Reply to review comments Materia:

General comments

"Global patterns of change in discharge regimes for 2100" aims to assess a global evaluation of the effect of projected climate change on hydrological regimes, and provides an estimate of the related uncertainties. I would like this manuscript to be accepted after minor revisions. In my opinion, the work is consistent and well-discussed, a few results are significant and I found very interesting the analysis of uncertainties shown in figures 4, 7, 8.

First of all we would like to thank the reviewer for his kind comments and the effort he took in revising the manuscript. We really appreciate his interest in our work. Please find below a step-by-step responds to his comments.

1) In the text (e.g. page 10976, lines 24 and following; page 10993, lines 25 and following) the authors point out the power and reliability of the multi-model ensemble. In my opinion this concept is sometimes overrated in hydrological science: there is no absolute evidence that the ensemble mean of GCMs provides more reliable results than a single GCM. Also, the first assumption for the quality of an ensemble mean is the independence of members, which is not true for coupled models that share parameterization or even components. In a recent paper (Materia et al., 2010 JHM) we took into account these themes, although in not such an exhaustive way. Discussing the effect of an ensemble of land surface models forcing a river routing scheme on its discharge, we pointed out that: (1) the ensemble mean tends to reduce minimum and maximum peaks, and resulting curves of seasonal cycle of discharge are flattened compared to observations. This applies in most of the rivers analyzed in this paper as well: exceptions are Parana (probably because the land surface model poorly represents the Pantanal, where the upper river flows), Yellow River (in which human management plays a crucial role), Zambezi. In the assessment of a variable whose seasonality and amplitude of the peaks play a crucial role, this can be a remarkable limitation of the multi-model technique.

   Indeed there is no absolute evidence that the ensemble mean of the GCMs provides more reliable information. Yet, all GCMs contain information on the atmosphere and possible climate changes. And by using a number of GCMs the available information is combined and as much available information as possible is included in the analysis. Moreover, the influence of discrepancies in single GCMs on the overall calculated direction of change are reduced.

   We added a comment on the use of the ensemble mean and its drawbacks to the discussion of the manuscript:

   > "Although using an ensemble of GCMs for the estimation of future change is often recommended (Boorman and Sefton, 1997; Murphy et al., 2004) previous studies also criticized the use of the ensemble mean change (Materia et al., 2010). By averaging the results of multiple GCMs extremes are reduced, discharge cycles are smoothened and changes become less pronounced. Still, by using multiple models, all available information is considered in the analysis, the influence of discrepancies in single models is reduced and model uncertainties can be analyzed."

2) Globally, two of the models taking part in the ensemble perform better than the multi-model analysis. I am aware that our paper does not go as deep in statistic as Sperna Weiland et al. (2012) do, but in my opinion this matter should be further examined in the discussion.

As part of this analysis we also investigated whether we could find a sub-set of models that outperformed the other models, or at least outperformed the other models in specific regions or for specific catchment statistics (see table 1). Our analysis did not confirm that a sub-set of better performing models exist on the global scale. For all catchment included in this analysis we calculated which model showed least deviation from the historic observed discharge cycle, its mean value and high and low extremes. Table 1 resulted from this analysis, it illustrates the difference in catchment specific top-5's, even for neighboring catchments and catchments with similar size or similar climatic conditions.
Therefore we believe that there is no subset of models (or 2 GCMs) that outperform the other models, at least not for the hydrological variables of interest in this study. A comment on this has been added to the discussion of the manuscript.

Table 1: Catchment specific model ranking based on pre-defined statistics.

Amazone	**MIROC**	Bramaputra	**GFDL**	Murray	**NCAR**	Niger	**HADGEM**
	ERA_CRU		**GISS**		**CCCMA**		**CCCMA**
	CGCM		**MEAN**		**GFDL**		**BCCR**
	ECHAM		**HADGEM**		**HADGEM**		**ECHAM**
	HADGEM		**CCCMA**		**CSIRO**		**CGCM**
Congo	**ECHO**	Danube	**IPSL**	Nile	**GFDL**	Orange river	**CSIRO**
	IPSL		**ECHAM**		**IPSL**		**CGCM**
	MEAN		**MEAN**		**HADGEM**		**IPSL**
	ERA_CRU		**CGCM**		**CSIRO**		**CCCMA**
	CGCM		**ERA_CRU**		**ECHAM**		**GISS**
Ganges	**MEAN**	Indus	**MEAN**	Parana	**MEAN**	Rhine	**HADGEM**
	HADGEM		**GISS**		**CGCM**		**CSIRO**
	ERA_CRU		**BCCR**		**ECHAM**		**ERA_CRU**
	ECHAM		**ECHAM**		**NCAR**		**CSIRO**
	GFDL		**CGCM**		**GFDL**		**CGCM**
Lena	**HADGEM**	MacKenzie	**IPSL**	Volga	**CGCM**	Yangtze	**GFDL**
	IPSL		**MEAN**		**ERA_CRU**		**CCCMA**
	BCCR		**CCCMA**		**MEAN**		**IPSL**
	MEAN		**ECHAM**		**GFDL**		**ERA_CRU**
	ECHO		**BCCR**		**IPSL**		**MEAN**
Mekong	**HADGEM**	Mississippi	**MEAN**	Yellow river	**ERA_CRU**	Zambezi	**CCCMA**
	ERA_CRU		**BCCR**		**CSIRO**		**HADGEM**
	MEAN		**ERA_CRU**		**HADGEM**		**ECHAM**
	GFDL		**ECHO**		**ECHO**		**NCAR**
	ECHO		**IPSL**		**CGCM**		**IPSL**

Specific comments

1) I would discuss a little further two limitations of this study, and more generally of land surface models. First of all water management and river regulation have not been included: this is a limit of present river routing schemes, and on a global scale there is not much we can do. Also, changes in land use are neglected here, but they could be a crucial variable in the future, especially in the context of water cycle.

   We added a comment on this to the discussion:

   > "Furthermore, it should be noted that the hydrological model introduces uncertainties as well, amongst others due to structural simplifications and parameter uncertainties and the absence of anthropogenic influences as for example water use and river regulation (Vrugt et al., 2003; Beven and Binley, 1992; Gosling et al., 2011; Sperna Weiland et al., 2010)."

   A comment on the absence of land use change was already included in section 2.2:

   > "For the future runs possible changes in land use and growing season are neglected."

   Additional comments have been included in the discussion of the revised manuscript:

   > "This study is restricted to hydrological changes due to climate change, for a full assessment of future water availability the impact of climate change on hydrological change should be placed in light of other factors as for example population growth, land use change and water management. The impact of these factors may be comparable or larger than the impact of climate change (Beven, 2011; Vörösmarty et al., 2000; Alcamo et al. 2007; Arnell, 2004)."

2) page 10975, line 12. "As changes...": I don't understand this sentence, maybe you want to get rid of the "as" at the beginning.

   Indeed sentence had to be re-phrased and is now merged with the previous sentence.

3) page 10979, line 7. The concept of "initialization" is not clear in this context, and the whole sentence is a bit vague. Please rephrase being more accurate in the description of the setup.

   Section has been re-phrased and clarified.

4) page 10985, line 4. I don't understand the sentence starting with "Although...". Please rephrase.

   Re-phrased: sentence is merged with previous sentence.

5) Section 3.5. I don't see any figure or table explaining this section, and also I am a bit confused about the meaning of Runoff Coefficient. Please supply this part with definitions and possibly a figure or a table.

In the revised manuscript we refer to the last column of table 4 for the percentage discharge change. The definition of the Runoff Coefficient is now improved in table 2 and the revised text refers to this table.