



## ***Interactive comment on “Climate change and sectors of the surface water cycle in CMIP5 projections” by P. A. Dirmeyer et al.***

**P. A. Dirmeyer et al.**

pdirme@gmue.edu

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### General comments

This paper presents a straightforward but interesting and relevant analysis of projected CMIP5 changes in hydrological quantities and their impacts on meteorological, agricultural and hydrological extremes. It timely points not only at changes in the means of these indicators but also in the interannual variability, affecting predictability and resilience often more than mean changes. The authors acknowledge that the direct link between the analysed indicators (10

> We thank the reviewer for the constructive comments. There seems to be some missing text in the posted "general comments", but we have responded to the specific

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comments below point-by-point.

Specific comments

8538L9: remove a “the”

> The extraneous word has been removed.

8541L11: what does the spatial interpolation to a higher resolution than the native grid imply for the quantification of the modelled extremes? There is a risk of over- or underemphasising extreme precipitation at the grid level.

> This approach was also used in our previous multi-model analyses of CMIP5 data. Our motivation is to avoid the loss of information in the process of interpolation through smoothing, either to a lower resolution grid than some models, or between grids of a similar resolution that are offset horizontally. Obviously the magnitude of extremes, especially positive extremes for non-normal (Poisson or other skewed) distributions like precipitation or streamflow on smaller rivers depends greatly on the total area under consideration. However, as this analysis focuses only on changes to low-order moments (means and standard deviations), the interpolation does not affect the results.

The reviewer does raise a subtle but important point: the results should not be interpreted as being representative of variability on the fine grid, but still at the resolution of the climate models (on the order of 104-105 km<sup>2</sup>) – this is now stated in the last paragraph of Section 2.

8541L21: I can't find such overlapping locations on the map. Can you indicate some areas where this occurs?

> The clearest example in the figure is over the south-central Amazon during JJA – this is now given as an example.

8543: generally RCP4.5 shows a weaker signal than RCP8.5. Can we deduce from this RCP8.5 in the middle of the century is comparable to RCP4.5 end of century,

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assuming a high degree of linearity in the responses?

> That might be a good first-order assumption, but given the non-linearities in the system (e.g., the Clausius-Clapeyron related exponential growth in specific humidity with air temperature that appears to underlie the increase in heavy precipitation paired against the more linear drying of soil with increasing temperature), it would probably be more applicable at larger scales than locally.

8544L5-7: I suggest to swap the colors of the red and blue tones in fig 4: red pointing at low values, blue at high values. Nice plot!

> We have reversed the color scale and we thank the reviewer for the compliment.

8545L12: was land use change accounted for in the analyses? It was imposed in the CMIP5 runs

> We have not tried to separate out the land use change signal from the greenhouse gas or aerosol signals – they are here considered together. Most CMIP5 models did not perform separate simulations with the range of subsets of the climate change forcings, which would have greatly aided such a breakdown. We would point the reviewer to Dirmeyer et al. (2013; doi: 10.1175/JCLI-D-12-00454.1) who found empirical evidence for land use change impacts on land-atmosphere interactions over North America in the last 150 years, and to Kumar et al. (2013; doi: 10.1002/jgrd.50463) who took a more nuanced approach to land use change signal detection.

8547L5-20: I suggest to add a qualitative summary of these factors to table 3

> We have added a summary sentence at the end of the paragraph: "Overall, the greatest increases in agricultural drought frequency appear to affect temperate (mainly European) crops and strictly tropical crops."

8551L20-21: the sentence about amplification is not fully clear to me

> What we try to say is that for soil moisture and runoff there are increases in both dry

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and wet extremes, but for soil moisture the dry extremes predominate while for runoff the wet extremes are more numerous. We have rephrased the sentence to try to clarify this.

8552L1: suggest to add “precipitation” after “mean”

> We have changed "a decrease in the mean" to "decreased mean precipitation".

8552L17: sentence is not correct

> A word was missing. It should read, "...precipitation is projected to change..."

Fig 4: the caption could mention that every symbol represents a single grid point. How about overlapping symbols: is the symbol size small enough?

> We have added a sentence to the caption: "Each mark is a grid box on the interpolated high-resolution grid." We experimented with a range of symbol types and sizes and the current configuration appears to allow the most underlying symbols to show through without the sparser symbols becoming too small to be clearly visible. There is generally good separation of changes in IASD as a function of changes in the mean, so the overall message of the figure is not misrepresented.

Fig 7 11: text on x-axis is unreadable; grey triangle in fig 11 does not show on my hardcopy

> We admit Figs 7-9 are rather crowded. Zooming the page in the PDF viewer works well, but the printed version is not easy to read. We have increased the size of the text in Figs 7-9, adjusted the size of some of the elements of the figure and thinned some of the labels to improve readability.

For Fig 11 we have applied a gamma correction to bring out the faint colors.

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