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Discussions

Interactive comment on "An evaluation of the importance of spatial resolution in global climate and hydrological models based on the Rhine and Mississippi basins" *by* Imme Benedict et al.

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The authors study the potential improvement of rainfall-runoff prediction by improving the resolution of both a climate/weather model and a hydrological model. In essence, this is a study where the hypothesis is that smaller resolution leads to better representation. This is a reductionist vision, which conflicts with the view that systems need to be described at the correct scale at which the dominant physical processes generate runoff. The question should be whether a reduction of scale still contributes to better process description. The correct scale depends on the landscape. Different landscape types (defined by topographical and ecosystem characteristics) house different runoff

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mechanisms, such as there are: saturation excess overland flow, saturation excess subsurface flow, Hortonian overland flow and fast and slow groundwater recession. These processes are physical and if connected to the correct landscape indicators can be regionalised without further calibration (e.g. Gao et al., 2016; 2014a). So instead of merely reducing the resolution of a (lumped) conceptual model, it is better to account for landscape in more detail, while retaining parameterization based on the dominant runoff mechanisms pertaining to these landscapes. The authors recognise as much on page 25, line 17, and in the following paragraph on page 26, but they don't seem to take it into practice.

The weakness of the paper is that there is no insight whatsoever in the hydrological model used. The references to Van Dijk 2010a,b are insufficient. This is grey literature about a model developed for Australia, which I cannot find on the web and which gives the reader no insight into the working of this model. There is also no indication whether this model (calibrated for Australian circumstances, I presume) would work for the Mississippi or the Rhine as well. Probably, it is a semi-distributed conceptual model that distinguishes between deep and shallow-rooting vegetation to represent the ecosystems. This may be a good and appropriate model for Australia, but without a description of the main characteristics of the model, the effect of scale in the hydrological response cannot be evaluated.

The most crucial parameter in any hydrological model is the storage capacity that the vegetation has created in the root zone. Surprisingly, this root zone storage capacity is independent on the soil parameters, because the vegetation adjusts the rooting depth to the soil, so as to create sufficient buffer capacity to overcome drought. This root zone storage capacity is scale-independent and directly connected to climate (Gao et al., 2014b), can be applied globally (Wang-Erlandsson et al., 2016) and locally (Boer-Euser et al., 2016), outperforming traditional soil-based approaches. So instead of using soil information and rooting depth as the main (and highly unreliable) input to hydrological models, it would be much better –and much easier – to use the scale-

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independent climate-based root zone storage capacity as the key input. I am curious to hear the opinion of the authors on this issue.

My assessment:

I do consider this a well-written and well-prepared paper, but I find the research question not very innovative: testing with an ill-described model (probably developed for local circumstances) whether a reduction of resolution results in better performance. Runoff processes are largely determined by climate, ecosystem and topography. A model that requires calibration of scale-dependent parameters is not suitable for such an exercise. Although I support the conclusion about the reduction of scale in the meteorology and the difference between the dominant rainfall bringing mechanisms in the Mississippi and the Rhine, I doubt the adequacy of the study on reducing the scale of the hydrological model. The authors apparently missed a considerable part of the debate on hydrological modelling, as for instance presented in Hrachowitz et al. (2013), where these issues were summarized after an intensive debate among the entire hydrological community.

References:

Boer-Euser, T., H. K. McMillan, M. Hrachowitz, H. C. Winsemius, and H. H. G. Savenije, 2016. Influence of soil and climate on root zone storage capacity, Water Resour. Res., 52, 2009–2024, doi:10.1002/2015WR018115.

Gao, H., M. Hrachowitz, F. Fenicia, S. Gharari, and H. H. G. Savenije, 2014a. Testing the realism of a topography driven model (FLEX-Topo) in the nested catchments of the Upper Heihe, China, Hydrol. Earth Syst. Sci., 18, 1895-1915, 2014a.

Gao, H., M. Hrachowitz, S.J. Schymanski, F. Fenicia, N. Sriwongsitanon, H.H.G. Savenije, 2014b. Climate controls how ecosystems size the root zone storage capacity at catchment scale, Geophysical Research Letters, 41, 7916-7923, doi: 10.1002/2014GL061668.

Gao, H., M. Hrachowitz, N. Sriwongsitanon, F. Fenicia, S. Gharari, and H. H. G. Savenije, 2016. Accounting for the inïňĆuence of vegetation and landscape improves model transferability in a tropical savannah region, Water Resour. Res., 52, 7999–8022, doi:10.1002/2016WR019574.

Hrachowitz, M., Savenije, H.H.G., Blöschl, G., McDonnell, J.J., Sivapalan, M., Pomeroy, J.W., Arheimer, B., Blume, T., Clark, M.P., Ehret, U., Fenicia, F., Freer, J.E., Gelfan, A., Gupta, H.V., Hughes, D.A., Hut, R.W., Montanari, A., Pande, S., Tetzlaff, D., Troch, P.A., Uhlenbrook, S., Wagener, T., Winsemius, H.C., Woods, R.A., Zehe, E., and Cudennec, C., 2013. A decade of Predictions in Ungauged Basins (PUB); a review. Hydrological Sciences Journal, 58 (6), 1–58, doi: 10.1080/02626667.2013.803183.

Wang-Erlandsson, L., W. G. M. Bastiaanssen, H. Gao, J. Jägermeyr, G. B. Senay, A. I. J. M. van Dijk, J. P. Guerschman, P. W. Keys, L. J. Gordon, and H. H. G. Savenije, 2016. Global root zone storage capacity from satellite-based evaporation. Hydrol. Earth Syst. Sci., 20, 1459–1481, doi:10.5194/hess-20-1459-2016.

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