

Authors' response

We thank the anonymous referee and the editor, Dr. Khosrawi, for their helpful feedback, which have resulted in a much improved manuscript. We further thank them for their time. Below we include our reply (written in an upright font) to the comment of the referee (written in italics), and a full overview of changes made to the manuscript during the revision process.

Best regards,
the authors

Anonymous Referee 1

The authors responded acceptably to most of my concerns. The exception is my major concern #2, which the authors did not respond to adequately. Indeed, they even have processed the observational data, so the least that could be done is including the observations in the analysis of the September eruption for the best-guess emission scenario, and discuss the conclusions from this.

- We have addressed the referee's comment by adding a section titled "4.3 Observational evidence" to the Discussions section of the manuscript, along with a figure in the appendix (Figure A12). Below we include the text of the new Section 4.3 along with the new figure.

- **4.3 Observational evidence**

The fall of 2014 was warm over the Greenland Sea (e.g., November in Ittoqqortoormiit, Jan Mayen, and Grímsey, Fig. A12b). Through observational and modelling evidence, Zoëga et al. (2023) argue that the 2014-15 Holuhraun eruption contributed to this warming signal through increased cloud LW trapping under limited sunlight. Although the simulations performed for this study here are not designed to exactly reproduce the 2014-15 Holuhraun eruption (for example with respect to the meteorology at the time) we do, nevertheless, see similarities in the climate response. When comparing anomalies from our `x1sep` simulations (which very closely resemble the 2014-15 Holuhraun eruption in terms of emissions and timing) averaged over the Greenland Sea (approximated by the area between 65°N to 80°N, and 25°W to 5°E) to anomalies from the ERA5 reanalysis for the same area, we find a warming signal in the fall months of September to November in both cases (Fig. A12a). This, along with the results of Zoëga et al. (2023), lends support to the credibility of the high-latitude winter warming mechanism discussed here.

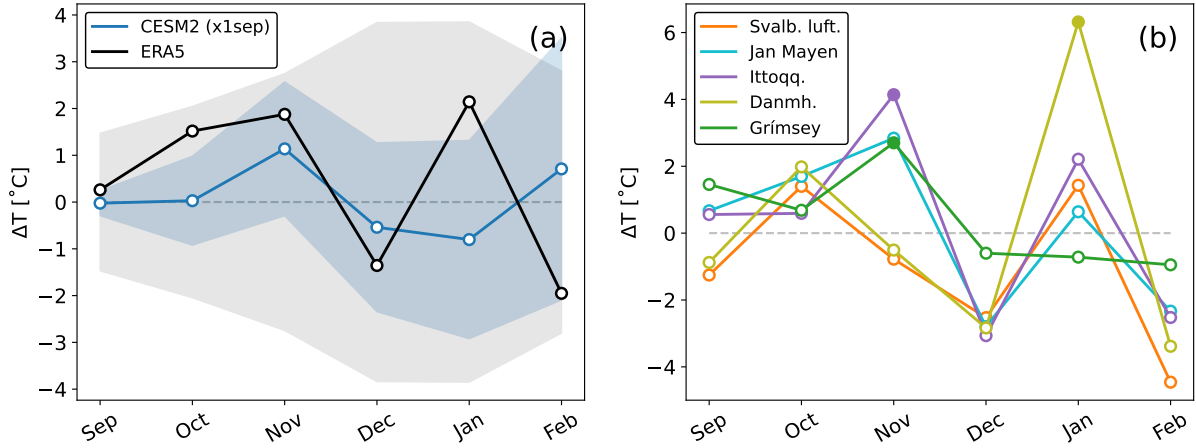


Figure A12: (a) Monthly mean surface air temperature anomalies averaged over the Greenland Sea as defined by the area between 66°N to 80°N , and 25°W to 5°E . The blue line shows the $\pi 1\text{sep}$ CESM2(CAM6) ensemble mean anomalies. The black line shows anomalies in September 2014 to February 2015 relative to the 1984 to 2013 (30 years) climatology from the ERA5 reanalysis. Shades indicate 95 % confidence interval and 95 % prediction interval for the CESM2(CAM6) simulations and ERA5 respectively. (b) Observed monthly mean surface air temperature anomalies from stations in and around the Greenland Sea: Svalbard lufthavn/airport (78.25°N , 15.50°E ; orange), Jan Mayen (70.94°N , 8.67°W ; cyan), Ittoqqortoormiit (70.48°N , 21.95°W ; purple), Danmarkshavn (76.77°N , 18.68°W ; olive), and Grímsey (66.54°N , 18.02°W ; green). Anomalies are for September 2014 to February 2015 relative to the 1984 to 2013 climatology. Prediction intervals are not plotted to preserve clarity. For all timeseries in both (a) and (b), filled dots indicate significant anomalies, open dots insignificant.

Overview of changes

We made a few additional changes to the manuscript to accommodate for the new Section 4.3 and Figure A12, and fixed a few technical things pointed out by Dr. Khosrawi. A full list of changes is included below. Line numbers refer to the newly revised manuscript.

- Lines 95 to 98: We added a new section titled "2.3 Observations and reanalysis" where we briefly describe the data we used to create Figure A12, and add the respective references.
- Line 107: We added a missing comma after "e.g."
- Lines 112 to 14: We added a brief description of the processing of the reanalysis and observational data.
- Line 199: We added a line break to avoid separation of number and unit.
- Line 313: We changed "Section" to "Sect."
- Lines 363 to 346: We added a section titled "4.3 Observational evidence".
- Lines 389 to 391: We added a few lines to the code and data availability statement to acknowledge the use of the reanalysis and observational data. This change does for some reason not appear in the track-changed version of our manuscript.
- Line 408: We added a figure in the appendix (Figure A12).