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Hydrology and Earth System Sciences
Discussions

Interactive comment on "Rain or Snow: Hydrologic Processes, Observations, Prediction, and Research Needs" *by* A. A. Harpold et al.

Anonymous Referee #1

Received and published: 7 October 2016

This review paper is an essential contribution to the science of understanding precipitation phase and improving our understanding of water resources. I expect this paper will be highly cited and circulated in the community and reviewed by funding program managers and modeling groups interested in improving hydroclimate at various scales (from small-scale hydrologic models to global climate models). This paper summarizes a number of key points and areas for improvements for understanding basic physics and improving our modeling of the hydroclimate. Moreover, the information is well written, presented clearly and concisely, and of high grammatical quality. I only have a few minor suggestions and typo changes to improve the manuscript.

Specific comments:

1) Line 21: Change "The review" to "This review" or "Our review". The previous sen-

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tence structure made it unclear which review is being referred to and required the reader to go back to the previous sentence wondering what review is being mentioned.

2) Line 184: either here or elsewhere, it should be mentioned that it is important to validate these microphysics (or other properties if you move this to the discussion) over various land surfaces / types. A microphysics scheme that performs well in Iowa (flat prairie) may not perform well over Idaho (complete mountain terrain) or the Oregon Cascades (coastal warm snow).

3) Line 248: The "(" should be moved to before 1967 based on how the reference is integrated into the sentence

4) Line 303: need parenthesis instead of brackets

5) Lines 433, 601: a space is needed between references

6) Line 583: what is meant by "performing the best"? The best precipitation over mountains? Lowest errors in climatology? Lowest errors in variability? Please clarify.

7) Line 641: "too" not "to"

8) Line 783 and Figure 3: The authors should consider adding an accompanying western U.S. climatology map of humidity to show it has significant spatial variability (implied by the statement here and similar ones elsewhere, but not presently shown).

9) Conclusion/Discussion: I would like to see a paragraph added here or in the previous section (5.6) discussing the implications of this review / points raised for findings from climate change studies focused on snowfall. For example, there are several done at the global scale / continental scale (O'Gorman 2014; Cayan and Pierce. 2013; Kapnick and Delworth 2012). These studies present large-scale changes in snowfall mainly due to temperature (all use temperature-based metrics for phase partitioning), but based on this review, miss the non-temperature induced sensitivity of phase type, likely with nonlinear consequences. Should the changes found in these studies be expected as the temperature signal at some point overwhelms all other signals? Or might the

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differences due to climate change be non-linear in all cases? A nice final point of this manuscript would place this study within the framework of these larger scale studies / findings as it is implied that reviewing and exploring phase type will have consequences for understanding future water availability and change.

10) Figure 1: The arrows and curly bracket should be changed to be a different color (not grey) to provide contrast. Perhaps red or blue? They presently do not stand out easily / show the movement of information as presently shown. A more contrasting color choice will make this figure easier to read and understand.

References

Pierce, D.W. and Cayan, D.R., 2013. The uneven response of different snow measures to human-induced climate warming. Journal of Climate, 26(12), pp.4148-4167.

Kapnick, S.B. and Delworth, T.L., 2013. Controls of global snow under a changed climate. Journal of Climate, 26(15), pp.5537-5562.

O'Gorman, P.A., 2014. Contrasting responses of mean and extreme snowfall to climate change. Nature, 512(7515), pp.416-418.

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