

Reply to reviewer comments on

“Brief communication: Impact of common ice mask in surface mass balance estimates over the Antarctic ice sheet”

by

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Dear Editor

Dear Dr. Macgregor,

On behalf of my co-authors and I, we would like to thank you for your comments on our manuscript. We believe that your comments have helped to improve the paper.

We have addressed all your comments one by one below, our replies are written in red.

Best regards,
Nicolaj Hansen

1. Because the manuscript is intended as a Brief communication and is presently >12 unformatted pages long, I must point out two things: 1. The new inset in Figure 1 is helpful but enlarges the figure unnecessarily. Please shrink the inset and perhaps reposition SW of Antarctica. 2. The MS is verbose and several statements are repeated nearly verbatim. Please review the MS one last time aiming to increase concision.

We have taken your suggestion and made Fig 1 smaller and moved panel B. Regarding the second point, we have made the first part of the discussion more concise:

“We find the differences between common and native ice mask areas small (<3%), but it alters the SMB by up to 6% over the ToAIS (140.6 Gt yr⁻¹) when compared to the ensemble mean from Mottram et al. (2021). RACMO2.3p2, MARv3.10 andHIRHAM5 0.11 -all have $\Delta\text{SMB}_{\text{Gtyr-1}}$ values close to or larger than their given uncertainties for their respective SMB estimate. This means that the effect of using the common mask in estimating SMB is close to or greater than the standard deviation of annual mean SMB estimates derived from the interannual variability in modelled SMB. We consider the standard deviation to be a minimum estimate of uncertainty within each model with actual uncertainties likely to be considerably larger, but difficult to estimate accurately (Lenaerts et al., 2019). Over the grounded AIS the common mask alters the SMB by up to 102 Gt yr⁻¹, see Table 1. This difference in SMB is close in magnitude to the grounded AIS mass loss of 109±56 Gt yr⁻¹ between 1992 and 2017 determined by the second ice sheet mass balance inter-comparison exercise (IMBIE2, Shepherd et al. (2018)), and thereby essentially determining if the AIS is losing or gaining mass. This means that small changes in SMB can lead to a non-negligible change in the total mass budget of the AIS. The model mean of the grounded $\Delta\text{SMB}_{\text{Gtyr-1}}$ is 54.2 Gt yr⁻¹, which would make a sizeable change in the mass balance results, Table 1. Basin 25 has few or no ice shelves, thus it has one of the largest impacts for $\Delta\text{SMB}_{\text{Gtyr-1}}$ for both the grounded basin (not shown) and when ice shelves are included.”

2. 21: Shouldn't this new enumeration still mention ice masks as a factor driving the SMB differences?

No, here we are talking about the Mottram et al 2021 study, which used a common ice mask

3. 42 and throughout: Table not Tab.

Changed

4. 56-57: Bedmap2 as a whole combines several different data sources, but its ice mask doesn't use all of those listed here. See p. 377 of Fretwell et al. (2013). It appears that the first MODIS Mosaic of Antarctica is the underlying source of the ice mask. Not sure if 125 m or 750 m for underlying tracing of

ice-shelf extent. Please check Haran et al. (2005).

This sentence was based on Fretwell et al. (2013) Table 3. Where they give information on the data they have used to derive the surface grid, which is shown in Figure 7 (still Fretwell et al. (2013)) their surface grid is the same as their ice mask.

5. 67: since not all the native masks explicitly distinguished grounded from floating ice
Changed
6. 68: In Table 2 we opted
Changed
7. 90-92: This new sentence is not quite making sense to me. Please revise.
We have rewritten it to:
“Moreover, it is shown how well the common mask agrees to a newly derived ice mask. We compare the common mask to the Reference Elevation Model of Antarctica (REMA, Howat et al.(2019)) mask over the AP, here it is clear that the common mask is smaller than the REMA in most coastal areas around the AP, Fig. 1 panel B.”
8. 99: Not sure what the new phrase is adding to the argument here.
It is added on the basis on the second main comment from referee 1. To tell that even though COSMO has the smallest relative difference between Δ area % and Δ SMB %, it does not indicate that it is closer to the “true” SMB, solely that it is least affected by the change in ice mask
9. 123: Here I suggest adjusting to “Given the importance of the ice shelves to the dynamics of grounded ice,” because the ice shelves themselves are influenced by force dynamics, so the sentence as is seems unclear.
Good suggestion, we have changed it
10. 125-126: These differences between area change and SMB change are the result
Changed
11. 134: decades ago, yet there have been
Changed
12. 139-140: The additional phrase does not flow well with the original sentence.
The paragraph has been changed to:

“The common mask is introduced during the post-processing stage after running the RCMs with their native masks. This has the disadvantage that model variables where the fluxes are linked to the orography, such as precipitation, can introduce a bias, if the native mask is located differently in the domain, compared to the common mask. The same orography bias can be true for winds and thus the sublimation rates as well. High precipitation rates are often strongly linked to the steep orography in coastal areas around Antarctica, especially in West Antarctica and on the windward side of the Antarctic Peninsula (basins 24 and 25), which is also where we see the largest differences in $\Delta\text{SMB}_{\text{Gtyr-1}}$ in Table 2. Comparing the size of the common mask with the REMA mask over the Antarctic Peninsula shows that the common mask is smaller around most of the coastline, Fig.2 panel B.”

13. 156: common tool
Changed

14. 168: fix tense change (quantify vs. compared)
It is changed to

“We have quantified the importance of the choice of ice mask for the Antarctic domain by comparing six different ice masks from the RCM”