The Cryosphere Discuss.,
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The Cryosphere Discussions

Interactive comment on "Brief Communication: Widespread potential for seawater infiltration on Antarctic ice shelves" *by* Sue Cook et al.

Anonymous Referee #1

Received and published: 20 August 2018

Review Summary: This manuscript presents an analysis of potential widespread nature of seawater infiltration into the firn of Antarctic ice shelves. The analysis utilizes the IMAU firn densification model forced by RACMO2.3 at the surface to assess the depth of three density horizons as being potentially permeable and thus enabling liquid water infiltration. When these horizons exist below sea level (assessed by differencing the FDM-determined density horizon depths with the Bedmap2 surface DEM), the authors characterize ice shelf areas as being potentially susceptible to ocean water infiltration. The authors appropriately acknowledge and quantify sources of uncertainty with the FDM, DEM, and density thresholds for permeability. Comparisons are made with available borehole and radar observations indicating and suggesting brine infiltration. Finally, the authors discuss the potential implications of brine infiltration and

mechanisms promoting or limiting the process. Although there are substantial (and well-acknowledged) uncertainties in the analysis, I believe this paper is well-crafted and identifies a process that is important, but typically overlooked in the analysis of Antarctic ice shelf stability. As such, I believe the paper should be published in The Cryosphere following relatively minor revisions.

My largest concern is with the comparisons with the validation datasets. These analyses are very qualitative in nature and I do not believe the authors suggest which density threshold for permeability is most likely to be correct. I suggest the authors more quantitatively present statistics related to the ground truthing (e.g., agreement, commission, and omission errors). Strengthening this side of the analysis would benefit the ice sheet modeling community and make the paper more impactful. Another concern is with the usage of the Bedmap2 DEM as the reason for its inclusion versus another DEM is not presented in the paper. Assessment of another DEM would be relatively straightforward and might offer insight into how much uncertainty is attributable to DEM choice. Finally, I offer some specific suggestions below on text and figure presentation.

Specific comments:

P2 Line 1 (and again near the end of the paper): The link to hydrofracturing is a bit unclear. Could you please describe in a sentence or two how bottom-up brine infiltration could contribute to (presumably) top-down hydrofracture?

P2 Line 28: Could you please add a citation for the 15% error associated with the FDM data?

P3 Line 11-12: This sentence is unclear, could you please restate it?

P3 Line 23+ and Figure 2: Areas of positive radar-derived brine identification are not clear. Are these the bold lines on Wilkins, whereas radar obs with no brine are thin lines? What about on McMurdo? What are the dashed lines? The labeling does not appear consistent between the subfigures. Please consider redrafting this figure to

make this clearer.

P5 Line 28: I don't believe this statement is fully justified. As the authors acknowledge, increased basal melting would draw down the surface of ice shelves, which will likely be experiencing increased surface melt (as indicated by the referenced Kuipers Munneke paper, as well as more recent studies). The Kuipers Munneke paper documents ice shelves likely to have exhausted their firn air content (FAC) by century's end. I would suggest the authors at least cross reference their results of brine infiltration with the areas that the Kuipers Munneke paper suggests will have their firn exhausted. Are the regions of potential brine infiltration also in areas where FAC will be exhausted? If so, this would suggest that brine infiltration is not likely to expand because ice shelves will be denser. The authors could add a sentence or two here with the results of this analysis, and it might provide information where brine infiltration will or will not be most likely in the future.

Figure 1: Could you also add error bars to the column plots?

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