Review comment on “Polar winter climate change: strong local effects from sea ice loss, widespread consequences from warming seas” by Naakka et al.

Summary:

This manuscript addresses the question how future changes in sea-ice cover and sea surface temperature impact the polar climate system in both the Arctic and Antarctic. For this purpose, four different atmospheric general circulation models are utilized to conduct sensitivity simulations with modified sea ice and sea surface temperature conditions (individually and combined). One outcome of the study is that changes in sea-ice cover dominate the climate impact locally in (formerly) ice covered regions, whereas sea surface temperature changes have more widespread effects on air temperature, sea level pressure and precipitation.

I think the study addresses a very relevant scientific question and provides novel approaches, in particular the combined and split sensitivity simulations to sea ice and sea surface temperature changes in both hemispheres. I found the description of the scientific methods, i.e. the experimental set-up and the database, to be clear and understandable, and the provided results support the authors conclusions. Overall, I think the study was conducted very thoroughly and provides interesting insights into a relevant scientific topic. However, I have some points that I think should be addressed before publication. This mostly concerns the discussion of the key results of the study in the context of existing literature, as well as some more technical remarks.

General Comments:

1.) Discussion of results: I like the description of the experimental set-up and the presentation of the results, however, it was challenging for me to find out in the end what exactly the key findings of this study are compared to the existing literature in the field. This specifically concerns the discussion of the results for the variables near surface temperature and precipitation. For changes in sea level pressure, the findings of the study are set into the context of existing literature between lines 410 and 417. I am missing similar sections for the near surface temperature and precipitation changes. For both parameters I only found one place each in the discussion section where references to existing literature were provided (line 397 and line 427, respectively).
Particularly the first 3 paragraphs (lines 380-409) of the discussion section actually bring up a lot of new results/information by referencing a lot of new supplementary figures, maybe this part can be shortened (or shifted to the results section) to provide more room for setting the key findings of the study into the context of the literature.

2.) Comparison of hemispheres: I think it is a nice feature of this study that both hemispheres are included, however, I am missing a summary about similarities or differences between both hemispheres. Without such a summary, I am wondering how useful it is to tackle both hemispheres within one single publication? I think Figure 3 (which I actually like a lot) is a bit of a wasted opportunity here, since it provides a nice summary on the (partly different) results of the model experiments for both hemispheres, but is only referred to very rarely throughout the manuscript (if I am correct it is not once referenced in the manuscript text for the Arctic).

3) Choice of the four (atmospheric) models: I think it is a nice feature of this study that sensitivity experiments are conducted with a (small) ensemble of models instead of one model only. However, I was missing an explanation why these particular four models were chosen for the study and a related discussion what uncertainties maybe come with the model selection.

4.) More of a technical comment: In Figures 4-9 there are contour lines which are not explained in the caption, please add a description. Reading the manuscript text, though, I am wondering how useful these contours are anyway. A lot of the discussion seems to evolve around matches/mismatches between spatial patterns of changes in e.g. sea-ice cover and atmospheric variables. Would it maybe be more helpful to include the changes in sea-ice cover and sea surface temperature, respectively, as contour lines into the subplots of Figures 4-9 (instead of the current contours of I assume the basic state of air temperature etc.)? If you prefer to keep the information on the basic state in the figures, showing it only in one of the subplots (since it is always the same pattern anyway) might improve the visual clarity of the remaining figure panels.

Specific comments (line by line):

- Lines 256-257: “The warming over regions that originally had sea ice is predominantly driven by decreases in sea ice cover, whereas the warming over the continent and ice shelves is mainly caused by warmer SSTs”. I think the finding that warming SSTs and not the sea-ice retreat drives the warming of the Antarctic continent is quite interesting and could be highlighted more! Either here or in the discussion/conclusions section.
- Line 264: I think the formulation that “All models except NorESM2” indicate a negative change in sea level pressure is, even though technically correct, a bit misleading. Figure 3b shows that actually the sea level pressure change in the CESM2 model is close to zero (probably no significant signal?), so that in the end actually one model shows an increase, one does not show any change, and two models show a decrease…
- Line 296: Here it is referred to precipitation changes “between 90°E – 120°E”, but no longitude labels are included in the related Figure 6. This makes it a bit hard to find the region that is mentioned in the text…

- Lines 437-439: This conclusion is unclear to me. If SST and sea-ice changes contribute “about the same” to average warming >60° N/S, how does this imply that “a major part of the polar near-surface warming […] is a response to remote SST forcing”?