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Discussions

Interactive comment on "Future discharge drought across climate regions around the world modelled with a synthetic hydrological modelling approach forced by three General Circulation Models" *by* N. Wanders and H. A. J. van Lanen

Anonymous Referee #4

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Summary

Authors evaluate changes in future droughts on a global scale using a mini-ensemble of three GCMs. WATCH forcing data and GCM outcomes are used to force a conceptual hydrological model. Impacts on drought characteristics are reported for five types of climate. Authors conclude that drought events will be less frequent but more intense.

General

The manuscript reads quite well with only a few minor errors. I am missing a figure showing the locations used for characterising the analysed climates. Also a map showing the relative changes on the globe would make the message of the article stronger.

Major comments

Seasonality effect on hydrological droughts: During winter, snow accumulation limits river flows thus triggering low-flow conditions, during summer we could expect low flows due to lack of rainfall. On a global scale covering different hydro-climatologic systems, where both these processes are observed, I would expect an analysis covering this seasonality. Authors should provide some analysis and discussion on this issue.

Impacts must be analysed in the context of the outcomes. For example, larger and uncertain drought changes are projected for arid and polar climates, however, how relevant are those in terms of potential impacts? This was not discussed by the authors. In addition, authors must discuss the strength of these changes by reporting statistical significance.

After correcting for bias GCM-driven hydrological runs, is surprising to see some striking differences between them and the reference run for the cold-type climates (considering that WFD is used as target for calibration and to force the reference run). This may suggest that either the bias correction or the hydrological simulation is failing during the control period to replicate the reference run. This issue should be properly addressed and discussed by the authors.

Authors must acknowledge that a mini-ensemble of three GCMs will most likely undersample the climate model uncertainty. In addition, a discussion on how well the selected GCMs could span the range of climate predictions could be provided.

Specific comments

P7704 l17, delete "and"

P7704 l21, define GHGs

P7705 l28, which

P7706 l3-14, as written it gives the impression that different bias correction methods were applied on different variables, and using different observation datasets as targets. Please rephrase for clarity

P7706 l20, define SRES A2 scenario. A short description of the A2 scenario should be given

P7707 l25, I would suggest to use a consistent nomenclature in the article. So, Fig1 and eqs 1-6 should refer to the same variable names

P7709 l20-22, I would suggest to briefly report on the performance of the synthetic model just for completeness

P7710, What about persistence of droughts? Is the smoothed time series accounting for frequent short-duration events? Please clarify

P7711, What about frequency of droughts? Will Q80 for control be different than for future time windows? Please clarify

P7711 l20-22, How many of these locations were excluded under this criterion?

P7712 l6, I would suggest replacing the term "scenarios" by "time windows/periods/.." to avoid confusion

P7712 l20, definition of "m" and "n" is not clear

P7713 l3-4, how many locations were selected? 1495?

P7713 l10-14, having defined a minimum threshold of 30 locations per climate region for reliable drought characterisation, what is the explanation to have nearly half (47%) selected locations under snow and polar climates? It would be interesting to see whether projected drought changes in these two climates have a significant impact

P7714 l20-25, P7715 l1-14, it is not surprising that reference and GCM-driven hydrological runs are similar since the latter were bias corrected using WFD as target over the same period. What is surprising is the fact that results show some striking differences for cold-type climates (D/E) even after bias correction, thus suggesting that either the bias correction or the hydrological simulation is failing during the control period to replicate the reference run. This must be addressed and properly explained

P7713 l22, "Sect. 3.2"

P7715 Fig2, I am missing an explanation for the odd behaviour of CNRM around 30 and 120 d duration

P7715 l5-8, most likely both desert and polar climates are related to extreme events, Does this mean that the conceptual hydrological model is rather weak for extreme climate conditions?

P7715-7716, section 4.2, reporting percentage changes respect to the control period is acceptable; however, readers deserve to know how significant these changes are from a statistical point of view. I would suggest testing the significance of these changes. Can these changes be related to a decrease of precipitation in equatorial/warm template climates or D climate becoming colder in the future, thus storing more precipitation as snow?

P7718 l2-3, climate-type D keeps coming back with peculiar results. Authors should aim at explaining these results more in depth

P7718 l26, "main reason"?

P7718 l26-27, what about defining this as "climate model uncertainty"

P7721 l13-14, it wouldn't hurt trying to hypothesise on possible causes for this mismatch

P7721 l25-27, I did not see any seasonal analysis throughout the manuscript so, this sentence may need rephrasing

P7736, fig1 define t and j

P7738, fig3 it might be better to show the relative change/difference with respect to the control period and enlarge the scale of the panels a bit

Recommendation

Based on the above review I would suggest publishing the article after major and minor revisions have been provided.

Interactive comment on Nat. Hazards Earth Syst. Sci. Discuss., 1, 7701, 2013.