

9 August 2024

Dear Reviewer 2,

Thank you for your time reviewing and providing constructive feedback on our paper. We have considered and responded to each comment offered, and our responses follow below in **bold**. In addition to manuscript revisions motivated by your comments, we have also slightly modified the title and some of the wording of the text to reflect the nature of the “concurrent” Arctic extremes we are documenting. A new paragraph has been added toward the end of the Introduction section to better frame our study around this relatively new research space emerging on concurrent weather extremes.

Thank you again for your review of our paper.

Sincerely,  
Tom Ballinger  
Corresponding Author

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### RC2 Comments

This study examines the rare melting events in the Labrador Sea and Bering Sea in March 2023, a time when the sea ice area typically reaches its maximum during the boreal winter. These melting events are explained by intense moisture transport from lower latitudes, driven by anomalous blocking over high latitudes. The authors also attribute the circulation anomalies to a preceding sudden stratospheric warming (SSW) event and its downward influence. As a case study, the authors effectively link the surface ice melting to stratospheric extremes. However, I have some suggestions and comments regarding the manuscript, as detailed below:

1. I agree with another reviewer's comments on the role of La Niña. The authors did not provide evidence to support this argument. They should either add more evidence regarding La Niña or remove the related conclusion. Considering the manuscript's length, it would be better to remove the arguments about La Niña from the abstract and conclusion. It is still acceptable to mention La Niña among other factors that may have played a role.

**We agree with both reviewers' comments. As mentioned in our response to comment #2 of RC1, we elect to keep the brief mention of La Niña as a potential background forcing mechanism of ridge development atop Alaska in Section 3.2, which then dovetails to a more elaborate Discussion in Section 4.2 on La Nina's role in shaping blocking anticyclone centers over the regions that experienced concurrent sea ice melt.**

2. All figures need improvement. The words/characters are too small.

**We have enlarged all the figures and recreated them in high-resolution formats to improve their legibility and interpretability.**

3. To what extent these two events are extreme? It would be helpful to show a line to denote the 5(1)% percentile or -1.5(-2) sigma.

**The rarity of these short-term, multi-day melt events is highlighted in Figure 3. This histogram indicates that the 20% four-day decline in SIC over both the Labrador Sea (red dashed line) and Bering Sea (blue dashed line) is rare (<1<sup>st</sup> percentile events for March since 2000).**

4. Figure 5 caption: The authors mentioned the black line denoting the mean T2m. Is this an error? It seems to represent the mean values of these variables.

**Thanks for catching our error. We have altered this to say this is the mean for each variable.**

5. It would be great to reorganize the size of the subplots in Figures 6 and 7. The current subplots are too small and not reader-friendly.

**We have slightly modified the size of figures to make both the fields and corresponding text more legible. Final uploaded figures in eps and tif formats are more legible than the version of the paper under review.**

6. Lines 35-36: Add Zhang et al. 2018 (10.1126/sciadv.aat6025).

**Thanks for your recommendation. We have added the suggested reference.**

7. Lines 148-149: Related to comments #3. The authors argued that the melting event is ‘unprecedented.’ However, the SIC anomalies ‘did not breach the 5th or 95th percentiles’ and thus do not seem that extreme. Could the authors re-examine the calculation or further clarify?

**As we mention in response to the reviewer’s third comment (as well as the third comment of RC1), while the sea ice concentration (SIC) fluctuations in the respective marginal seas are not all that extreme as shown in Figure 2, the 4-day change in early March SIC that occurred concurrently in both areas is extreme (Figure 3). This feature and the meteorological conditions that shaped it comprise the foci of our study.**

8. Lines 314-315: The authors did not show any evidence about the downward longwave radiation or surface energy balance in the current study. Given this is in the discussion part, it would be better to cite previous studies here. Some polar AR studies have already presented these results, such as Hegyi and Taylor 2018 (10.1029/2017GL076717), Mattingly et al. 2018 (10.1029/2018JD028714), Wille et al. 2019 (10.1038/s41561-019-0460-1), Frances et al. 2020 (10.1126/sciadv.abc2695), Zhang et al. 2023 (10.1038/s41558-023-01599-3), etc.

**We have added some analysis on downward longwave radiation during the AR events and added the suggested references within the revised last paragraph of Section 4.1.**