

Response to Reviewer 2

“The importance of regional sea-ice variability for the coastal climate and near-surface temperature gradients in Northeast Greenland”

Shahi et al

Dear Reviewer,

We are again grateful for your constructive reviews and appreciate the valuable time put into this. We have revised the manuscript according to your suggestions.

In the following, we mark **red** the comments given by the reviewer, give our answers and comments in black, and indicate how we addressed the amendments in the manuscript in **green**.

– on behalf of the author team,

Sonika Shahi

General comments

Thanks to the authors for their detailed responses to the reviewer comments. I feel the manuscript is improved in this revision. In particular the physical significance of the STG is more understandable and the manuscript has become easier to read with the edits to the text and removal of some unnecessary abbreviations.

We appreciate your positive comment and the valuable suggestions you provided during the review process which improved the manuscript.

I do have some remaining comments that should be addressed before the manuscript is considered for publication. Most importantly, I am still not following the argument in Fig. 12 that Z500 increases are associated with ablation decreases. It seems to me that this figure is attempting to summarize the authors' findings about the influences of (a) large-scale circulation and (b) local surface type on the ZR climate in a way that is not logically supported by their study framework, as detailed in the specific comments below. I also have a number of requests for clarification and technical corrections, as described in the detailed comments below.

We agree with the comments made and have modified the manuscript in response. We modified Figure 12 accordingly. We provided detailed answers below.

Specific comments

I am still not convinced by the authors' argument that Z500 increases are associated with ablation decreases and vice versa, as presented in the schematic diagram in Fig. 12. Their results show that (a) days with a stronger inversion in the ZR tend to have anomalously high Z500, and (b) higher sea ice coverage is associated with a stronger inversion and less ablation. However, it does not necessarily follow from these results that higher 500 hPa heights lead to less ablation, as Fig. 12 implies. It could be the case that the presence of a mid-tropospheric ridge (i.e. higher Z500)

increases temperatures throughout the atmospheric column but with a greater increase at the higher elevation stations - as indeed the authors seem to state in L931-933 - which would manifest as a stronger inversion, but nevertheless a warmer lower atmosphere in absolute terms that promotes enhanced melting during the summer. I suspect that if the authors inverted their composite technique by calculating mean SMB on summer days with above- and below-normal Z500 over the area, they would find that increased Z500 leads to increased melt, contradicting the conceptual framework in Fig. 12.

We agree on the fact that many factors play in, and it is difficult to isolate them into one. For instance, a Z500 anomaly will have different impacts on spatial melt patterns if it occurs below, around, or above the melting point. In response, we modified Figure 12 and removed the feature representing Z500 from the figure and all the references associated with it in the main text to avoid confusion. Furthermore, we simplified other components of the conceptual figure and hope to satisfy the reviewer's criticism. Below we show the updated Figure 12:

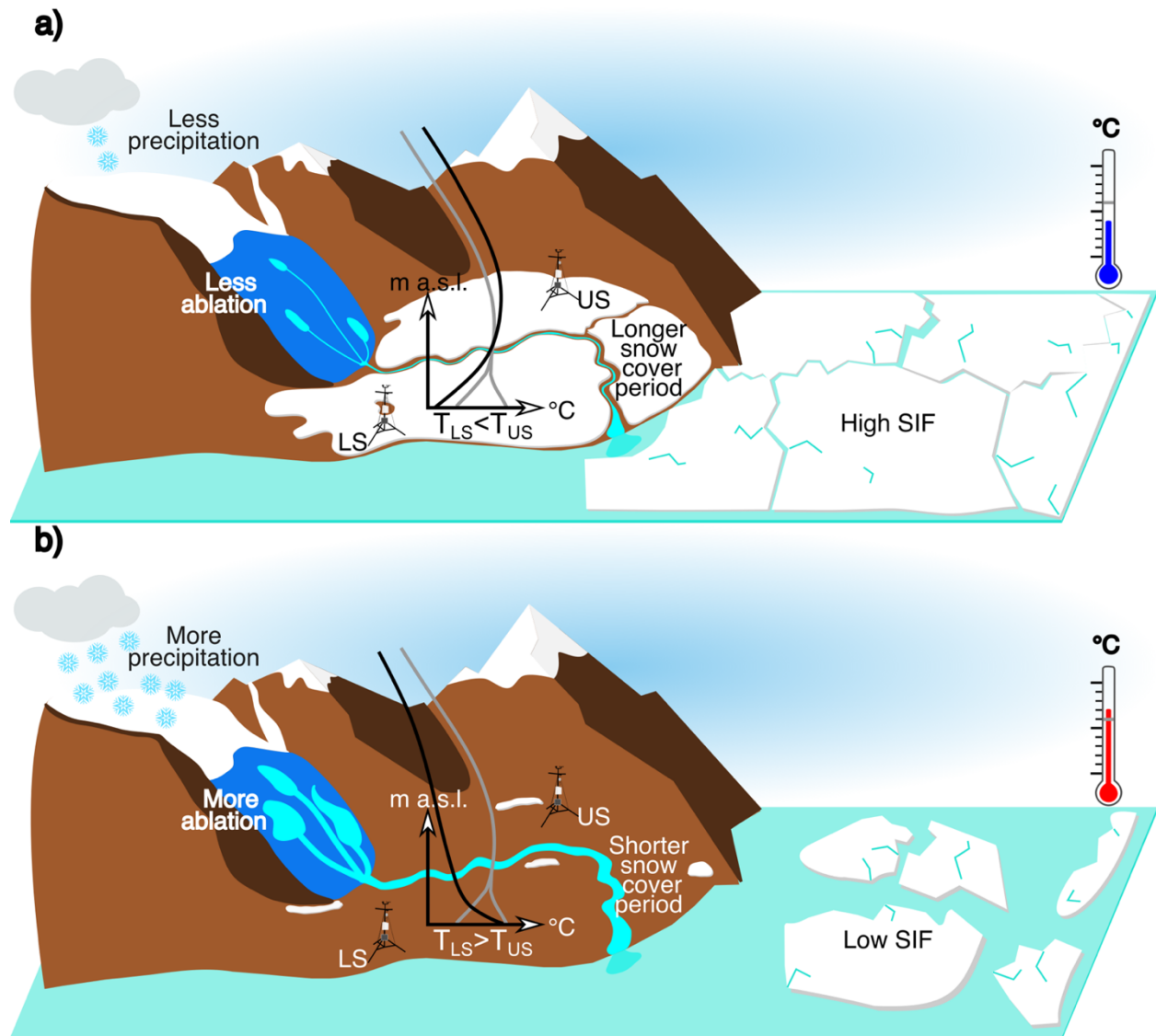


Figure 12. A schematic representation of some important linkages in the Zackenberg region (ZR), fractional sea-ice cover (SIF) in the Greenland Sea, and surface condition of A. P. Olsen Ice Cap (APO) especially for the summer season. The temperature at the lower station (LS), T_{LS} , can be higher or lower than the temperature at the upper station (US), T_{US} . (a) The upper panel shows the conditions when STG_{US-LS} is shallow (T_{LS} is less than T_{US} ; less negative or positive (inversion) STG_{US-LS}), when there is more snow in the valley, when SIF is high, along with low precipitation amounts, and little snow/ice ablation at APO. (b) The lower panel shows the opposite conditions when STG_{US-LS} is steep (T_{LS} is more than T_{US} ; more negative or less positive STG_{US-LS}), when there is less snow in the valley, when SIF is low, along with high precipitation amounts, and strong snow/ice ablation at APO. The solid grey line represents a climatological mean of the temperature profile in the ZR and the corresponding solid black lines represent the mean temperature profile in each condition

The influence of snow cover on STG is a key result described in section 3.1 and Fig. 5. I think it should be mentioned in the abstract and incorporated into the conceptual diagram (Fig. 12).

Thanks a lot for the suggestion. In response, we also added snow cover conceptually in Figure 12. We also mentioned the influence of snow cover on STG in the abstract (L16–17):

“For all seasons, our results show that snow cover and near-fjord ice conditions are the dominating factors governing the temporal evolution of the STG in the Zackenberg region.”

Be clear about discussing slope temperature gradient(s) as singular or plural. For example, L14 and the first sentence in L17 are about "slope temperature gradients" (plural), but then the next sentence in L17 switches to "STG" (singular) without an apparent reason for the change, and the rest of the abstract refers to "STG" (singular).

Thanks a lot for the suggestion. In the revised manuscript, we only used the singular form of STG in the abstract.

L11-12: "Due to its sensitivity to ecosystem components" - what does this mean? Does this mean that regional ecosystem processes are sensitive to stability conditions? Please rephrase.

This line paragraph is rephrased as per the suggestion (L11–13):

“Since the regional ecosystem processes are sensitive to atmospheric stability conditions, it is crucial to capture this complexity including adequate cryosphere coupling.”

L15-23: Are the results about the local- and large-scale drivers of STG valid for the full year? This should be specifically stated in the abstract, since summer-only results are reported later on in the abstract.

Thanks for the suggestion. We added the time frame for clarity in L16–17:

“For all seasons, our results show that snow cover and near-fjord ice conditions are the dominating factors governing the temporal evolution of the STG in the Zackenberg region.”

L20: The physical meaning of a "shallow" STG is not clear to the reader here. (I realize the description was taken out due to my request that a preceding sentence in the abstract be simplified.)

Thanks for pointing this out. We added the meaning of the 'shallow' STG in L20–22:

“A positive SIF anomaly coincides with a shallow STG, i.e., more positive (inversions) or less negative than the mean STG, since the temperature at the bottom of the valley decreases more than at the top.”

L25-28: This sentence added to the revised abstract is confusing. Is the authors' hypothesis that the local conditions associated with anomalously low sea ice (i.e. a decrease in atmospheric stability and SMB) will become more prominent in the future with climate warming?

Thanks for the suggestion. We modified the sentence in L26–28:

“Based on our findings, we speculate that the local conditions in the Zackenberg region associated with anomalously low sea ice (i.e., a decrease in atmospheric stability) will be more prominent in the future with climate warming.”

Be consistent with capitalization of the word "Arctic" throughout the manuscript. For example, it is not capitalized in L112 but is capitalized in L130.

Thanks for the suggestion. We now consistently capitalized the word Arctic throughout the manuscript.

L535-536: This sentence is a fragment. Do the authors mean that the potential relationships between these factors were examined?

Thanks for pointing this out. We added the missing fragment in the L435–436:

“In particular, the potential relationships between the STG, large-scale atmospheric circulation, surface and atmospheric moisture, and sea ice over the Greenland Sea were examined.”

L1096-1097: I think it would be helpful to provide a little more detail about what the "significant implications" actually are. Are the authors making the point that their results show complex relationships between lower and higher elevations temperatures that vary with changes in local- and large-scale conditions, which should be considered by modeling studies that often only employ low elevation records?

Yes, and thanks for the suggestion. We added the following sentence at the beginning of the paragraph (L797–800):

“This study shows complex relationships between temperatures in low and high elevations that vary with changes in local- and large-scale conditions. Studies that calibrate vertical dependences of environmental variables based on low-elevation measurements and standard methods for spatial extrapolation may miss out on parts of the complexity and hence limit applicability.”

Technical corrections

L15: "a" regional climate model

Done.

L16: "were" --> "was"

Done.

L16: "near fjord-ice condition" --> "near-fjord ice condition"

Done.

L22: "affect" --> "affects"

Done.

L92: "on" --> "in"

Done.

L94: "AWS" --> "AWSs"

Done.

L117: "anticyclone" --> "anticyclones"

Done.

L122: "warms" --> "warm"

Done.

L211: "exposition" --> "exposure"?

Done.

Figure 2 caption: "in" the ZR

Done.

L226: "was" --> "were"

Done.

L245: "data is" --> "data are"

Done.

L287: "predecessor" --> "predecessors"

Done.

L482: "exists" --> "exist"

Done.

L546: "are" --> "is"

Done.

L995: "condition" --> "conditions"

Done.