW: The 'additional drainage above flood plain' in the PCR-GLOBWB-MODFLOW works (e.g. de Graaf et al., 2015, 2017) was not intended for improving groundwater head simulation performance. Yet, such drainage was introduced to improve/discharge performance of the online coupled PCR-GLOBWB-MODFLOW. In fact, the introduction of the drainage above flood plain was based on the earlier works in Sutanudjaja et al. (2011, 2014). Initially, such drainage was not used in Sutanudjaja et al. (2011), which focused on offline coupling approach of PCR-GLOBWB-MODFLOW. In this offline and one-way coupling approach for modeling spatio-temporal groundwater head dynamics, Sutanudjaja et al. (2011) conceptualized that groundwater discharge/baseflow as merely a function based on groundwater and surface water head differences, via RIV and DRN packages of MODFLOW (McDonald and Harbaugh, 1988; Harbaugh et al., 2000; Harbaugh, 2005). However, as the online two-way coupling approach between PCR-GLOBWB and MODFLOW was established in Sutanudjaja et al. (2014), we realized that flows from RIV and DRN are too slow to satisfy fast/quick-response component of groundwater discharge originating from mountainous regions where many springs tapping groundwater are located higher up in the valleys and feeding tributaries and main rivers. To include such fast groundwater discharge (baseflow) component, it is assumed that groundwater above flood plain is drained based on a linear reservoir concept (for more detailed, see Sutanudjaja et al., 2014 and Sutanudjaja, 2012).

- Related to the aforementioned comment, I am just wondering how the discharge/flow WaterGAP model will perform when an online two-way coupling/integration between G3M and WaterGAP is used. I know that this is still outside the scope of your current study/manuscript, which still focusses on steady-state (and offline approach) simulation. Yet, could you please speculate about this in the discussion part of your

manuscript? Do you expect that you have to calibrate your parameter values such as river conductances (e.g. c_swb and c_riv in Equations 5 and 6) in order to get good discharge performance? If calibration is required, could you please hypothesize about its consequence to your groundwater head simulation performance?

Minor comments:

P1L20-21: What do you mean by "… externally provided values for GW storage …"? Please rephrase. GW storages of PCR-GLOBWB-MODFLOW are always based on (internally) simulated groundwater heads.

P4L18-20: This sentence is not clear for me. Please consider to rephrase. Do you mean that you excluded large mountainous areas in your model simulation? Could you please be more specific about how you defined mountainous areas? It may be helpful for readers if you provide some examples of such mountainous area locations.

P7L20: "Globally constant but different values …" This is hard to read for me. Please consider to rephrase.

P9L32: I suggest providing global flux values in annual unit, e.g. m3 year-1 or km3 year-1 (as commonly done in other hydrological studies, such as Döll et al, 2014; Rodell et al., 2012).

Page 10, Figure 3: Please provide values in annual unit, e.g. m3 year-1 or km3 year-1.

P11L10-13: Could you please share your hypothesis or reason why the model cannot simulate losing rivers in Niger? Is it related to the forcing/input error?

P19L1: … world wide …

P19L24-25: Please give a brief explanation about the method of Morel-Seytoux et al. (2017).

With kind regards,

Edwin Sutanudjaja

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