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Hydrology and Earth System Sciences Discussions

Interactive comment on "Effects of climate model radiation, humidity and wind estimates on hydrological simulations" *by* I. Haddeland et al.

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1. The authors apply a very simple bias correction method, which multiplicatively adjusts, separate for each calendar month, grid point and field (R, H, W) the mean GCM field value with the mean baseline field value (WFD). This adjustment ratio is applied to daily values. This method has deficits as it a) leads to temporal field inconsistencies from one month to the next and b) does not correct the higher moments of the distribution like the method proposed by Piani et al. (2010). So I suggest using this method also for the correction of R, H and W, which would make the method of bias correction consistent throughout all fields (P, T, R, H, W) in the study.

Response: The Piani method was one of the options when selecting the bias correc-

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tion method. However, a simpler method was first chosen for a test area (Ganges-Brahmaputra) in order to see how it performed. The results indicated that a simple correction method results in a much closer match (mean monthly ET and runoff, figs 4 and 5). Hence, we proceeded with the simple method, because 1) we thought it is of value to show that a close match can be achieved by a simple method. 2) We are quite confident in the statistics of the precipitation and temperature data of the WFD as they are constructed with strong contribution of gauge measurements, which to a lesser degree is true for R, H, and W. Thus, it seems justified to apply a more sophisticated method for the bias correction of P and T in the corresponding GCM data. Also, 3) especially R and H are closely connected to P, T and each other. Hence, if a sophisticated bias correction method should be implemented, one should also take cross correlation between the variables into account. We do agree, however, that more sophisticated, and possibly more physically correct bias correction methods are of interest, but we argue that the more sophisticated methods is a logical next step that is not necessary to make the points for this study. A short discussion on the issue can very well be included in the paper, though.

2. The entire study is based on the concept of GCM bias correction. I am not convinced that this is a suitable approach for climate change studies.

Response: We agree that the better way to hydrological projections would be that the GCMs reproduced the current climate (precipitation, temperature and other fields) better that what they currently do. However, it will take a while before the GCM outputs are "good enough" to use directly in impact studies, and we think hydrological projections should be made even though bias corrections are needed. We agree that this method includes drawbacks and uncertainties, and we do need to communicate these issues to the users of the results. We suggest to include a short discussion in the current paper, but it is a discussion of a more principal character than can be discussed fully in the paper in question (also noted by the reviewer and the editor). There is an extensive discussion in the Hagemann et al. (2011) paper. Here, we repeat some of the thoughts

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in a shortened version, while referring to the Hagemann et al (2011) for more details. This can also be included in a revised version of the paper. We do welcome a future in-depth discussion in HESS.

"Despite the recent progress in the development of GCMs, they still exhibit a number of significant systematic biases in their ability to simulate key features of the observed climate system (Randall et al. 2007). Currently, GCM outputs cannot be used directly in hydrological impact studies without some form of bias correction, see Hagemann et al. (2011) for a more detailed discussion. The issue of climate model bias correction will be of interest for years to come, even though it is desirable that this will no longer be necessary in the long-term perspective. Whether the bias correction is adding or uncovering another level of uncertainty that is related to the uncertainty induced by the choice of the GCM, is a matter of scientific debate. The latter seems to apply in cases where biases lead to positive regional feedbacks to the climate change signal. This, for example, may be the case in regions with strong land–atmosphere coupling where the coupling strength will change under future climate conditions, as pointed out by Seneviratne et al. (2006) and van den Hurk et al. (2005). Hagemann et al. (2011) noted that the bias correction of P and T identified, but not necessarily caused, this extra level of uncertainty. How to handle and possibly reduce this uncertainty is an important question in climate change impact research, and should be subject to future investigations whose outcomes have to be communicated to the impact research communities."

References not included in discussion paper:

Randall, D. A., and Coauthors, 2007: Climate models and their evaluation. Climate Change 2007: The Physical Science Basis. S. Solomon et al., Eds., Cambridge University Press, 589–662.

Seneviratne, S. I., D. LuÂÍ thi, M. Litschi, and C. SchaÂÍ r, 2006: Land–atmosphere coupling and climate change in Europe. Nature, 443, 205–209.

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van den Hurk, B., and Coauthors, 2005: Soil control on runoff response to climate change in regional climate model simulations. J. Climate, 18, 3536–3551.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 8, 7919, 2011.