The Cryosphere Discuss.,
https://doi.org/10.5194/tc-2018-65-RC1, 2018

The Cryosphere
Discussions

Interactive comment on "Brief communication: Impact of the recent atmospheric circulation change in summer on the future surface mass balance of the Greenland ice sheet" *by* Alison Delhasse et al.

Anonymous Referee #1

Received and published: 6 May 2018

Overview

This manuscript examines the inability of GCMs to reproduce recent high-latitude Northern Hemisphere circulation changes and the effect this has on model projections of future GrIS SMB. They force the MAR regional climate model with a number of different reanalysis and GCM boundary conditions, provided by the ERA-Interim reanalysis and three GCMs for the past climate and by the GCMs for the future climate. These sensitivity experiments ultimately show that GrIS SMB will be subject to much more significant future decreases if the recent (post-2000) shift toward negative sum-

mer NAO continues. They also show that GCMs that project temperature increases but do not capture recent circulation changes show a smaller decrease in SMB.

Overall, this work makes a useful contribution to our understanding of the effect of circulation changes on GrIS SMB and how well this is reproduced in GCMs. There are a few minor problems with the authors' characterization of recent circulation changes and the presentation of their methods and results. These issues and the recommended corrections are described in detail in the specific comments below.

Major comments

In the introduction, the authors partially attribute the recent increase in GrIS melt and mass loss to an increase in incoming solar radiation (p. 1–2). Similarly, in section 3.2 (p. 6), they state that "The current observed melt increase since the 2000's is partly due to the increase in downward shortwave radiation (SWD) caused by more frequent anticyclonic situations enhancing the melt-albedo feedback". In both cases, a single reference (Hofer et al., 2017) is provided. However, that study's claim – that decreasing summer cloud cover is driving the recent GrIS mass loss acceleration – is contradicted by a number of other works, which have demonstrated the important role of clouds and poleward moisture transport in providing melt energy during summer melt events. See, for example, see the Bennartz et al. 2013, Van Tricht et al. 2016, and Solomon et al. 2016 papers that show that clouds enhanced melt and/or reduced meltwater refreezing during recent major melting events. Also see the Neff et al. 2014, Bonne et al. 2015, Fausto et al. 2016, and Mattingly et al. 2016 papers, which together show that poleward moisture transport played a critical role in forcing the extreme July 2012 GrIS melt event, and that these types of moisture transport events have increased during the same 2000–2016 period discussed in this study.

The paper should be modified to more fairly reflect the breadth of the literature on this topic, noting that while one paper found a decreasing trend in summer cloud cover after 2000, most other studies on the topic have pointed to the key role played by poleward transport of warm, moist air and the resultant cloud cover in forcing GrIS melt events. Including this information will also help align the characterization of recently observed circulation changes with the authors' statement that "both simulations forced by warmer reanalysis suggest a SWD decrease as well as in GCM-forced simulations with a warmer climate as a result of an increased cloud cover... This effect combined with a higher free atmosphere temperature explains then the increase in downward longwave radiation (LWD) in a warmer climate" (p. 6, lines 9–12).

Section 2.2.1, p. 3: More detail is needed here about the ERA-Interim atmospheric temperature forcing. Are the ERA-Interim atmospheric temperatures increased in a uniform manner at all vertical levels? Are they only increased near the surface? Or are they increased at 850 hPa, 700 hPa, 600 hPa, and 500 hPa, in a manner analogous to the temperature anomaly calculations for the GCMs (section 2.2.2)?

Figure 2 should be altered to include both positive and negative SMB anomalies (Fig. 2a) and differences (Fig. 2b) on a diverging color scale (like Figures S5 through S7 in the supplement). In addition to the areas of negative SMB anomalies / differences along the margins of the GrIS, the color scale is likely concealing areas of less intense positive anomalies / differences in the interior GrIS.

How is the statistical significance of anomalies calculated? (i.e. pg. 4, line 22; pg. 6, line 2)

The manner in which SMB anomalies in the experiments are discussed is confusing. On pg. 5 (lines 4–10), the SMB anomalies in the MARera2K+x experiments are described as having "significantly more negative" SMB anomalies and an "enhanced decrease in SMB" compared to the warmer reanalysis and GCM-forced experiments. However, in the Conclusions (pg. 7, lines 27–31), the SMB anomalies in the experiments with warming and a circulation change (i.e. the MARera2K+x experiments) are first described as having SMB anomalies that are "two times higher on average", then are described as having a "higher decrease in SMB". The language in the Results

and/or the Conclusions should be edited to be consistent, and to make the nature of the SMB anomalies clarified.

Minor comments

p. 1, l. 10: change "is similar" to "are similar" p. 1, l. 13: change "atmospheric conditions will persist" to "atmospheric conditions persist" p. 1, l. 20: change "have been attributed" to "has been attributed" p. 1, l. 21: misspelled "heighten" p. 2, l. 1: change "solar radiations" to "solar radiation" p. 2, l. 7: change "rises" to "raises" p. 2, l. 18: change "relatively" to "relative" p. 2, l. 19: change "consists in" to "consists of" p. 2, l. 20: change "radiations" to "radiation" and "precipitations" to "precipitation" p. 4, l. 8: change "Like with" to "As with" p. 7, l. 19: change "First experiments consisted in" to "The first experiments consisted of" Supplement: change "relatively" to "relative" throughout Table S2

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