Hydrol. Earth Syst. Sci. Discuss.,
https://doi.org/10.5194/hess-2019-346-RC1, 2019

Hydrology and Earth System Sciences
Open Access
Discussions

Interactive comment on "Using altimetry observations combined with GRACE to select parameter sets of a hydrological model in data scarce regions" *by* Petra Hulsman et al.

Anonymous Referee #1

Received and published: 7 October 2019

This was an interesting m/s to read, and I believe this study has some interesting insights worthy of publication. However I do believe it needs some improvements. More detail below.

Comment 1) I got lost in some of the technical detail around the various alternative calibration strategies tested for calibration. As the abstract seems to suggest insights relating to calibration strategy are the main contribution of this m/s, so I think this needs some more attention. For example, the research hypotheses (l. 109-11) do not address this aspect. In the introduction, can you provide some discussion around the rationale for the different experiments? In fact, to support that, it would be helpful if the authors

could provide a table listing, for each variant, the objective function, any transformation of model or observation data (i.e. the observation model), the potential benefits of the variant (i.e., why was it tested), and the empirically-found pros and cons.

Comment 2) Please consult Domeneghetti (2016) and Oubanas et al. (2018) and consider whether they may be relevant to your discussion.

Comment 3) With the caveat that I did not understand all details, I seem to gather that one of the main conclusions of this m/s is that selecting parameters based on rank correlation between discharge and altimetry water level is not sufficient to constrain model parameters, and that altimetry levels need to be converted to actual discharge to provide an appropriate constraint. Is that correct? If so, then that would be expected when evaluating against a performance measure that is extremely bias-sensitive, like Nash-Sutcliffe efficiency (NSE). However, while I know NSE is religiously adhered to by some hydrologists, it is not a relevant performance indicator for all possible uses of river discharge modelling (and indeed many hydrologists have already found a new religion in the more information-rich components of Kling-Gupta Efficiency, KGE). For many practical applications, a high correlation may well be more important than a bias-free estimate, for example in flood and drought applications. Even if volumetric accuracy is more important (e.g. in water resources volume management) then, in this case, you have some gauged data, so provided correlation is high a post-model bias correction would be straightforward. (Although of course station gauge data always have some bias of their own against the unknown truth!). Furthermore, given the almost certainly large uncertainty and bias in the CHIRPS rainfall data for this region, it is likely that a parameter set minimising bias will compensate for the biases and errors I the rainfall data. (Perhaps there are some rain gauge data to test this). In summary, I would recommend not relying on NSE nearly as much, and also considering correlation measures, perhaps by using the KGE breakdown. At the very least, more discussion is needed.

Comment 4) Please add some discussion about the performance of the different variants against the different flow signatures introduced in l. 276-280. Rather than referring to Euser et al., why not include the formula in a table and list the performance of each model variant? I note that most of the signatures are sensitive to bias (see below) and the runoff coefficients also to bias in rainfall. That means that the potential bias in the spatial rainfall estimates and station discharge records needs to be discussed.

Comment 5) I would like to see some comparison of model vs remotely sensed GRACE and altimetry data, and the performance of the different calibrated variants against it.

Comment 6) GRACE observations are coarse and subject to various uncertainties. To better understand uncertainty relating to calibration to GRACE, can you discuss the contributions of the different storage terms to the temporal variation? This would help to understand where the main uncertainties might be, e.g., how important surface water storage variations are. Also, given the proximity of lakes, dams and wetlands (Cahora Bassa, Lake Malawi, Bangwelu wetlands), they may well have had an influence on GRACE water storage variations. There is no question they are sufficiently close to affect the signal, but perhaps their water level variations haven't been very large during the analysis period. Please discuss this and provide some evidence. For example, you could look at their water level changes (e.g. from altimetry) and you could map the temporal correlation of each GRACE pixel to the respective pixels over each of these 3 areas. Finally, please discuss the SEE between model and GRACE water storage in comparison to the random noise in the GRACE solutions.

Comment 7) The apparent benefit of having accurate river cross-section data along with the altimetry data is an interesting one, and could be the most important contribution of this m/s. Can you explore opportunities to build on this insight a bit more please? For example, it is my understanding that profiles can be derived from the altimetry measurements. I am not a radar altimetry specialist and appreciate the authors are not either, but I am sure insights can be found in the literature. Secondly, given the importance of river geometry, can you discuss whether river width and pseudo-bathymetry from optical remote sensing might help you (see Sichangi et al., 2016; Hou

et al., 2018), particularly now there are such data globally at Landsat resolution. In fact, a simple and useful addition would be to add a map of each virtual and actual gauge derived from the Global Surface Water Dataset which is a great resource (Pekel et al., 2016; https://global-surface-water.appspot.com/map). Finally, one of the other reviewers will probably already suggest you mention the SWOT mission. While not seeing inherent merit in arm-waving, in this case, it is interesting to discuss to what extent the SWOT observations might provide richer and/or more accurate data (e.g. on river cross-section and profile) than the current crop of altimeters.

References

Domeneghetti, A. (2016). On the use of SRTM and altimetry data for flood modeling in dataâĂŘsparse regions. Water Resources Research, 52, 2901-2918

Hou, J., Van Dijk, A.I.J.M., Renzullo, L.J., & Vertessy, R.A. (2018). Using modelled discharge to develop satellite-based river gauging: a case study for the Amazon Basin. Hydrology and Earth System Science, 22, 6435-6448

Oubanas, H., Gejadze, I., Malaterre, P.O., Durand, M., Wei, R., Frasson, R.P.M., & Domeneghetti, A. (2018). Discharge estimation in ungauged basins through variational data assimilation: the potential of the SWOT mission. Water Resources Research, 54, 2405-2423

Pekel, J.-F., Cottam, A., Gorelick, N., & Belward, A.S. (2016). High-resolution mapping of global surface water and its long-term changes. Nature, 540, 418-422

Sichangi, A.W., Wang, L., Yang, K., Chen, D., Wang, Z., Li, X., Zhou, J., Liu, W., & Kuria, D. (2016). Estimating continental river basin discharges using multiple remote sensing data sets. Remote Sensing of Environment, 179, 36-53

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., https://doi.org/10.5194/hess-2019-346, 2019.