

The Cryosphere Discuss., author comment AC1
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Reply on RC1

Michael R. Gallagher et al.

Author comment on "Relating snowfall observations to Greenland ice sheet mass changes: an atmospheric circulation perspective" by Michael R. Gallagher et al., The Cryosphere Discuss., <https://doi.org/10.5194/tc-2021-150-AC1>, 2021

Kind thanks to the reviewers and editors for their time and effort in examining our work, the critiques and comments provided were detailed, helpful, and have resulted in a significantly improved manuscript. Almost all changes suggested by reviewer comments were integrated into the revised submission, figures have been modified, and the authors have provided responses directly to comments from individual reviewers where necessary. Thank you also for the additional time it will take you to read these responses, any further commentary is of course welcome and we are happy to clarify as necessary.

Reviewer one, thank you for your supportive comments on the methodology and results of the study. We agree with the emphasis on reproducibility and accountability and we have revised the manuscript to reflect this. Clear and open presentation of methodology is in the best interest of research and progress, and we've made a clear statement that the code is available to anyone who should be interested. Thank you also for providing detailed comments and technical corrections.

All of the specific comments from reviewer two were integrated into the revised texts, as these critiques were insightful and have improved the text. Below are a few specific comments where important or requested:

Reviewer one: "can you comment on why Fig.3 shows that patterns [b,1] [c,1] and [d,1] occur most often in 'melt' months but that the regression in Fig.6 and Fig.7 seem to have more 'non-melt' months data samples? Is the (top) histogram overlapping melt & non-melt bars or stacking them?"

The histogram is stacking the melt and non-melt bars. The reasons these southerly patterns occur more often in non-melt months is simply because of the larger portion of the year, 5 vs 7 months. While this is a small difference, it's enough to approximately even out the number of both blue and orange points. Although the long-tail in the histogram is entirely orange.

Reviewer one: "Figure 1: I suggest to add the 2km elevation line in Fig.1c"

We had included this in a prior revision, but it was rejected during internal review for

being too 'busy'. If the editor would like, we can add this to the figure.

Reviewer one: "It is mentioned (L. 363) that not all months are included in the regression of Fig.6. Could you specify which months that are and why not all months from the GRACE observations are utilized?"

This was poor wording on the part of the author, the idea to be communicated was that the trends quantify the linear relationship between a specific circulation pattern(s) and the mass change that month. While there are clear relationships, the mass change in any given month is also impacted by the circulation patterns that occurred in that same month. Meaning a month with 7 [c,1] occurrences but 20 [a,4] occurrences would have a very different relationship to mass balance than a month with 7 [c,1] occurrences but 20 [e,1] occurrences. All available data was included in the figures.

Reviewer one: "Section 4.2.1: I think I am misinterpreting something in the discussion about dynamic mass loss. L. 328 states a bound on dynamic mass loss of 10 to 30 Gt/year, but as this is read from Fig.5 this should be 30 Gt/month? But if that is the case, the comparison to the estimated dynamic loss of 50 Gt/year from literature (L. 336) is no longer 'realistic to the first order'. Could you please check and/or clarify the units presented in this part?"

This was confusing wording on the part of the author, the 21 Gt/month is the correct number from the mass loss in the non-existent year with zero snowfall. However, the average snowfall above 2km is approximately 17 Gt/month. Thus the net mass loss due to dynamics above 2km is ~4 Gt/month according to our methodology. In a year, this would be 48 Gt, the wording in the text has been changed to be this clear.