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The Cryosphere Discussions

Interactive comment on "Higher mass loss over Greenland and Antarctic ice sheets projected in CMIP6 than CMIP5 by high resolution regional downscaling EC-Earth" *by* Fredrik Boberg et al.

Anonymous Referee #1

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The paper basically downscales one member of the GCM EC-Earth-version 2 and one member of the GCM EC-Earth-version 3 for two different timeslots for Greenland and Antarctica in order to study how temperature and surface mass balance might change in the future in a high-end warming scenario. Although this is an interesting exercise and the question of how the mass loss differs in CMIP6 compared to CMIP5 is certainly relevant, I have several major objections that need to be resolved, before I can recommend the paper for publication.

First of all it is argued that there is a higher mass loss for both ice sheets in CMIP6 compared to CMIP5. However, such a bold statement cannot be made by downscaling

only one member of each ensemble. It is therefore necessary to do an analysis of a good set of CMIP5 and CMIP6 members, using different GCMs. Is the increase in the Antarctic and Greenland temperature increase (and surface mass loss) in CMIP6 compared to CMIP5 a general feature of these GCMs or is it more pronounced in EC-Earth compared to the other members. By not comparing to the other GCMs, wrong conclusions might be made about how CMIP6 differs from CMIP5.

Secondly, the authors find a large increase in warming and surface mass loss in CMIP6 than CMIP5. However, decadal variability of precipitation on the ice sheets is large and comparing a 20-year and 30-year time slots might therefore still be affected by natural variability. The authors use the DMI member of EC-Earth and it is nowhere discussed how this member relates to the other EC-Earth members. Such an analysis is necessary to better understand the contribution of natural variability compared to antropogenic forcings and climate sensitivity that might be different in CMIP5 compared to CMIP6.

As far as I understand, only the control simulation of the HIRHAM downscaled EC-Earth-version 2 has been performed (in previous papers). A basic evaluation of the HIRHAM downscaled EC-Earth-version 3 would be needed to better understand the model biases, especially given the strong warm bias in Antarctica for the present-day in the GCM.

If I understand correctly, the surface mass balance is taken over the entire ice sheet and not only the grounded ice sheet. If so, this should be changed – only the surface mass loss (and gain) over the grounded ice is relevant (as the authors are aware of).

Minor comments:

Since there is no dynamic ice sheet model, I suggest to consistently talk about surface mass loss instead of mass loss (see title for example).

For Antarctica only 1 year of spin-up is used. This is probably not enough for the

regions with substantial mass loss. Can you comment on this?

P5l133 “All these component models have improved the representation of the physical processes greatly.” This statement seems optimistic given the large deterioration in EC-Earth-v3 for Antarctica. Apart from that the statement is too unspecific.

A suggestion would be to put more focus on the differences between the temperature and precipitation change in the regional model compared to the GCM. For the run-off this might not be possible, but this is – to some extent – driven by the two previous variables. An interesting question to discuss in some more detail would be how the larger temperature and precipitation change in CMIP6 translates to surface mass loss.

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