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Interactive
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Interactive comment on "Constraining projections of summer Arctic sea ice" *by* F. Massonnet et al.

D. Notz (Referee)

dirk.notz@zmaw.de

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In this manuscript, F. Massonet and co-authors aim at constraining the time period during which the Arctic will become almost ice free in summer time for a given emission scenario in CMIP5 model simulations. They do so by selecting a subset of six models from the 29 models they analyzed. The selection is based on three observational parameters for the period 1979–2010 which the authors show to be of relevance for the future evolution of the ice pack.

General comments

I very much like the analysis of why the parameters describing sea-ice coverage during the period 1979–2010 do not directly correlate with the future evolution of sea ice in the time domain. This, in my opinion, is currently the scientifically strongest part of this paper. Regarding the resulting selection of a subset of model simulations, some

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Interactive Discussion

Discussion Paper

additional work could possibly improve the impact of this publication, as outlined below. I also recommend to put some more work into better structuring the paper. *Once the list of rather minor items outlined below have been addressed, this paper will be suitable for publication.*

Specific comments

(Comments marked with a * are suggestions that could be addressed, but the paper would be publishable even if the authors choose not to address those in a revised version)

p.2932, l.25ff.: Please give references for the differences between first-year and multi year ice. At the moment, the implications of more first-year ice are summarized some-what too vaguely for my taste

p.2935, l.14: It is mentioned that care must be taken when analyzing the output. How was such care taken in the present study? Did you normalize the sea-ice extent by the ocean area, for example?

p.2935, l.23: When you average across all models, do you consider the mean of all en-semble members of a single model as "one model"? If yes, which implications does this have given your argument on p.2945 l. 14ff that a multi-simulation mean has different properties than individual simulations?

* p.2937, footnote: It might suffice to say in l.15 "However, this might be a misleading result since for a mean state X and any variable Y, correlation can exist between X and Y/X even if no such correlation exists between X and Y." and to then drop the footnote

p.2939, l.21: Why does "the rapid loss at some point in time" cause more uniform trends over the longer period? Even if the loss wouldn't be rapid, the long-term trends for the transition from a large ice cover to almost ice free would be rather uniform, I believe.

* p.2940, your discussion of the U shape: Such U shape is a very common 1st deriva-

Interactive
Comment

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Interactive Discussion

Discussion Paper

tive for the smooth transition between two stable states, since both end points of the shape are constrained at 0 on the y axis. The most striking feature of Fig. 4 is hence possibly the fact that the rate of maximum sea-ice loss occurs at a similar sea-ice extent. While you mention this later in the paper, you might want to focus on this already here.

* p.2941, l.4-6: Is the increased variability at a sea-ice extent 2-4 million km^2 possibly related to the maximum decline at a similar sea-ice extent?

* p.2943, l.2: A comment on the reasons for the decrease in variability for longer time periods would be nice. Is this simply an artifact of the fact that the models become almost ice free and the variability for a trend extending from today's condition to almost ice free is very small?

p.2943: Selection of models I: I was wondering how fairly you treat models with multiple simulations as opposed to those with just one simulation. It seems easier for a model to survive your selection criteria if it either has very many simulations or just one. Those with three simulations might have a smaller chance getting through your procedure, since they are evaluated on a par with the model which provides ten simulations. It seems to me that a fairer selection procedure would be to *first* derive a plausible range of simulations as described for the multi-model ensemble and to *then* select a model if any of its simulations falls within this "plausible" range – independent of the number of simulations a certain model provides. The resulting "plausible" range is likely larger than the $\pm$ 20 % criterion that is currently applied to all simulations of models with multiple ensemble members. It would also be helpful if you gave actual numbers for the range that a model must meet in order to be selected.

p.2943: Selection of models II: More fundamentally, I was actually surprised to see that you went through the procedure of showing in a very nice way how removing time as an independent allows you to see similarities between almost all simulations - only in order to then follow earlier studies in narrowing down the uncertainty by picking a

small number of models, which unsurprisingly narrows down the range of uncertainty. The beauty of your approach seems to me that you can actually retain much more models for your analysis by considering the fact that their specific time variable might not match observations, but that their overall sea-ice evolution might well do so. As such, it seems to me that you could build on the findings in Fig. 4 to nicely combine the strategies of earlier papers to re-calibrate models *and* to select certain models in an informed way to narrow down uncertainties of future sea-ice evolution. What you do is certainly not wrong, but it seems that it doesn't fully harvest the insight you gained from your analysis shown in table 2 and Fig. 4. Hence, you could certainly ignore this suggestions and take it up for later work, or see if it makes sense to already go down this route for this publication.

p.2945, l.7: I'm not sure about robustness, in particular because of the high variability of trends. For example, for MPI-ESM-LR we find that just shifting the period of interest from 1979-2010 to, say, 1984-2014 we get very different trends for the same simulation. Robustness of your method would, in my opinion, be better shown by being able to construct a similar range by inclusion of more models as just outlined.

p.2946, l.26: A choice of any selection criteria will reduce uncertainty. If, for example, I select all models whose name starts with C or G, I also get reduced uncertainty :-)

Supplemental material: Figure CMIP5.gif is not clear to me. What is shown? For both figures, some description in the supp. material and figure captions would be helpful.

Technical comments

Overall structure

I found it sometimes quite difficult to follow the paper's line of reasoning, since it was not always clear what a certain part of the text was heading at. At the moment, the sections sometimes seem to exist almost independent of one another, and the reader must often infer their logical connection himself. To maybe help future readers to more

quickly grasp the storyline of this contribution, the authors might want to consider to

- give a section outline of the paper at the end of the introduction
- to more clearly follow and to actually specify a story line like
  1. We would like to constrain sea-ice projections by better understanding the divergence of model results
  2. To do so, we examine which observational parameters are related in a specific way to the future evolution of sea ice
  3. This then motivates what is being done in the current section 3.2
  4. Building on the finding that certain selection criteria are related to the future evolution of sea ice, certain models can be selected as described in the current section 4 and projections can be constrained.
- change section headings: section 4 is not really a discussion, but contains many new results, section 3.2 is not really a summary of sea-ice projections but more an analysis of which parameters can be selected for which reason etc.

Smaller comments

p.2932, l.17: constrained for what by what?

p.2934, l.18: what is "local mean sea ice"?

p.2934, l.18: where did you mention your "initial idea" before?

p.2936, l.20: improvements/tuning: these are two very different things, but the "/" suggests that they are very closely related

p.2938, l.14: changes or anomalies?

p.2939, l.14, l.18: I do not see why this is "on the one hand" and "on the other hand". To me, these seem to be rather unrelated things?

Interactive
Comment

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Interactive Discussion

Discussion Paper

p.2939, l.28: "minimum trend" -> maybe more clear to use "most negative trend"

p.2942, l.26: please specify what criteria I and V are, most readers won't remember

p.2942, l.29: please specify how you "slightly changed the end points". Or at least refer to the caption of the figure for further explanation.

References: I don't think you have to embed the page numbers where you cite a specific paper. It is actually confusing, since this is usually not being done.

p.2953, table 1: MPI-ESM-MR uses a $0.4° \times 0.4°$ tripolar grid in the ocean

Grammar etc.

I find that the very ample usage of bracketed parts of sentences doesn't really improve readability. For example, almost every sentence of the abstract contains some bracketed parts even to the point that the abstract closes with one of your main results in brackets. In my opinion, if something is important, it should be incorporated into the sentence, if it's not, it can be left out. If the incorporation into the sentence makes the sentence very long, the sentence should be split up. Also generally, it'd be helpful if some long sentences could be split into two. Thanks!

There is sometimes some uncommon usage of English throughout the paper. It'd be nice if a re-submission could thoroughly be checked by a native speaking co-author. Examples for such (at least according to my non-native gut feeling) uncommon usage of English:

p.2932, l.24: "in large part" -> "to a large part"

p.2933: l.6: "participating to" -> "participating in"

p.2933: l.11: usage of "underlined"

p.2934, l.5: "their" refers grammatically to Wang and Overland

p.2934, l.18: usage of "contemporary"

p.2934, l.19: remove either "current" or "over (the) recent decades"

p.2937, l.15: usage of "is a concern"

p.2937, l.15: "even though" -> "even if"

p.2937, l.16: usage of "besides"

p.2938, l.2: usage of "yet"

p.2939, l.11: remove "of them"

p.2939, l.25: dominate -> dominating

p.2939, l.26: usage of "manifests"

p.2939, l.27: "identified with" -> "marked for"

p.2949, l.26: "if the Arctic" -> "as the Arctic"

Interactive comment on The Cryosphere Discuss., 6, 2931, 2012.