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Interactive comment on "CMIP5 model selection for ISMIP6 ice sheet model forcing: Greenland and Antarctica" *by* Alice Barthel et al.

Anonymous Referee #1

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Summary This article summarizes the selection of atmosphere-ocean coupled climate models (AOGCMs) to use for forcing for the stand-alone ice sheet simulations as part of the CMIP6 ice sheet intercomparison project (ISMIP6). The manuscript summarizes the methods used to select the models and recommends 6 models each for use with Antarctica and Greenland ice sheets. The models used in the selection process are those from CMIP5 AOGCMs (CMIP6 were insufficiently available for testing at the time of this analysis). Three "core" models are chosen for both Antarctica and Greenland based on their fidelity to observations during the satellite record period (1979-2005). Three more models ("targeted") were selected for use based on representation of a range of future atmosphere-ocean conditions from both the RCP2.6 and RCP8.5 emissions scenarios. This submission documents the selection criteria and subsequent of

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Discussion paper

specific AOGCM selection for forcing of regional models for the ISMIP6. The work described is new and unique in that it uses both atmospheric and oceanic observations (rather than just atmospheric as in previous work) in the selection criteria. Antarctica and Greenland are treated separately, and with some overlapping and some unique variables as part of the evaluation of the AOGCMs.

The manuscript is well written, represents a significant scientific advance w.r.t. model selection for boundary conditions for ice sheet models. I recommend it be accepted for publication in The Cryosphere with minor revisions and technical corrections as follows:

Minor revisions: Much of the regional variability in Antarctica is related to the zonal asymmetry in the Southern Annular Mode (SAM; or likewise the depth, location, and seasonal migration of the Amundsen Sea Low, ASL). Some models do a better job than others at capturing this – which is different than the metrics of zonal jet location and strength. There are many atmospheric and oceanic metrics used to select the model criteria in this submission, although none directly measure whether or not the models capture asymmetric nature of the SAM (although the combination of oceanic and atmospheric metrics used may indeed capture it indirectly). A full analysis of this (whether or not models capture this asymmetry, not to mention how, exactly, to measure if the models do) is beyond the scope of this paper. I do feel, however, that some mention is worthwhile – do you believe your metrics indeed capture this even if indirectly? Or do you think some of the regional biases might be due to a particular model's lack of an ASL? A model's fidelity or lack thereof to ASL could help explain some of the regional discrepancies in projected changes as well. (e.g. M. Holland, L. Landrum, Y. Kostov and J. Marshall, 2016, Sensitivity of Antarctic sea ice to the Southern Annual Mode in coupled climate models, Clim. Dyn., DOI 10.1007/s00382-016-3424-9; J. T. M. Lenaerts, J. Fyke, B. Medley. The signature of ozone depletion in recent Antarctic precipitation change: a study with the Community Earth System Model, 2018. Geophys. Res. Lett., 45, 23, https://doi.org/10.1029/2018GL078608)

A couple sentences summarizing the figures/main point for each appendix would be

helpful (have one sentence for Appendix C, none for A, B).

Conclusions? Please finish!

Technical corrections (I can't figure out how to cut and paste Greek chi here so I write [chi]): Line 147: "historical metrics [chi] described above" but chi is not defined above. I believe [chi] in this case is the RMSE from the observations for each given variable – state this

Lines 315-322: Section 4.3 Top 3 (Greenland) Last sentence in first paragraph ("model 1, model2") sounds like a placemarker – eliminate or re-write

Lines 435-455 Check figure numbers. Mismatch between titles (in bold) and descriptions below (e.g. lines 439: "C2 Robustness of Antarctic. . .." Followed in line 440 by "Table C3 lists the . . ."

Figure 1. Regional oceanic boundaries (and some of the text over the map of the continent) for Antarctica are difficult to see (very difficult in the printed version – better on the screen) – recommend trying for different colors, or perhaps thicker outlines of the regions. The most difficult regional texts are "Weddell (WS)" followed by "Amery (AM) caption:"Greenland. . .inside the usual boundaries of MAR simulations" define MAR?

Figures 2, 3, 5, 6, A.1, A.2, B.1, B.2 The symbols denoting models that were in top3 and top6 ensembles are very difficult to see (and not stated in captions for A.1, A.2). Figures 3 and 6 highlight w different colors so perhaps not as important in these, however in the other figures these symbols need to be easier to spot – with color, or bold, or?

Table C2. Rewrite caption. . .says "three top models" and give statistics for four models (which are the four that give the two top-three combos). . .

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