

Response to reviews.

Reviewer 1.

Snow plays a critical role in the Earth's climate system due to its high albedo and effective thermal insulating effect. Its presence can delay sea ice growth in winter and surface melting in summer, and also can contribute significantly to the sea ice mass through formation of snow-ice which is a major contributor for sea ice mass in the Antarctic and becomes more and more important in the Arctic. It is also a difficult parameter in the model to be represented because of lack of observations in the poles. The article written by Holland et al. assessed the influence of snow on sea ice in experiments using the Community Earth System Model, version 2 for a pre-industrial and a 2xCO₂ climate state, and found that the sea ice in the Arctic and Antarctic responses differently to increasing snow accumulation on sea ice. Through their study, Holland et al. underscore the importance of accurately representing snow accumulation on sea ice in coupled earth system models. The article is well structured, and well written. Snow is a hot topic in the recent studies and the article is worth to be published. Thus I recommend publish this article after some minor revision.

Thank you for your helpful comments on our manuscript.

General comments:

For figures, I suggest to set same limit for the y-axis for easy comparison, for example, Figure 2, using [-220, 220] for y-axis whether in the Antarctic and Arctic. Similar for the other figures.

Thank you for the suggestion. We have remade the figures where possible to use the same y-axis for equivalent variables in the Antarctic and Arctic to enable better comparison.

Specific Comments:

Line 15-16: To check "increasing snow results in a decrease in both sea ice growth and sea ice melt". From Figure 8, the decrease in congelation ice growth and basal ice melting is correct, but it is not true for the other type of ice growth and melting.

We have clarified that this refers to a decrease in congelation growth and surface ice melt. We also now mention that there is a difference between areas of perennial ice (where these factors dominate) and areas of seasonal ice.

Line 39: Snow ice was observed in Arctic (e.g., Granskog et al., 2017, JGR) and potentially becomes more and more common in the Arctic (Merkouriadi et al., 2020, GRL). Please add one statement about snow ice in the Arctic also.

We have now added a statement regarding snow ice in the Arctic with these citations.

Line 70-71, Rewrite this sentence to make it more understandable.

We have simplified this sentence by taking out the initial clause.

Line 76-77: Wind-driven blowing snow into leads leads to snow loss on sea ice in the Antarctic,

which is typically not represented in climate models. This means that snow in the climate models tends to be overestimated, right? Could you discuss a little bit about this effect affect the snow simulation in the CESM2 and how it affects your results in the whole article?

We have added a statement here that this means the models are “missing a potentially important Antarctic snow sink and may overestimate snow-ice formation.”. We further elaborate about the impacts on the net sea ice mass budgets: “However, the net impact on sea ice mass budgets is unclear since much of the snow lost to leads may result in ocean supercooling and ice growth.”

Line 148-149: citation of references with earlier publish year in front
Fixed

Line 180, Change “make small contributions” to “only contribute slightly”
Changed as suggested.

Line 195-197: It is a too long sentence, hard to udnerstand. Suggest to rewrite it.
We have split this into two sentences to make it easier to understand.

Line 226, remove “(“and “)”, and for before Fsnow. And how about for Fsnow 1.5 and 1.75
We have removed the parentheses here as suggested.

Results for the Fsnow 1.5 and 1.75 cases are discussed in the last sentence of this paragraph. We have added some clarifying text to this sentence to emphasize that this is for the Fsnow 1.5 and 1.75 cases.

Line 229: Please check it is Fig. 3a or Fig. 3b?
Thank you for catching this. It should indeed be Fig. 3b and is now fixed.

Line 231: Refer to Fig. 3C aslo? It is much easier to see in Fig. 3c.
Thank you for this suggestion. We now also reference Figure 3c here.

Line 257: “This will feedback” is difficult to understand for me. Could you rewrite it?
This has been rewritten to clarify that the atmosphere changes will influence ice-atmosphere heat exchange.

Line 259-260: citation references with earlier publish year in front
Fixed

Line 302: remove “that is present”
Removed as suggested.

Line 323-324, Combine “This dominates This is balanced by” two sentences into one.
The sentences have been combined into one.

Line 410: For Figure 11, set same upper limit for x-axis for the SH and NH
We will set the same upper limit here and in similar figures.