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Hydrology and Earth System Sciences
Discussions
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Interactive comment on "Recent climatic, cryospheric, and hydrological changes over the interior of western Canada: a synthesis and review" *by* C. M. DeBeer et al.

Anonymous Referee #2

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Overall Response

The review component of this work is well researched and well presented, although some gaps are apparent and some literature has been missed (see details below). Nevertheless, this manuscript falls short with respect to the synthesis component. Although the authors do a good job of painting an overall meta-picture of cryospheric change, they fail to synthesis an overall system response, particularly as to why unambiguous cryospheric changes have not manifested into detectable hydrologic (i.e. streamflow) changes. Going into greater depth on this last issue would be of far greater relevance to a hydrology audience. Right now all the authors have to offer is the rather

flaccid statement "How watersheds respond to this change is being actively pursued within CCRN by improving our process-based knowledge of these systems combined with diagnostic testing and prediction using numerical models". There is enough research between MAGS, BOREAS, DRI, WC2N, IPY and IP3 that the authors should be able to at least offer a rudimentary outline of potential or proposed linkages between cryospheric and hydrologic change.

As it currently stands, this manuscript is predominantly a review article, the content of which overlap substantially with the recent review of cryospheric changes presented in Derksen et al. (2012). Although one could argue that by using alternative data sources, this work serves to present additional evidence of, and therefore, increases the robustness of any overall conclusion of "unambiguous changes in temperature, snow and ice", that alone isn't enough to merit this as a standalone piece of publishable work, particularly in a hydrology-focused journal. In its current form this manuscript is a failed opportunity to both point out knowledge gaps in process understanding linking cryospheric and hydrologic change, and provide guidance regarding priority research questions for an important region of Canada.

Detailed Comments

Page 8618, Line 26: Use Stewart et al. (2011) as a reference for the DRI network.

Page 8618, Line 29: I also could not find a reference for the IP3 network, but a link to the website would be collegial

Page 8620, Lines 5-9: Showing a map of station density here would be quite compelling (see example figure 1 which shows the locations of AHCCD precipitation stations. The figure was extracted from presentation given by Éva Mekis at the DRI Precipitation and Drought Indices Workshop, Toronto, April 30, 2009, http://www.drinetwork.ca/09precip/mekis.pdf).

Page 8620, Line 11: Clarify that the CANGRD data set is a product of Environment Canada. The readers should also be referred to http://open.canada.ca/data/en/dataset/3d4b68a5-13bc-48bb-ad10-801128aa6604 for the data source and description. Nevertheless, CANGRD is no longer a readily available product, so some additional text should be devoted to the methodology behind it (i.e. what interpolation technique).

Page 8631, Line 8: Is the assertion ". . . and our own analysis . . ." backed-up be submitted or published research. If not, then either include the relevant work in the manuscript or remove this statement.

Page 8638, Line 8: The acronym CALM is not defined.

Page 8646, Lines 21-22: Include a reference to Adam et al. (2006). Also, Luce et al. (2013) give an example of how misrepresenting high-elevation precipitation trends results in an apparent paradox between observed annual streamflow and precipitation trends in the Pacific Northwest.

Page 8646, Section 9.1: The very recent climate data comparison work of Rapaić et al. (2015) for the Canadian Arctic is highly relevant to any discussion of climate data uncertainty and should be cited.

Page 8648, Lines 11-16: For a hydrology journal, this rather superficial explanation is insufficient. There is enough research to delve deeper into this issue (see following comment).

Pages 8647 – 8649, Section 9.2. Use results from WECC sites (and additional research from other regions) to delve a bit deeper into how hydrologic system responds (or is expected to respond) to climatically-driven cryospheric trends. For example, what is the importance of 1) permafrost and groundwater interactions and feedbacks (e.g. Ge et al. 2011; Walvoord et al. 2012); 2) Soil moisture, evaporation and changes in growing season length; 3) lakes & wetlands and the effects of intermittent connectivity, dynamic drainage area and closed drainages (e.g. Shaw et al. 2012; Brannen et al.

2015); 4) the presence (or absence) of glaciers and streamflow response to climate change/variability (e.g. Fleming and Clarke 2003); and 5) the spatial heterogeneity (lateral and vertical) on hydrologic response to climate change/variability in mountainous terrain (e.g. Fleming et al. 2007). In other words, what do we currently know about processes linking the cryosphere and hydrology, how complete is this picture, and what are the knowledge gaps?

Figure 2 through 4: Are the dots representing statistically significant trends missing? Or are their simply no statistically significant trends in any of these figures?

Figure 6: It is difficult to read the text in this figure.

References:

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Ge, S., J. McKenzie, C. Voss, and Q. Wu, 2011: Exchange of groundwater and surface-water mediated by permafrost response to seasonal and long term air temperature variation. Geophys. Res. Lett., 38, L14402, doi:10.1029/2011GL047911.

Luce, C. H., J. T. Abatzoglou, and Z. A. Holden, 2013: The Missing Mountain Water: Slower Westerlies Decrease Orographic Enhancement in the Pacific Northwest USA. Science, 342, 1360–1364, doi:10.1126/science.1242335.

Rapaić, M., R. Brown, M. Markovic, and D. Chaumont, 2015: An Evaluation of Temperature and Precipitation Surface-Based and Reanalysis Datasets for the Canadian Arctic, 1950–2010. Atmosphere-Ocean, 53, 283–303, doi:10.1080/07055900.2015.1045825.

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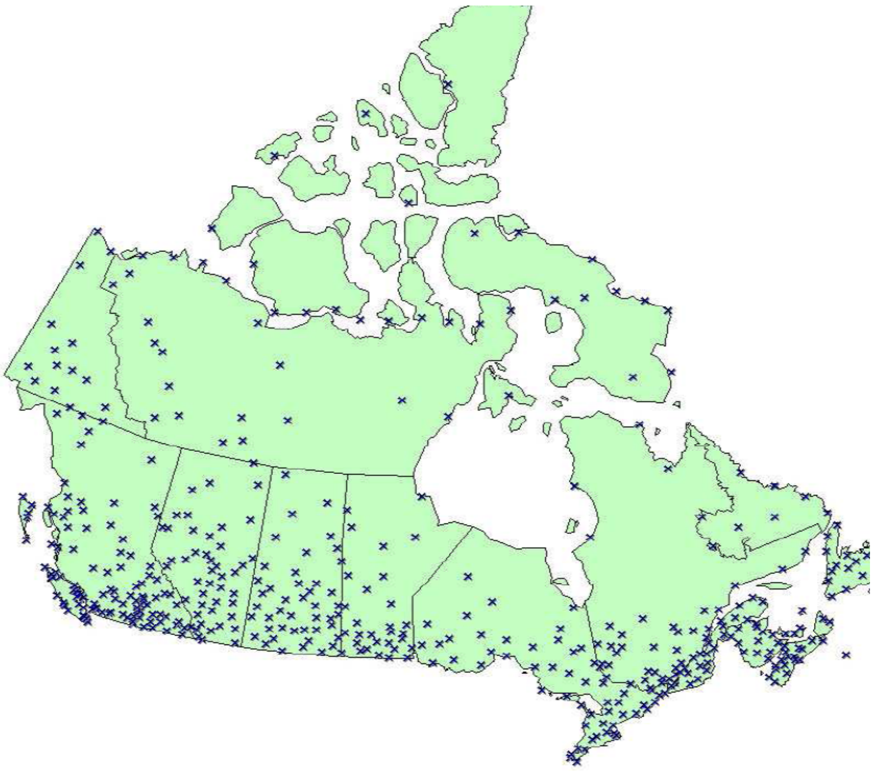

Fig. 1.