The Cryosphere Discuss.,
https://doi.org/10.5194/tc-2017-157-AC1, 2018

The Cryosphere Discussions
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Interactive comment on "Assessment of Snow, Sea Ice, and Related Climate Processes in Canada's Earth-System Model and Climate Prediction System" *by* Paul J. Kushner et al.

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Received and published: 3 February 2018

General comment: Thank you for the feedback on this paper and the suggestions, which led to an improved manuscript. The major change suggested was to include more information on the snow cover extent (climatology), and we have accordingly revised Figure 3 to include observed and simulated SCE. A general point we will mention is that this overview of the system's performance was kept concise to establish a baseline for future model versions.

Specific comments/replies:

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Discussion paper

RC: This is a well-written and useful record of how well snow and sea ice are simulated in an earth-system model and a related seasonal prediction system, albeit with rather brief discussions for the large number of figures shown.

Reply: Thank you for the kind feedback. We attempted to keep the discussion concise with the aim of establishing a baseline record of this system's performance.

RC: There should at least be references to how the land surface components of CanSIPS and CanESM2 represent snow, and any differences between them.

Reply: Thank you for this suggestion. This is addressed in the revised text, where we have provided more detail on the component models in CanESM2, CanCM4, and CanCM3.

Changes to the manuscript: component models of CanESM2, CanCM4, and CanCM3 are listed and relevant citations included.

RC: Without a figure showing annual cycles in snow cover extent, it is hard to judge how (physically) significant the trends in Figure 4 are. It would also be nice to see some time series of modelled and observed SCE to judge the trends and variability.

Reply: Thank you for pointing this out. We have added two rows to Figure 3 showing the seasonal cycle of SCE and used this to calculate the relative size of the observed changes in SCE in the discussion of Figure 4. We decided not to add additional time series of SCE since these trends are discussed extensively in Mudryk et al. (2017) and Mudryk et al. (in review, https://www.the-cryosphere-discuss.net/tc-2017-198).

Changes to manuscript: Figure 3 (attached to this reply) expanded to include snow cover extent (SCE) and description of Figure 4 discusses magnitude of changes relative to climatology.

RC: A reference could be added in the conclusions for the design of LS3MIP (https://www.geosci-model-dev.net/9/2809/2016/).

Reply: Thank you, added.

Change to manuscript: Reference added.

RC: Figure 5: information that the IQR of observations is based on 5 datasets is repeated twice. Colour is redundant in this figure.

Reply: Thank you, corrected. We chose the coloring to distinguish the observations from the models.

Change to manuscript: Figure caption corrected.

RC: Figure 6: information that spatial means of trends have not been removed is repeated twice.

Reply: Thank you corrected.

Change to manuscript: Figure caption corrected.

RC: Figure 8: the latitude numbers could be rotated to be upright. Stating that the ORCA1 grid will be used without explanation or reference is not helpful.

Reply: Thank you, change to figure made and caption corrected.

Change to manuscript: Figure slightly modified and caption corrected.

RC: Figures 11 and 14: contours are labelled, but colour bars would be helpful.

Reply: Thank you, however in our view, the colors are intended to help distinguish features, but since contours are labelled and described in the caption we decided not to include a colorbar.

Changes to manuscript: none.

Interactive comment on The Cryosphere Discuss., https://doi.org/10.5194/tc-2017-157, 2017.

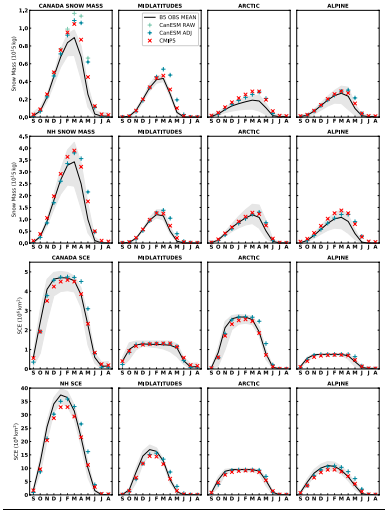

Figure 3: First row: seasonal cycle of NH 1981-2005 snow mass (in 10^{15} kg) for regions defined in Mudryk et al. 2015: midlatitudes – Northern Hemisphere nonalpine land regions south of 60°N, Arctic - nonalpine land regions north of 60°N, and alpine. Gray shading represents the range of Blended-5 datasets, the black curve represents the Blended-5 mean, the light teal points (in the first column of the first row only) mark the ensemble mean of CanESM2 using its land mask, and the dark teal points mark CanESM2 adjusted to represent the same land fractions as the observational mask from the Blended-5 dataset. The CMIP multi-model mean, adjusted to the observational mask, is show with red x symbols. The legend in the second column top row applies to the figure as a whole. Second row: as in top row, but for Canadian land mass only. Third and fourth rows are similar to the first and second rows, but for snow cover extent in 10^6 km^2. The estimate of observed snow cover extent is derived from the Blended-5 SWE dataset using the approach of Mudryk et al. 2017, and is based on a 4 mm SWE threshold for the presence of snow cover; the simulated snow cover extent is based on snow cover fraction directly produced by the models.

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Fig. 1. Revised Figure 3 for revised ms.