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Comment

# ***Interactive comment on “Expansion of global drylands under a warming climate” by S. Feng and Q. Fu***

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Response to the comments on manuscript acpd-13-14637-2013

We would like to thank both reviewers for their comments and suggestions on our paper entitled "Expansion of Global Drylands under a Warming Climate", which are very helpful to improve the presentation of our paper. We have addressed the issues that both reviewers raised, and considered their valuable suggestions and comments in the revisions. The following are our point-by-point responses.

Reviewer #2

Summary

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This paper shows global drylands have increased over the last 60 years, and are projected to continue increasing through the 21st century. Under a high-GHG scenario (RCP8.5), global dry lands are projected to increase by 10%. Such a climate change signal is important for several reasons, most notably because more people will be affected by water scarcity.

Overall, the paper is well-written, the figures are clear and communicate the important results. The main conclusions are important and sufficiently novel.

I recommend publication in ACP pending a few minor edits.

#### Minor Comments

At first, it is unclear why the precipitation climatologies are adjusted (Section 2.1). Perhaps a sentence can be included to explain why this was done? I assume it is due to the use of different precipitation (CPC/UD) and PET (GLDAS) data sources. If so, why not just use precipitation and PET from GLDAS? GLDAS precipitation is based on observations, correct?

Response: The climatology from the two datasets is slightly different because of different number of observations and different spatial interpolation methods were used (New et al., 2000). We adjusted the datasets with the same climatology in order to focus on the temporal variations and long-term trends. We adjusted the UD dataset simply because CPC is updated in near real time while the UD doesn't. Several sentences were added to clarify these points.

The GLDAS precipitation is originally from the NCEP-NCAR reanalysis and is then adjusted based on the gridded precipitation from the Climate Research Unit (CRU) of the University of East Anglia. So it is an assimilated dataset based on observations. Additionally, because the CRU prioritizes spatial coverage, in areas of sparse station coverage, the 1961-1990 climatology is used (which introduced prior to the gridding operation) to ensure every land cell has a value for every time step. As a result of these

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gridding strategies, the face values of CRU precipitation in some arid and hyper-arid regions were filled using the climatological mean for part or even the entire studying period. This suggested that the CRU data, and hence the GLDAS precipitation, might be problematic when used to investigate the change of drylands. Therefore, it is better to use the CPC/UD precipitation instead using the GLDAS precipitation.

Related to the prior comment, why are the model climatologies adjusted to observations (Section 2.3)? Just to aid with the interpretation of the figures? Such a modification should simply shift the trends up or down, not change the magnitude of the trends (Page 14643, Line 25), correct?

Response: The model climatologies were adjusted to observations in order to focus on their temporal variation and long-term trends. Yes, such a modification does not change the magnitude of the trends. A few sentences were added in the text to clarify it.

Why is only one realization for each model used (Section 2.3)? Some models have up to 10 realizations, so the authors are not using a lot of the available model data. The projected signal seems pretty clear, so adding the additional runs will likely not change anything.

Response: We agreed that using all the realizations in individual model would not change the conclusions. By doing so, however, the models with more ensemble runs will be given more weight to the final results. For a fair comparison of the model performance and also to evaluate the agreement of the model projections (e.g., Fig.7), it is better to use only one realization for each model.

I'm curious about a natural variability component. At Page 14643, Line 10, the authors mention this point. Is the simulated natural variability of global dry lands large? For example, what does Figure 3 look like if each realization is plotted? Do some realizations show a decreasing trend? Is there significant decadal variability, perhaps related to the PDO or AMO?

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Response: Adding the temporal variations in the areal extents of drylands in individual model in Fig. 3 makes it unclear. By examining such plot, we see that the areal extent of drylands in individual model show considerable decadal variations, which might be related to PDO or AMO in the model. However, no consistent decadal variations are simulated among the models as expected, so those internal variations were canceled when computing the ensemble mean. The plot also suggested that one model shows a decreasing trend in total dryland area for RCP8.5, which is summarized in page 14645, lines 20-23. Since plotting temporal variations in the areal extent of drylands from individual models adds little information but make the figure unclear, it might be better to just show the ensemble mean along with the model uncertainties as we did in Fig.3.

I'm also curious if there is a hemispheric asymmetry in the expansion of global dry lands?

Responses: We examined the expansion of drylands over the Northern and Southern Hemisphere. Though the areal extent of drylands is smaller in the southern hemisphere, the two hemispheres showed similar expansion in drylands.

Grammar

Page 14638, Line 5. “: : :have expanded in THE last sixty years: : :”

Page 14639, Line 8. “: : :have expanded in THE last sixty years: : :”

Page 14641, Line 7. “: : :irregularly with several years behind: : :” is confusing. I assume you mean that they are not updated in real-time?

Page 14646, Line 18. Perhaps place Fig. 6 as panel c in Fig. 5, to aid visual comparison?

Page 14649, Line 12. I think you mean “: : :which IS likely to expand: : :”

Page 14649, Line 22. I think you mean “: : :which accentuates the urgent NEED to

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develop: : :”

## Figures

Please add units to Fig. 3 (percent).

In the caption of Fig. 5, panel c is referenced, but does not exist. I think you mean, “and (b) same as (a) but to: : :”

All above suggestions on grammar and figures were followed in the revised paper.

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