

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 #1

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General Comments:

This paper sets out to provide a synthesis and review of climatic, cryospheric and hydrological changes over the interior of western Canada. The review aspect is handled reasonably competently (with some updating needed in some sections), but the paper does not really provide much synthesis and new insight from the research carried out in CCRN. My recommendation to the authors is develop a more concise version of this paper and place most of the material in the current paper in “Supplementary Material”. The observed changes can be summarized in a single Table and key graphics, with the discussion organized along thematic lines e.g. drivers of change, response and inter-

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actions of the regional hydroclimate, important feedbacks and linkages, key knowledge gaps for providing relevant information for decision makers. As it stands, the paper is largely an update of the IPY paper of Derksen et al. (2012) and does not make a significant contribution to the scientific literature.

Detailed comments:

- The Abstract lacks quantitative information coming out of the review. The claim that the paper provides an integrated review of observed changes is somewhat presumptuous. The phrase “further diagnosis is required...” is vague. Diagnosis of what? What are the key issues undermining confidence? Suggest you also change “predictions” to “projections”.

- P. 8617 lines 12-13: This statement needs nuancing a bit. It is true of recent satellite-based datasets but not of reanalyses and in situ climate data. Perhaps a more general statement along the lines of “Observational datasets are of varying length with most of the satellite-derived information covering a relatively short period of record. Evaluating change across datasets is challenging as data may not be homogeneous, may reflect different spatial and temporal scales (e.g. in situ observation versus a satellite-derived spatial average), and may be responding to different processes (e.g. snow depth observations made in open areas at climate stations will not capture the influence of changing vegetation on snow cover).”

- P. 8618 line 25-30: What about the CNRCWP network?

- P. 8620 lines 10-11: This reads like you interpolated the data to generate CANGRD! I think you need a bit more documentation for CANGRD. Unfortunately the available online documentation for CANGRD is rather poor. However, here is how it was described in Rapaic et al. (2015): “The reference dataset chosen was CANGRD because it includes the latest version of the Adjusted and Homogenized Canadian Climate Data (AHCCD) from Mekis and Vincent (2011) and Vincent et al. (2012). The CANGRD dataset uses optimal interpolation of station anomalies combined with high-resolution

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thin-plate spline estimates of the monthly mean field to obtain gridded monthly values at a nominal 50 km resolution (Milewska & Hogg, 2001; Milewska et al., 2005; Zhang et al., 2000).” You can get the refs from Rapaic et al. Rapaic, M., Brown, R., Markovic, M., & Chaumont, D. (2015). An Evaluation of Temperature and Precipitation Surface-Based and Reanalysis Datasets for the Canadian Arctic, 1950–2010. *Atmosphere-Ocean*, 53(3), 283-303.

- P. 8622 Section 2.3: The material referenced in this section seems rather dated. I suggest you contact Xuebin Zhang at Env Canada to see if there have been any more recent analyses of extremes carried out for Canada. The recent paper by Casati and de Elia (2015) would be relevant. Casati, B., & de Elia, R. (2014). Temperature Extremes from Canadian Regional Climate Model (CRCM) Climate Change Projections. *Atmosphere-Ocean*, 52(3), 191-210.

- P. 8622: It would be useful to point out the linkages between an increasing frequency of winter warm spells and hydrology in this section. Winter warm spells also impact snowpack properties (e.g. formation of ice layers) with important ecological consequences. I think this is discussed in the other Callaghan et al (2011) paper. Callaghan, T. V., Johansson, M., Brown, R. D., Groisman, P. Y., Labba, N., Radionov, V., ... & Wood, E. F. (2011). Multiple effects of changes in Arctic snow cover. *Ambio*, 40(1), 32-45.

- P. 8624 Change Heading 3.1 to “Adjusted precipitation datasets for Canada”. The precipitation data were adjusted for systematic changes in procedures and instrumentation but they were NOT homogenized (i.e. consistency evaluated through comparisons with surrounding stations).

- P. 8624 lines 15-17. Clarify the text to avoid giving the impression that this project carried out the interpolation of station values in CANGRD.

- P. 8624 Section 3.2: The recent paper by Rapaic et al. (2015) is relevant to this section. They found that CANGRD gave increasing precipitation trends that were two

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times higher than other datasets.

- P. 8625 lines 20-21: Vincent et al. (2015) updated the climate trends presented in Zhang et al (2000). You should be citing the results from the recent paper.

- P. 8631 line 16. Replace “They found. . .” with “He found. . .” to be consistent with the reference. The Derksen et al (2004) paper is probably more relevant than Brown (2000) as their study region over central NA approximates your region of interest. Their March SWE series suggests the region went through an extended period of above average SWE from about 1945 to 1980. Derksen, C., Brown, R., & Walker, A. (2004). Merging conventional (1915-92) and passive microwave (1978-2002) estimates of snow extent and water equivalent over central North America. *Journal of Hydrometeorology*, 5(5), 850-861.

- Section 4.2: This section is well written but the linkages need to be highlighted between changing snow (e.g. earlier melt onset, changing melt dynamics, winter melt events, changing snowpack properties) and hydrology, permafrost etc. What is happening to the vertical gradient in SWE over the mountains? How are changes in the solid/liquid fraction of precip affecting runoff amount and timing? What does a shorter snow season mean for soil moisture and ET?

- no comments on following sections.

- Section 9.2: I was expecting more synthesis here and less restating of findings from the various sections. What significant insights have been obtained on climate-cryosphere-hydrology linkages and understanding from CCRN research? What are the key gaps in the science that need to be addressed to meet user needs? What are the user needs?

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