The following is a review of "Precipitation Ansatz dependent Future Sea Level Contribution by Antarctica based on CMIP5 Model Forcing" By C. B. Rodehacke and others.

This manuscript describes the execution of an ensemble of ice-sheet model simulations. The experiment is designed to explore how the treatment of, and estimating method for, precipitation in a continental ice-sheet model simulation may impact future estimates of Antarctic mass balance and potential for sea-level contribution. The authors make use of the state-of-the-art PISM model of the Antarctic Ice Sheet, and run two different precipitation strategies with a range of emission scenarios, Earth system models, and ocean forcing. The manuscript includes a thorough examination of the model response to these variations, and the authors spatially and temporally investigate the differences resulting from use of the two different precipitation-forcing methods. The authors highlight which areas are susceptible to mass loss, no matter which forcing is applied (i.e. West Antarctica). However, in the rest of Antarctica, the authors find a varying degree of different precipitation patterns within their ensemble. Most importantly, results using the different precipitation methods do not agree on whether future forcing would result in overall thickening or thinning of the East Antarctic Ice Sheet. These results suggest that ice-sheet model projections may have a strong dependence on how precipitation is determined, and the simulation of future precipitation may constitute a significant uncertainty in projections of the Antarctic Ice Sheet.

Overall, I find this is a well-designed study. The authors cover a wide-range of variations in their experiments, and the results are comprehensively discussed. The figures are also very helpful in representing all the results from the full set of simulations, and they represent a thorough depiction of model results. The results presented are interesting and will certainty have an impact on how ice-sheet projections are conducted in the future. Therefore, I support publication of this manuscript in ESD, with suggested edits. Please find comments and suggestions to the authors below.

General Comments:

In general, I find that the authors do a good job of describing their experiments and that they use language effectively to convey their points. There are some locations in the text, however, where I feel that the sentences are awkwardly phrased, and I note a number of these below. I have gone through the reviewer comments and responses from the authors with respect to the first submission of this proposal. Overall, I find that the authors have done a good job of responding to the comments and suggestions from the reviewers. However, I do note that in many cases where confusing and/or awkward wording is present, this phrasing is the result of new text that was added during the revision process. Since I am suggesting a number of edits below, I urge the authors to read their newest revision and to make sure that new edits are clear and specific, and that the additional phrases flow with the rest of the surrounding text. Also, the authors should make sure to use precise language, especially when referring to ocean vs. atmospheric temperatures; when using the term "model", which could refer to any number of models utilized in this study; when describing (and enumerating) the ensemble simulations; and when referring to the years and types of model forcing (i.e. years of forcing, and whether it is a transient forcing or an average forcing).

In addition, I noted that there are a few important comments that the authors did not

address in their response to Reviewer 1. In my opinion these were important points, and I think they should result in additional edits during this round of reviews.

More specifically, I think that the authors could still put some time into improving the readability of this long manuscript, by separating the sections in a more comprehensive way. Specifically, the Results and Discussion section contains methods, results, and discussion. I suggest that the methods contained in the Results be placed in the Methods and Materials section, and the Method and Materials section be organized into sub-sections (e.g. separating the forcing with the Ice Sheet Model description, as commented below). Similarly, the Results and Discussion can be separated into a Results and a Discussion section, and much of the current Conclusion section (which involves discussion of study limitations) can be placed into its own subsection of the Discussion (commented on more below).

With respect to the Conclusion, I agree with Reviewer 1 that the conclusions should be only a couple paragraphs and summary the main conclusions for the reader (in case those were lost in the many pages of text). The Conclusion section does do this now, but the many limitations take away from the interesting summary of your findings. Since the text is so long, the authors should take a serious look at reorganization of the manuscript, with the reader in mind. This should allow them to strengthen their conclusion as well, and include comments on what their results suggest about uncertainties in ice-sheet model projections (see additional comments to this point below). A strong, clear conclusion will help put this important work in context and take claim to some well-deserved findings.

Finally, the title, as stated, has an awkward word ordering. Reviewer 1 noted this, and I agree. I suggest something like "Future Sea Level Contribution from Antarctica due to CMIP5 Model Forcing and its dependence on Precipitation Ansatz." Having a title that is readable will be beneficial for attracting readers and will help your manuscript make its intended impact on the modeling community once your study is published.

Additional Specific comments/suggestions:

Abstract- In general, this abstract summarizes many of the results. However, the wording could be made clearer with simplification of the sentences (for instance, your plain language summary is very clear). Also, in some cases you could directly state your results (line-specific comments below). Finally, I suggest you use ansatz in the abstract, so that a general reader would know what your title means (or at least deduce it from how it is used).

Line 4: Missing word – nine CMIP5 "models"? Also, since it is the projections that are ranging not the models, please rearrange the sentence as something like: "future projections, ranging from strong mitigation efforts to business-as-usual, from nine CMIP5 earth system models to run an ensemble…", to be clearer.

Line 5: "In contrast to various former studies, only the historical (1850–2005) and scenario (2006–2100) forcing drive our ensemble of simulations, which neglects unavoidable continuous warming consistent with the higher climate scenarios beyond the year 2100." I was not sure what this sentence meant until I read your response to Reviewer 1. Please try to state this point in a simpler way – that is that you, for instance, 'run your simulations with

forcing derived from 1850-2100 CMIP5 output, so results past 2100, in contrast to previous studies, do not represent projections.'

Line 8: "The spatially and temporally varying climatic forcing" – this is also a vague statement. I think here that you are trying to say that you run the full ensemble, using various rcp scenarios, derivation of anomalies, and models to investigate the full spread of model realizations. Please be more specific.

Line 11: "…in a broad marginal strip…" Please be more specific about where this strip is located.

Line 13: The change to referencing boundary conditions here is confusing. Could you say "forcing" instead to be clear that this refers to the same CMIP5 forcing you refer to earlier in the abstract?

Line 15: as "an" invariant scaling constant

Line 27-28: "The discrepancy of the simulation results between both methods describing the precipitation illustrates the uncertainty of the possible range of future precipitation growth in a warming atmosphere." This sentence is a very nice summary of your results. Please add something similar into the actual abstract, since currently, there is no equivalent concluding statement.

Line 36: perhaps (Church et al., 2013a) should come after "behavior" since the past IPCC reports did not consider ice sheet models. Then, perhaps reference some ice sheet models that have been used for future projections (or maybe ISMIP6) after "ice-sheet models".

Line 42: This could be stated more clearly. For this study, for example, you construct an ensemble that includes the full range of 21st century spatial and temporal patterns of atmosphere/ocean exhibited by CMIP5 models, and this ensemble is used to drive hundreds of PISM simulations (instead of just running one run or a small subset of runs).

Line 63: Adding a concluding statement to this paragraph would be helpful to show your point. Stating something about the fact that these studies suggest that the scaling is highly variable, across ocean and land, and would be expected to not be well captured over Antarctica with a single scaling.

Line 93: surface mass balance (SMB) is "estimated to be"

Line 105: Specify that here you refer to WAIS.

Line 109: And dynamic grounding line migration. Also, note the years for which these quoted fractions are relevant.

Line 130: "In particular, the ansatz of the precipitation determines whether the global sea level rises or falls." Isn't this the conclusion of this manuscript? Or are you saying here that this is your hypothesis? Or is there past documentation that this is the case? Maybe you could say something like, "Here we quantify how the ansatz of the precipitation determines whether the global sea level rises or falls".

Line 130: Even though “ansatz” is the perfect word for your context, it should be defined for the reader. There is not much benefit to having the reader not understand. I suggest this is defined either in the Abstract or the Introduction (where forcing is discussed). Also, your conclusions (perhaps in a new conclusion section) should again use word “ansatz” to summarize what your extensive set of experiments has found. Currently, it is only used once in the entire manuscript, which is a shame – you should take advantage of such a perfect term in your discussion and conclusion.

Line 131: Like 2), 1) should start with “We”, so something like “We utilize both the temperature and the precipitation anomalies from CMIP5 models on top of the reference background distributions (see Table 2) that were used to drive the ice-sheet model during spin-up.”

Line 134: Please state again for 2) that the anomalies are placed on top of the background climate.

Line 136-137: “In some cases, negative temperature scaling is considered unrealistic (Frieler et al., 2012).” I might be missing something here, but it is not clear to me how this statement is relevant. Could you be more specific in the text how this statement follows?

Line 143: Please specify “Beyond 2100”, instead of “Afterwards”

Line 143: Please rephrase “to keep the natural variability.” The intended logic is not clear to the reader.

Line 144-147: “we use either” – You use this phrasing a number of times, but it sounds like you choose either one or the other (due to some criteria or randomly). What you actually mean is that you run one set of runs with the first 50 years and then another set with the second 50 years (as a variation on your ensemble). You also say “Additionally, the number of scenarios is twice as large, since the mean states of the first and last 50 years show in general marginal differences. Anomaly forcing is computed relative to either the first or last 50 years of the control run. In the following, the first 50 years act generally as reference.” Which I think says that you run a set of experiments for each of the first and second 50 years, and that for each set of anomalies, they are put on top of whichever is the background climate for the 1850-2100 runs. The way it is worded presently is awkward and unclear, and I do not think it effectively illustrates your point. Please try to make this clearer in the text and rephrase. I think this wording was, in part, why Reviewer 1 could not compute how many runs were actually conducted in the ensemble.

Line 149: Instead of “triggers”, please use “would be expected to trigger”

Line 153: Before, “Our simulations do not reflect this ongoing warming” please add something similar to “Note well,” or an equivalent to highlight this sentence for the reader.

Line 154: After “Also,” please be clear about why you are including this discussion. Something like: “Also, over longer timescales, there are feedbacks that are not captured by our simulations, for instance …”

Line 159: Please reiterate in this last sentence why it is true. For example: "Therefore, since only 21st century climate conditions are used to force the ensemble after 2100, our ensemble of ice sheet simulations beyond this year should not be considered a projection."

Line 167: Are these identical because there is no meltwater runoff occurring (that is, you are only showing the precipitation ultimately?), and the fact that the surface topography is the same? It is not clear to me what point is being made by including this statement in the text. Can you elucidate in the text if it is indeed important to include here?

Materials and Methods: I suggest splitting this section up into subsections (see comments below), and moving some details from the results into this section. That is, this methods section should describe all of your experiments, just not the main experiments. The extra sensitivity experiments (i.e. the basal melting sensitivity test description) should at least be named or listed in an organized way here, and then you can refer to them later in your results section.

Line 215-Line 221: Please specify "ocean temperatures" instead of just temperatures throughout this paragraph. Also, because this is a description of your forcing, it should probably be included in the Materials and Methods and not the Results.

Line 233-245: This first paragraph describes the methods for temperature scaling. Since your methods section discusses two points: the model forcing and the ice-sheet model setup, I urge the authors to have two sections within Materials and Methods, one to discuss the forcing, and including these scaling equations, and another section to discuss the ice sheet model. Breaking up the section would improve readability.

Line 249: Should this be "(last 50 years)"? Since below you compare these results against if you replace it with the first 50 years (line 250)? Or does this mean if you replace it with the full transient forcing of the first 50 years (instead of the average) the results do not change? Please check the wording of these sentences with respect to the first/last 50 years since the current version is confusing.

Line 295-Line 315, and Line 349-356: These paragraphs are examples of those that could be moved to the current Conclusion section, which I suggest you change to a "Discussion" section.

Sections 3.5-3.6: These sections are also more Discussion, since they put together results from a wide range of your figures. I suggest separating these into a discussion section, and allowing the discussion section to have sub-sections so that it is organized into your thoughtful topic areas. In this case, the parts of the current conclusion could be a final subsection to the Discussion (that is one could be "Limitations" which are more appropriately included in the Discussion not conclusion), allowing the actual Conclusion to be a much shorter summary of the important findings.

Line 470: "Anyhow" is informal. Please use a different phrase here.

Line 518: "corrected" should be used instead of "correct"

Table 1: Again, the statement "the first or last 50 years" makes it sounds like it is either one or the other, instead of both (that is, I am looking for a column in your table to tell me which

one of those you chose). The same for "PISM1Eq (Figure A10) or PISM2Eq (Figure A11)". Please rephrase to make it clear that both are done in all of these cases.

Line 633: Some concluding words about what this means for uncertainty in projections would strengthen your conclusion. For example, something similar to or expanding upon "The discrepancy of the simulation results between both methods describing the precipitation illustrates the uncertainty of the possible range of future precipitation growth in a warming atmosphere."

Table 1: In addition, "e.g. section 3.2: "Precipitation scaling"" – this is a perfect example of the misplacement of the description of the scaling. In this case, in describing all the experiments, the references should point to sections of the Methods, not to the Results.

Table 4: A reference to Fig. 1 would be appropriate in this caption, since your regions are defined nicely in that figure.

Figure 11, A13: It is not clear what distinguishes an ice shelf as "fringing". Please specify in the text or use more appropriate terminology.

Figure 12: Please reference a specific section or location instead of a reference to "please see text for details".

Section A3: This section does not really qualify as "Additional Discussion". Perhaps it should be an Appendix B for additional methods?

Line 974: "the first 30 years of the transient historical period (1850–2005)". This is confusing the way it is written. It would be clearer to specify (1850-1879) as the exact 30 years you refer to. Also, please clarify if you mean the transient forcing or the average over this period.

Line 976: Reference here the location (Section) of the manuscript where you describe the quantification of uncertainties due to the driving model. Also please specify that you mean the driving model for calculating precipitation forcing (Is that the case, actually?). Or do you mean the Earth System Model? Actually, I am not positive which model you mean here.

Line 985: Please reference here the figure that illustrates this point.

Line 1005: What does the term "trends" mean in this context? Please specify in the text or use different term.

Line 1015-1017: Please specify the years that correspond to each estimate.

Line 1031: "However, only for MIROC-ESM the reference state" is awkward. Please rephrase, that is: "However, the reference state only matters for MIROC-ESM…"

Line 1032: "not negligible" => "a non-negligible"

Line 1034: "amounts" => "amount to"

Line 1040: “The temporal evolution of the actual basal melting rate (Figure A13) increases until 2100 and falls back afterward onto the value of the year 2071 because we apply the last 30-years-forcing recurrently after 2100.” Is awkwardly phrased. One suggestion: “The basal melting rates increase until 2100, but then suddenly decrease back to 2071 values, since by experimental design, the last 30 years of forcing (2071-2100) is repeated after year 2100.” - or something similar for clarity.

Line 1061: “with a lower strength” => “with lower emissions”, maybe? “Strength” used in this context is vague.

Line 1128: This seems like a conclusion that could be included in the main text, and stated in a similar manner.

Figure A5, A6, A7: Please specify “the year 2000”, Is the “the simulated sea level for each individual simulation at the year 2000,” or something similar.