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Interactive comment on "Evaluation of the CMIP5 models in the aim of regional modelling of the Antarctic surface mass balance" *by* C. Agosta et al.

Anonymous Referee #1

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This paper is one of the many papers that try to evaluate the potential of CMIP simulations for downscaling future climate change projections with RCMs. It focuses specifically on the Antarctic, and more so on projections of the Antarctic surface mass balance. The limits of RCMs for the Antarctic are usually somewhere over the Southern Ocean for very good reasons. This paper therefore evaluates and ranks the Southern Ocean climate simulated by CMIP5 models for their (putative) usefulness as driving Antarctic RCMs. Although I am sure that this paper is not not a groundbreaking one, and does not give a definite answer to the question asked (How can we really be sure a given GCM is useful for this purpose?), it is nevertheless a useful contribution to the general discussion of how to chose driving climate models for RCM-based downscal-

ing, over the Antarctic and elsewhere. It is generally well written and clearly structured, although I have the impression that the English could be improved at some instances (but I'm not a native speaker).

As a general point, I would have liked to see an evaluation of the Antarctic climate (not necessarily the surface mass balance) simulated at least by the coupled models identified here as the "best" ones. If one can show, a posteriori, that the climate models that correctly simulate the Southern Ocean climate also do a good job over the Antarctic, at least in the mid troposphere and further up (where RCMs arguably do not add much value to driving climate models - the added value is often limited to near-surface fields), then confidence in the pertinence of the selected criteria (and consequently, the proposed "ranking" of the climate models for the specific purpose) could be increased. Without this, it somewhat troubles me that some of the models identified as apt for the Antarctic were recently discarded for driving RCMs in other regions (e.g. McSweeney et al., Clim Dyn 2015; Jury et al., J. Climate).

Specific comments.

- Abstract, L19-22 : "Finally, climate change over the Southern Ocean is much more dependent on the initial state of winter sea-ice extent and on the local feedback between air temperature increase and winter sea-ice extent decrease than on the global warming signal." I think this sentence cannot be understood by anyone who has not read the paper. The abstract should be able to stand alone. The word "initial" is misleading: it's the present-day simulated coupled model sea-ice extent, not the one a model is initialized with.

- P. 3115, L. 1-2: "Antarctic mass budget is 10 times lower in magnitude than the individual input/output components." Is the same true for projected changes ? Please justify. Maybe you could modify "uncertainties of input" to "uncertainties of change of input" in the following sentence: "Consequently, when using the input-output method, uncertainty in mass change equals the sum of the uncertainties of input and output

estimates.

- P.3116, L7. "while GCMs results": "GCM results" is better English I think

- P.3116, L8. "GCMs results might be biased there because surface schemes are not properly adapted." Why should they be better over the ocean?

- P. 3316, L19. "we considered the first realization only (r1i1p1)" Did you check whether r2 would change the results?

- P3117, L.20. define crmse, not rmse. You use crmse afterwards without introducing the acronym

- P. 3118, l. 14. Indexes -> indices

- Shouldn't section 3.1 be part of the "Methods" section ? At least the justification of the chosen variables seems to belong to the Methods in my sense.

- P. 3121: "The 5 models with the highest skill scores are MIROC-ESM/MIROC-ESM-CHEM (but show incorrect circulation patterns). . . ". Is that really correct English?

- The order of figures in supplementary information is confusing. Text first mentions S8 and S9, then S2 to S7. S1 is only mentioned in the annex, p.3125...

- p.3122, line 21-25: "This section highlights the importance of simulating current climate conditions correctly, as future projected anomalies in climate over Antarctica will be significantly dependent of the conditions of winter sea ice cover over the Historical period." How much does this statement depend on the red circle (is this BNU?) that seems to be somewhat of an outlier? Would the relationship between sea-ice change and present sea-ice extent still be significant without this one model? Basically, the negative correlation shows large sea-ice changes for models that have large initial sea ice extent. Is that really surprising? This relationship is necessarily stabilized by the fact that for a given temperature change, a high-sea-ice-biased climate model will have a large delta SIE because the area of the marginal sea-ice region (say, the outermost

500 km that disappear because of the warming) scales almost linearly with its colatitude (roughly we are talking about circles around the pole). In other words, I wonder whether there would be a (significant) relationship if the sea-ice change were measured not in terms of sea-ice extent, but in terms of northward retreat of the sea-ice edge?

- Concerning the circulation criteria you chose: Not clear to me whether the criteria you have chosen are only postulated here to be the ones that influence SMB modeling (with some good arguments) or whether there are any independent proofs to this? Section 3.1 gives good arguments but are there any references, previous model simulations or anything else, that really show that these criteria are necessary and sufficient?

- Are there more ensemble members of the identified "good" models? If yes, please check whether the results are robust.

- p.3124, line 26: "We observe that 850hPa air temperature change combined with the 1980–2010 sea-ice extent bias explain more than 80% of the variance of the change in surface ocean temperature, precipitable water and sea-ice extent,. . ." Is that really surprising? Almost any climate variable scales with temperature under climate change...

Interactive comment on The Cryosphere Discuss., 9, 3113, 2015.