Response to review comments of Anonymous Referee #1 on the manuscript "Improved large-scale hydrological modelling through the assimilation of streamflow and downscaled satellite soil moisture observations" By Lopez Lopez, Wanders, Schellekens, Renzullo, Sutanudjaja and Bierkens, 2016

We would like to thank Anonymous Referee #1 for the time and effort spent to review our manuscript. His/her comments and suggestions are very thoughtful indeed and will have a positive contribution in the quality of this manuscript. According to your comments, we will try our best to revise and improve this manuscript. In the revised manuscript, the revision will include the following aspects:

General comments:

The more overaching questions that global modelling community and authors of this paper too, need to ask is – to what effect do we do these improvements?

And also – what is the development problem that these global models, improved by the approaches described in the paper, are trying to solve.

Some discussion of these aspects would be great to have in each paper that deals with global hydrological modelling.

This paper deals with improvement of just one global model, but there are 10+ of such global models now, and their development seems to be done by relevant groups with limited interactions. What is the point of having parallel similar modelling efforts and where will this go? At what point in the future we will accept that we have a reasonable global model (s), and will not invest into this anymore?

Understanding and measuring the global water cycle is of utmost importance, no doubt. But this will not be achieved through global modelling. We need to focus our attention on improvement of actual data acquisition – through remote sensing methods, if traditional techniques do not work (and we know that they do not).

It would be good to have some elements of discussion on the above in this paper (and other papers that cover global modelling).

Answer:

A number of large-scale hydrological models have been developed in recent years. As the reviewer comments, parallel modelling efforts are carried out to improve their models accuracy. Although it must be said that models are also compared with each other, such as was the case in the ISI-MIP I project as well as in the current project EartH2Observe: a paper on this by Beck et al. will be on line with HESSD soon.

As the reviewer indicates there are a lot of global models out there and a lot of the (initial) development has been done in parallel. However, the EartH2Observe project that funds this research has brought together 10 global models and is actively working on finding share ways to improve our global water budget estimates though news means. The present study moves aside from achieving this improvement through specific modifications in the model structure, such as calibrating the model parameters according to in situ observations. Instead, various experiments were carried out to improve model estimates using global earth-observations products, such as the downscaled AMSR-E soil moisture data. These experiments may constitute a step forward to show the suitability of remotely sensed observations into global models for their application at a river basin scale. Further investments and improvements in actual data acquisition, through remote sensing methods, may benefit large-scale hydrological model estimations compared with those obtained from local-scale hydrological models (as it is discussed in section 5. Conclusions). We will modify the ending of section 4. Discussion to include some aspects according to reviewer's comments:

"… is used.

To improve the representation of the global water cycle using global hydrological models, one could follow multiple strategies. Improve the quality and quantity of ground observation, increase the spatial resolution of the global models or obtain more detailed information on the catchment properties (e.g. soil data). Another way forward is the assimilation of observations and the use of high spatial resolution meteorological data to bridge the gap between the different spatial scales for which large-scale hydrological models are designed and the river basin scale. The advantage of this approach is that is provides a global improvement of the hydrological simulation and the satellite data often have a global coverage. In this study we show the potential gain in model accuracy of using remotely sensed observations. Previous studies on the potential gain of satellite observations for global and continental hydrological models agree with the obtained results in the present manuscript (Andreadis and Lettenmaier, 2006; Lievens et al., 2015). …"

Additional references to be included

Andreadis, K. M., & Lettenmaier, D. P. (2006). Assimilating remotely sensed snow observations into a macroscale hydrology model. Advances in Water Resources, 29(6), 872-886.

Lievens, H.; Tomer, S. K.; Al Bitar, A.; De Lannoy, G. J. M.; Drusch, M.; Dumedah, G.; Hendricks Franssen, H.-J.; Kerr, Y. H.; Martens, B.; Pan, M.; Roundy, J. K.; Vereecken, H.; Walker, J. P.; Wood, E. F.; Verhoest, N. E. C.; Pauwels, V. R. N. (2015). SMOS soil moisture assimilation for improved hydrologic simulation in the Murray Darling Basin, Australia. Remote Sens. Environ., 168, 146–162.