Reply to review comments G.A. Corzo:

First of all we would like to thank Professor Clarke for his review comments which helped us improve the quality of our manuscript.

General comments

The paper presents interesting results from the combination of experiments with multiple GCM forcing the PCR-GLOBWB. In general the results for identifying changes in discharge regimes and their patterns are valuable. The paper discusses important conclusions related to the changes in the 21st century that are based on the use of conventional statistics. The comparison of previous research and their individual conclusion is clear and a good piece of the state of the art for the global analysis and climate change research, even if this information shows to have no clear trend or coherence between paper results. It is well known that the high complexity of the results from global modeling makes unreliable conclusions obtained from simple means, maximum or minimum of time series. Not only because they GCM models have high bias and their sensitivity to the initial conditions is high, it is also well known that the hydrological model used will be much more sensitive to weather conditions in some regions of the planet than in others. This is related to how much is one cubic meter in the Sahara and how much is for the Amazonia. So relative local measures or statistics need to be somehow weighted to be able to compare spatial patterns. This will have important variations on the conclusion that might mix the weakness and strengths of the model (which is not calibrated) with the real problem. I believe that the statistical approach used might not be the right decision and pattern recognition techniques on individual spatial analysis should be performed using technique like the ones suggested by the papers of Corzo et al., 2011 or Lloyd-Hughes 2010.

Here we do not completely agree with the review comments. The water balance component of the hydrological model is 1-D (vertical comlumn only). This means that the spatial pattern of the water balance component is influenced by the weather pattern provided by the GCM alone. The interaction between the model cells is limited to the rivervrouting of access runoff.
Within this study we are not interested in the relative size of increases and decreases, as for example "is our decrease in low flow in the Danube comparable to the decrease in the Murray.". We are merely interested in the region and basin specific in- and decreases that can be expected and how these compare to results of earlier studies for the same basins. Therefore we think that a pattern scaling method is not relevant for our conclusions.
The strengths and weaknesses of the model have already be discussed in Van Beek et al. (2011) and we do realize that for several basins the modeled discharge is slightly biased, for example discharge in the drier regions is often overestimated as is the case with other global hydrological models (see Gosling and Arnell (2011)). Yet, by focusing on relative instead of absolute changes the influence of the bias is reduced. And for the interpretation of the relative changes we direct the reader to the plots with the basin specific discharge cycle. The absolute river discharge quantities have a more meaningful value than the local cell specific discharge values which are displayed in the map and the routing plays an important role in the upscaling and aggregation of the local changes to values that are better interpretable by the reader.
We have removed the cells where absolute discharge is close to zero (e.g. less than 0.01 m^3/s) from the manuscript (colored grey), as changes are highly uncertain and have little value in these cells with limited to no discharge.

In my opinion, the paper as it is now requires to better define the limitations and assumption of the approach.

Indeed, the discussion section has been extended with the limitations present in this study which have also been mentioned by the previous reviewers.

Aside of the major and minor comments of the other reviewers, I believe the use of a graphical representation of the experimental process would be of great help.

Good comment, a figure illustrating the experimental process has been added to the manuscript.

References:

Corzo Perez, G. A., van Huijgevoort, M. H. J., Voß, F., and van Lanen, H. A. J.: On the spatio-temporal analysis of hydrological droughts from global hydrological models, Hydrol. Earth Syst. Sci., 15, 2963-2978, doi:10.5194/hess-15-2963-2011, 2011.

Lloyd-Hughes, B.: A spatio-temporal structure-based approach to drought characterization. Int. J. Climatol., doi:10.1002/joc.2280, in press, 2010.