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Discussions

Interactive comment on "The critical role of uncertainty in projections of hydrological Extremes" *by* Hadush K. Meresa and Renata J. Romanowicz

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Dear Editor and Reviewers,

Thank you very much for the constructive comments that will help to considerably improve and clarify the manuscript. The reviewers, put enormous effort into proof-reading our paper line by line and trying to clarify all the less-than-satisfactory statements and mistakes. We believe that the input will improve the manuscript significantly. All comments have been addressed point-by-point. Following the reviewers' feedback we will make the corresponding changes in the manuscript. Reviewers' comments are in italics.

Anonymous Referee #2 Received and published: 15 January 2017

Overview

RC. The authors assess the effect of different uncertainty sources on climate change projections. The presentation of the results is easy to follow and interpret. Especially Figure 9 is very informative. However, there is room for improvement using specific comments and checklist below. I recommend major revision as the model calibration part is not clear. AC. We thank the reviewer for concise and valuable comments.

Specific Comments:

RC1. Table 2: Optimal values of some parameters are out of lower and upper limits e.g. CFMAX which cannot be reached by an algorithm e.g. SCEUA, CMAES etc. How was this achieved by a calibration algorithm? Did you follow a manual calibration scheme? AC1.The table 2 is now corrected (the new version is given in AC. 27 of the answers to the 1st reviewer). We do not use deterministic calibration, instead the GLUE -based stochastic calibration is applied. That table was put by mistake.

RC2. Demirel et al (2013a) is in the reference list but not in the text. AC2. Thank you, it has been corrected

RC3. Please explain the abbreviations used at legend in figure caption. The legend of Fig8 is confusing: "distn"? AC3. Thank you, it has been corrected. "distn" replaced by "distribution"

RC4. Did you compare uncertainty in HBV model parameters with other studies (Addor et al., 2014; Demirel et al., 2013b; Osuch et al., 2015) using HBV model for forecasting hydrological extremes? How would the results overlap for 10 day forecast (Demirel et al., 2013b) and long term climate predictions in EUROCORDEX (dataset used in this study)? AC4. The uncertainty in HBV model parameters were compared with the other studies, including Osuch (2015) and Demirel et al (2016b). The latter explored the influence of uncertainty in input, hydrological model parameters and initial conditions on 10-day ensemble flow forecasts. The results show that parameter uncertainty has the largest effect on the medium range low flow forecasts, which is consistent with the present paper findings. Addor et al. (2014) concentrated on the influence of different hydrological model structure, involving three hydrological models, emission scenarios, climate models, post-processing and catchments. Their results indicate that influence of model structure varies with the catchment. However the authors did not take into account hydrological model parameter uncertainty, which is the main focus of the present paper. Osuch (2015) compared three sensitivity analysis techniques to describe the HBV model parameter interactions. We used the output of that paper to eliminated less sensitive HBV model parameters in order to minimize computational cost.

RC5. Fig5: Parameter uncertainty should be presented differently to assess the contribution of each parameter uncertainty to total uncertainty. From this figure the reader can't see the most uncertain parameter. A figure similar to Figure 4 in Demirel et al (2013b) or Fig9 in the current manuscript can be very useful for modelers. This can be easily done as the GLUE results would allow such ranking. AC5. Thank you for the comment. We decided to remove this figure and subsection 4.4 following the first reviewer comments.

RC6. Conclusion 2 (ii): Please explain the drizzle effect? Not clear. AC6. Simulated climate variables (precipitation and temperature) by individual GCMs/RCMs often do not reach agreement with observed climate time series. This is due to the effect of systematic and random model errors of GCMs/RCM simulations. Such systematic errors lead to simulate many drizzle days (i.e., too many days with very low precipitation intensity and too few dry days). The drizzle effect is related to the performance of climate models. It presents itself in the form of frequent rainfall of a very small intensity. The physics behind precipitation generation is very complex and involves processes operating on a wide range of scales. The frequent 'drizzle' is produced mainly by convective parameterization. It appears in many climate models and invokes errors in the intensity and frequency of precipitation (Terai et al. 2016). The correction can be

performed using the number of wet days in a month (Osuch et al. 2016). Because of this bias in precipitation, using direct climate model output as inputs to hydrological modelling for low flow analysis often leads to unrealistic results and therefore bias-correction is required in the case of low flow projections.

RC7. Section 3.6 and Conclusion 5 (v): Is ANOVA method a global or local sensitivity analysis method? Can interactions (parameter etc) be assessed using this method? Why ANOVA is used instead of other elementary and global methods e.g. Morris, SOBOL, PEST, FAST etc. These aspects of the ANOVA method should be described in section 3.6 and conclusions should follow these details. AC7. Nowadays, many global sensitivity methods have been proposed and used, such as Fourier amplitude sensitivity test (FAST), Regional Sensitivity Analysis (RSA), Analysis of Variance (ANOVA), Parameter Estimation Software (PEST), Morris, and Sobol method. Among these global sensitivity analysis methods, ANOVA is proved to be one of the most robust and effective tools to analyze both continuous and discrete factors (Montgomery, 1997), and it is widely applied in hydrology (Bosshard et al., 2013; Zhan, et al., 2013; Lagerwalla, et al., 2014; Addal et al.,2014; Giuntoli et al., 2015; Osuch, 2015). We used ANOVA approach due to its numerical facility (MATLAB) and ability to evaluate the main and interactive effects between factors considered.

RC8. Conclusion bullets are confusing. Two times "iv" exists and sentences are not clear. There are typos too. For example Conclusion vi should start with capital. Please rephrase them with short and clear conclusions. And relate them to the results section. Bullet conclusions in Demirel et al (2013b) can be an example. For each result section one paragraph is given in conclusion. AC8. Thank you, it is corrected in the main manuscript.

References

- Bosshard, T. Carambia, M. Goergen, K. Kotlarski, S. Krahe, P. Zappa, M. and Schar, C. Quantifying uncertainty sources in an ensemble of hydrological climateimpact projections. WATER RESOURCES RESEARCH, VOL. 49, 1523-1536, doi:10.1029/2011WR011533, 2013 - Montgomery, D.C. (1997). Design and Analysis of Experiments. Wiley and Sons Ltd.: New York. - Zhan, Y.; Zhang, M. Application of a combined sensitivity analysis approach on a pesticide environmental risk indicator. Environ. Model. Softw. 2013, 49, 129-140. - Lagerwalla, G.; Kiker, G.; Muñoz-Carpena, R.; Wang, N. Global uncertainty and sensitivity analysis of a spatially distributed ecological model. Ecol. Model. 2014, 275, 22-30. - Addor, N., O. Rossler, N. Koplin, M. Huss, R. Weingartner, and J. Seibert (2014), Robust changes and sources of uncertainty in the projected hydrological regimes of Swiss catchments, Water Resour. Res., 50, 7541-7562, doi:10.1002/2014WR015549. - Giuntoli, J.-P. Vidal, C. Prudhomme, and D. M. Hannah. Future hydrological extremes: the uncertainty from multiple global climate and global hydrological models Earth Syst. Dynam., 6, 267-285, 2015. doi:10.5194/esd-6-267-2015 - Osuch M. Sensitivity and uncertainty analysis of precipitation-runoff models for the middle Vistula basin, in GeoPlanet: Earth and Planetary Sciences, 2015. DOI:10.1007/978-3-319-18854-6-5.

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