

General Comments:

The authors present an extended high-emission scenario run with the coupled climate – ice sheet model NorESM2-CISM2.1. The study is the first to use NorESM with an interactive ice sheet model and adds nicely to other coupled climate – ice sheet and extended future warming scenario studies. Uncertainties in future projections of the Greenland ice sheet and its effects on the climate system are large. Therefore, it is desirable that more Earth system models include interactive ice sheet components. Multi-centennial simulations are necessary to account for the long time-scale processes in the land ice system.

The text is well-written and clearly structured. The figures are good. However, the text sometimes refers to fields (e.g. barotropic stream function or precipitation) for which no figures are included. It would be helpful to include such figures, maybe in the appendix. The text becomes a bit repetitive sometimes, especially in the discussion. The low climate sensitivity of the model and the corresponding small amount of land ice melting are pointed out too often. I think it is sufficient to do this in the introduction and then in the discussion again when necessary. With respect to the low melt rates, it may be useful to add some words about the relative cooling around Greenland compared to the uncoupled simulation (Fig2) and the potential implications of this relative cooling for the ice sheet melting in the discussion.

This study provides results with a newly coupled climate – ice sheet model. Substantial conclusions are made. The methods are clearly outlined and the results are sufficient to support the conclusions. Focusing on climate – ice sheet interactions, the manuscript should be suitable for publication in ESD, with minor revisions to be made.

Detailed Comments:

L11: “low weak amplification” – Do you mean “weak polar amplification”?

L39: “own” – better rephrase: “include”.

L47-49: Ackermann et al., 2020 (GRL) did similar simulations with their Earth system model including an interactive Greenland ice sheet. You may consider to add them here.

L69: Please add a reference for the used configuration “NorESM2-MM”.

L94f: Why is the orography updated every 5 years but surface types are updated annually? I understand that this publication focusses on the model results and that a detailed model description is done separately. However, I find it difficult to understand the workflow of the coupling procedure.

L104f: How is the horizontal and vertical spreading of freshwater done? Could you elaborate more on this or provide a reference? A second question: is there a heat flux associated with the solid and liquid runoff?

L117f: “stand alone” – should be: “standalone”.

L122f: You may consider to move this sentence to the beginning of section 2.

Fig1d: You refer to the sea-level curve as “cumulative sea level contribution” but in the caption it says “Greenland ice mass changes.” Does this curve show the ice loss or the actual sea level rise including other effects like thermal expansion? Please clarify.

Fig1h: It may be more intuitive to invert the y-axis to see the decline (less negative numbers) in line with the other timeseries.

L159: How is ice discharge treated differently in NorESM2fixed compared to the control simulation? I understand the different treatment between NorESM2 and NorESM2fixed but thought that the treatment in NorESM2 is the same as in the control simulation. Please clarify.

Fig2 third row: With “anomaly” you mean the changes since the 1850s of the respective simulation? Please clarify.

L166: It would be helpful to include a figure similar to Fig2 for the barotropic stream function.

L167: Please clarify, that you mean the barotropic stream functions in NorESM2 and NorESM2fixed that diverge from the control run and converge to each other.

L168: “... lower minimum values ...” – better rephrase: “weaker gyre circulation”.

L182: “Around the Greenlandic coastline” – better rephrase: “Around the coastline of Greenland”.

L182-184: Where does the cooling around Greenland come from?

L185: Should probably be Fig3.

L196ff: This sentence seems a bit misplaced here in the results section. I suggest to move it to the introduction.

L200: “... is largely staying the same ...” – better rephrase: “is largely unchanging”.

L200ff: You may consider to add a figure for precipitation.

L207: “... during winter ...” – which winter? Better use DJF / JJA etc.

L207: Like above: same for “summer precipitation”.

Fig4: Does the figure show annual mean values? Please clarify.

L214: Do you annual mean sea surface temperatures? Please clarify.

L219f: “Between 2100s and 2300s increase by ... since 1850s”. Unclear formulation: Do you mean temperature increase between 2100s and 2300s or temperature increase since 1850s? Please clarify.

L221: Remove “still.”

L224f: “The North Atlantic (above 50°N) and Arctic Ocean are becoming fresher” – To which simulation are you referring?

L226: “... are visible in a more saline ...” – The differences are barely visible. You may think about adjusting the colorbar and adding a north polar stereographic projection, maybe as supplement.

L229: “... advancing divide ...” – better rephrase: “increasing meridional gradient”.

L230-232: You may consider to include a figure for salinity at depth.

L238f: "... covers more area ..." very difficult to recognize in Figure 6. If I understand correctly, maximum sea ice extent in the Arctic by 2100 is the light blue solid line in the upper panels. By eye it looks to me as NorESMfixed has a larger sea ice area but differences are small anyway. Maybe drop this sentence or include a more distinct figure.

L242f: "... ice free during summer and nearly all-year ice free... (see Fig1) with a mean annual sea ice area of less than ...". Otherwise the next sentence beginning with "The remaining winter sea ice ..." sounds contradicting.

L246: What do you mean with changes of GrIS in NorESM2fixed? Greenland does not change in this simulation, does it?

L250: "... additional melt areas starts" – should be: "start".

L253: From Figure A1 it looks like SMB is always below 8 m/yr everywhere. Do you mean seasonal accumulation rates in the text? Please clarify.

L257: It would be helpful to include figures for ice velocity.

L260: "... direct SMB comparisons ..." – should be: "comparison".

L260-262: "As explained in section 2, ... This has been improved ..." – consider to move this part to discussion.

L268f: Why "lack of SMB classes"? I thought, the classes are the same for both simulations.

L270-274: Refer to Figure A1.

L276f: ablation is less pronounced – To me it looks like the anomaly in 2200 is much more pronounced than in 2100. Please clarify.

L278: "there is less or decrease in accumulation..." – I find this sentence confusing. Should this mean "there is less of decrease", meaning that the rate of change becomes smaller? Please clarify.

L279f: Ablation increases compared to 1850.

L294: Consider to rephrase: "Arctic amplification factor is 0.2 higher in ... than in ..."

L301: Should be "in."

L307: "... and are hence harder to compare."

L307ff: Consider adding "by the year 2300."

L310: "lack of calving" – Do you mean an actual calving scheme with an iceberg model? In the method section you mention a calving parametrization for the ice sheet model.

L313: "Underestimating"

L313: What do you mean with "suggested" in this sentence?

L323f: "... not be developed enough..." "What development do you mean here?"

L343: Remove “and”

L353: For comparison it would be helpful to add the SAT increase in NorESM2 between 2015 and 2100.

L355: “ ... air temperature changes ...” Remove “changes”

L356f: Repetition: you already mentioned several times the low CS of NorESM. Please consider to point this out only where necessary.

L359ff: Maybe the other way around: “Low GrIS mass changes allude to a low Arctic amplification and ...”

L363: “This emphasizes ...”

L363: “... of coupled climate – ice sheet models ...”

L371: “becomes”

L373: remove “time”

L379: “ – which contrasts model studies with EMICs”