## Reply to review comments B. Fekete:

*We would like to thank the reviewer for his extensive review and the interesting topics he brings forward. To a certain extent we do agree with his general perception that the biases present in current generation GCMs hampers / disables their use in hydrological climate impact analysis. This study even illustrates this, by looking into the (in)consistencies between GCMs. Yet, here we also want to emphasize that we as hydrologists are forced to use what is available and currently GCMs still provide us the best means to assess the future hydrological impacts of climate change.*

### Gerenal comments

Weiland et al. presented a detailed assessment of climate change on the hydrological systems. They carried out global hydrological model simulations using climate forcings from 12 GCM simulations following the 20C3M (contemporary) and A1B (future) emission scenarios. One has to note that the new CMIP5 simulations for AR5 are already available, and this work would be more relevant if the authors used more recent GCM results.

> *Unfortunately the CMIP5 simulations have only recently become available and still they are only in a very limited form provided to the wider public. Due to the computational demanding character of this study we have been working on it over 2011 and at the start of the analysis the CMIP5 simulations were not available yet.*

The findings presented in the paper largely confirm previous similar studies with a few exception. This work will undoubtedly be regarded as important contribution by the majority of the scientific community. Unfortunately, I am probably in the minority, which has serious concerns. Before I delve into my comments, I would like to emphasize, that I came across other works of the presenting authors and I have deep respect for their scientific contributions in the past. My current criticism is targeted more to the scientific community in general than to the authors in particular. According to my understanding, ensemble simulations first were introduced in weather forecast to assess the impact of uncertainties in initial conditions on the predictions. In that context, the same meteorological model is driven by different initial conditions and a suite of simulations are carried out as an ensemble to characterize the robustness of the prediction. Ensemble GCM simulations appear to be a result of model inter-comparison exercises that were carried out to better understand the differences in different GCMs. It is widely realized that the differences between GCMs are often bigger than the change that individual GCMs predict as the authors also pointed out. It is less emphasized that these large differences between GCMs have little to do with uncertainties in the climate system and rather they are clear evidences of the glaring wholes in our current understanding of global circulations.

> *We agree with the reviewer and added a comment on this to the discussion of the manuscript.*
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> "Here one should realize that the uncertainties obtained from the ensemble of GCMs are merely model structural uncertainties, resulting from the still limited understanding of atmospheric processes. They do not represent real world uncertainties. Yet, as real world uncertainties are unknown, the ensemble uncertainties at least provide us with some quantification of the probability of change required for adaptation strategies (Beven et al., 2011)."

The considerable differences between the different realization using the same GCM (presented in the supplement) seem to fly in the face of multi-decadal simulation being a boundary value problem, where the uncertainties in the initial conditions from the present diminishes over time and the dominant forces dictating future climate is the anticipated change in the boundary conditions (such as the geochemical composition of the atmosphere).

> *Indeed over time the difference between the individual realizations of a single decreases, this is illustrated by figure 13a, which show that the consistency on the direction of change between ensemble members of a single GCM (only difference are the initial conditions) is larger than the consistency between single realizations of multiple GCMs.*

At some point, one has to ask the question of what level GCM future simulations can be taken seriously. While GCM undoubtedly capture fundamental processes in the climate system, they are clearly not up to the task to provide quantitative estimates that policy makers could use. GCMs have serious difficulties reproducing the past which led to a whole new "science" of GCM bias corrections, where GCM bias appears to be a euphemism for error. The various approaches that apply the changes derived from the GCM simulations on top of contemporary observed climate are meant to provide future predictions that are somewhat relevant for policy makers. In reality, these "bias corrections" just hide the fact that the underlying GCM simulations are clearly not up to the task of real world application.

> *Indeed, we also illustrated this point by analyzing the ability of a GCM forced hydrological model to reproduce global discharge regimes in our previous paper (Sperna Weiland et al. 2010, HESS) and we therefore do not apply any bias-correction in this study. We feel the possibly biased GCM outputs still provide us with information on the consistency between them, which can be used to quantify the likelihood of change or to illustrate the high uncertainty in regions where the models do not agree.*

In this respect the authors approach to accept GCMs as they are, apply the GCM output in a hydrological model and than look at the differences in the predicted runoff and discharge in a relative term and use that relative change with respect to contemporary observed hydrography is not any better than correcting the climate forcings (air temperature and precipitation) before applying in hydrological simulations. To some degree, one could argue that it is actually worse given the perceived non-linearities in the runoff response. In reality, the hydrological system response is quite linear particularly in wet regions, which leads to a fairly uniform precipitation elasticity of one percent change in precipitation causing 2-3 percent change in runoff, which is the equivalent of a change in precipitation translating the same absolute change in runoff where the runoff ratio is about 1/3 (which is the global average).

In a summary, I have no objection to publish the paper in its present form, which is well written, consistent and informative, but I have strong reservations for taking this word seriously.

> *We do agree that the quality of the current generation GCMs makes the absolute changes obtained from them debatable, yet they are still the best available means to analyze future climate change. We added a comment on this to the discussion:*
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> > "Although the biases present in GCM data hamper reliable hydrological climate change impact assessments (Pielke et al., 2009), they still provide the best available means for assessing future changes (Beven et al., 2011)."