Supplementary Information for

Anatomy and Impact of a High Arctic Atmospheric River Driving Extreme Winter Rain and Snowfall

Hannah Bailey[1], Jason E. Box[2], Ben G. Kopec[3], Valtteri Hyöky[1], Hannu Marttila[1], Jeffrey M. Welker[4,5], Jack Kohler[6], Dmitry V. Divine[6], and Alun Hubbard[7,8]

[1]Water, Energy, and Environmental Engineering Research Unit, University of Oulu, 90014 Oulu, Finland
[2]Department of Glaciology and Climate, Geological Survey of Denmark and Greenland, 1350 Copenhagen, Denmark
[3]Great Lakes Research Center, Michigan Technological University, Houghton, MI 49931, USA
[4]Ecology and Genetics Research Unit, University of Oulu, 90014 Oulu, Finland
[5]Department of Biological Sciences, University of Alaska Anchorage, Anchorage, AK 99508, USA
[6]Norwegian Polar Institute, Tromsø, 9296, Norway
[7]Geography Research Unit, University of Oulu, 90014 Oulu, Finland
[8]Department of Geosciences, UiT - The Arctic University of Norway, N-9037 Tromsø, Norway

Correspondence to: Hannah Bailey (hannah.bailey@oulu.fi)

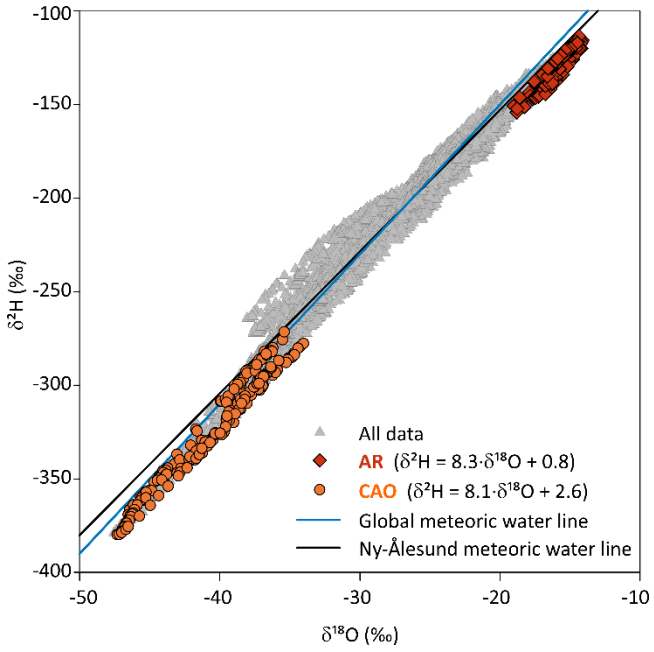

Figure S1: Atmospheric vapour isotopes during the March 2022 AR and CAO. δ^2H-$\delta^{18}O$ relationships for atmospheric water vapour measured at the Zeppelin Observatory during the March 2022 atmospheric river (AR) and subsequent cold air outbreak (CAO). Grey triangles show the full vapour isotope dataset for the observation period (1 January to 31 May 2022; 30-min averages), while coloured symbols indicate samples associated with the AR (red diamond) and CAO (orange circle) phases. Linear regressions are shown for the AR and CAO subsets. The global meteoric water line (GMWL) (Craig, 1961) and Ny-Ålesund meteoric water line (based on all campaign data) are shown for reference.

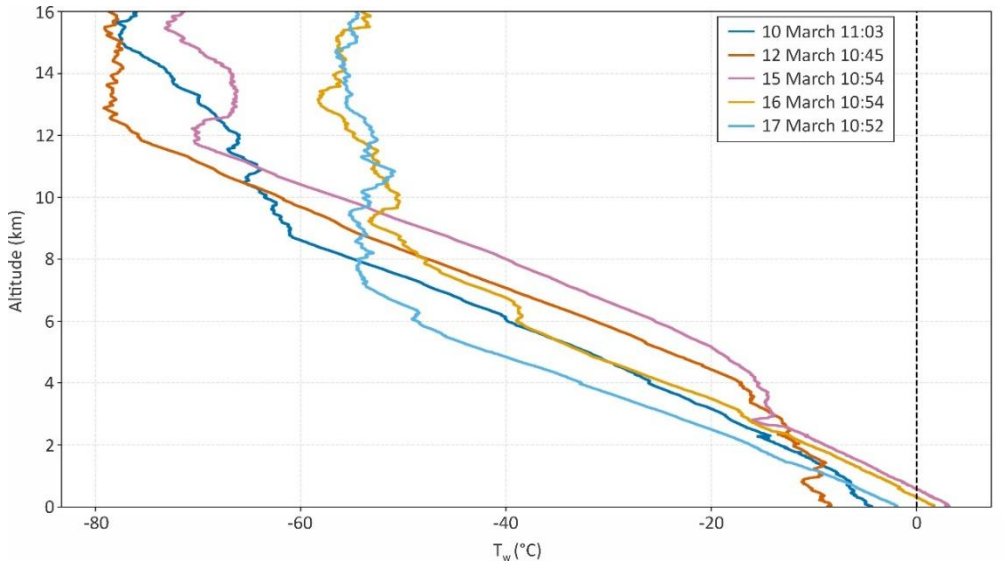

Figure S2: Vertical wet-bulb temperature profiles during the March 2022 AR. Vertical profiles of wet-bulb temperature (T_W) derived from radiosonde soundings launched at Ny-Ålesund on selected dates before, during, and after the March 2022 AR (Maturilli, 2022). The dashed vertical line indicates the 0 °C threshold used to estimate the melting level.

Table S1. Snowfall stable isotope data from Ny-Ålesund.

Sampling date	δ^2H (‰)	$\delta^{18}O$ (‰)	d-excess (‰)
06/01/2022	-87.7	-15.65	37.5
08/02/2022	-62.7	-12.12	34.3
24/01/2022	-60.6	-9.71	17.1
01/02/2022	-100.8	-15.28	21.5
02/02/2022	-100.3	-15.76	25.8
08/02/2022	-189.8	-24.62	7.1
09/02/2022	-81.7	-13.79	28.6
22/02/2022	-81.8	-14.97	37.9
26/02/2022	-98	-16.92	37.4
26/02/2022	-104.1	-16.15	25.1
06/03/2022	-76	-11.54	16.3
09/03/2022	-137.8	-18.38	9.2
19/03/2022	-82.7	-12.57	17.8
16/04/2022	-128.1	-16.79	6.2
18/04/2022	-143.1	-19.53	13.1
26/04/2022	-162.9	-24.47	32.8
27/04/2022	-158.5	-24.03	33.8
05/05/2022	-86.1	-13.63	22.9
06/05/2022	-74.2	-12.01	21.9
08/05/2022	-186.6	-26.1	22.1
08/05/2022	-169	-24.12	23.9
16/05/2022	-48.9	-7.52	11.3
19/05/2022	-46.6	-8.86	24.3
22/05/2022	-40.2	-6.3	10.2

References

Craig, H.: Isotopic Variations in Meteoric Waters, Science., 133, 1702–1703, https://doi.org/10.1126/science.133.3465.1702, 1961.

Maturilli, M.: High resolution radiosonde measurements from station Ny-Ålesund (2022-03), https://doi.org/doi.org/10.1594/PANGAEA.914973, 2022.