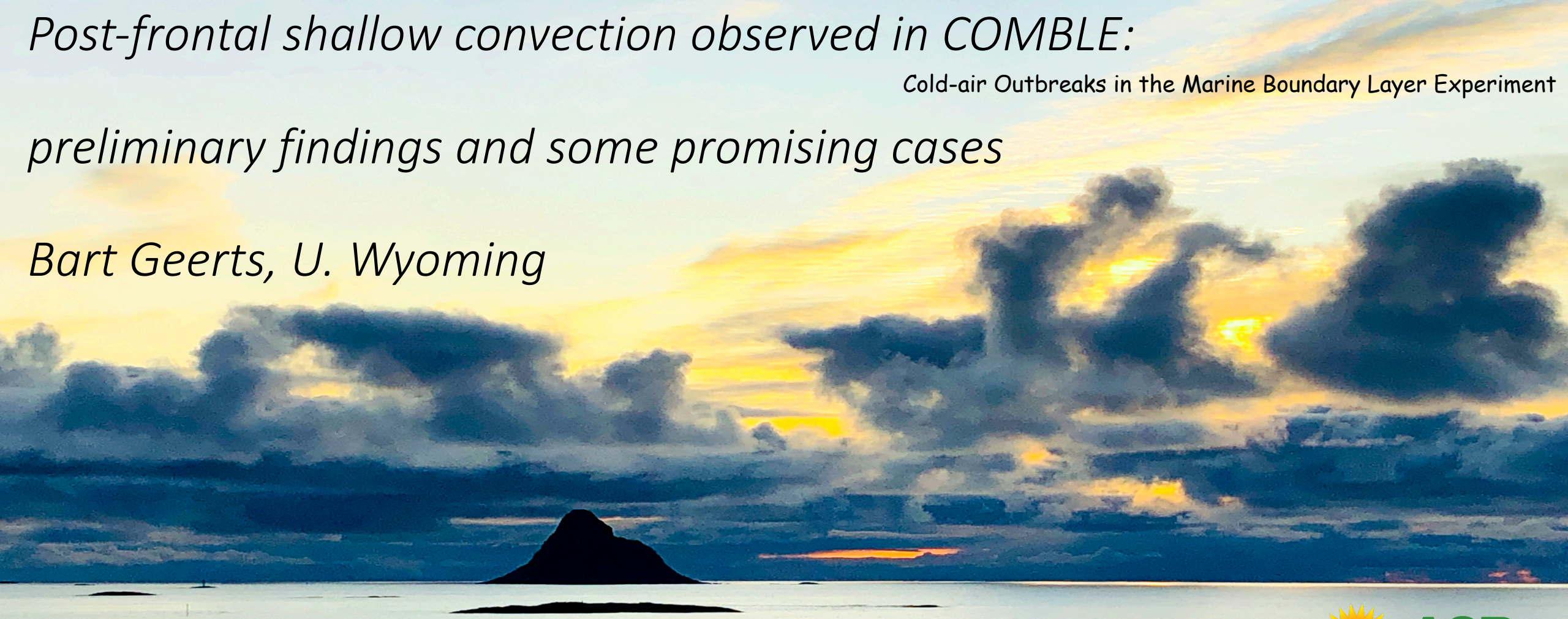
Post-frontal shallow convection observed in COMBLE:

Cold-air Outbreaks in the Marine Boundary Layer Experiment

preliminary findings and some promising cases

Bart Geerts, U. Wyoming



Thanks to Christian Lackner, Branko Kosovic, Tim Juliano, Min Deng, Zach Lebo, Yishi Hu, Peng Wu, Mikhail Ovchinnikov

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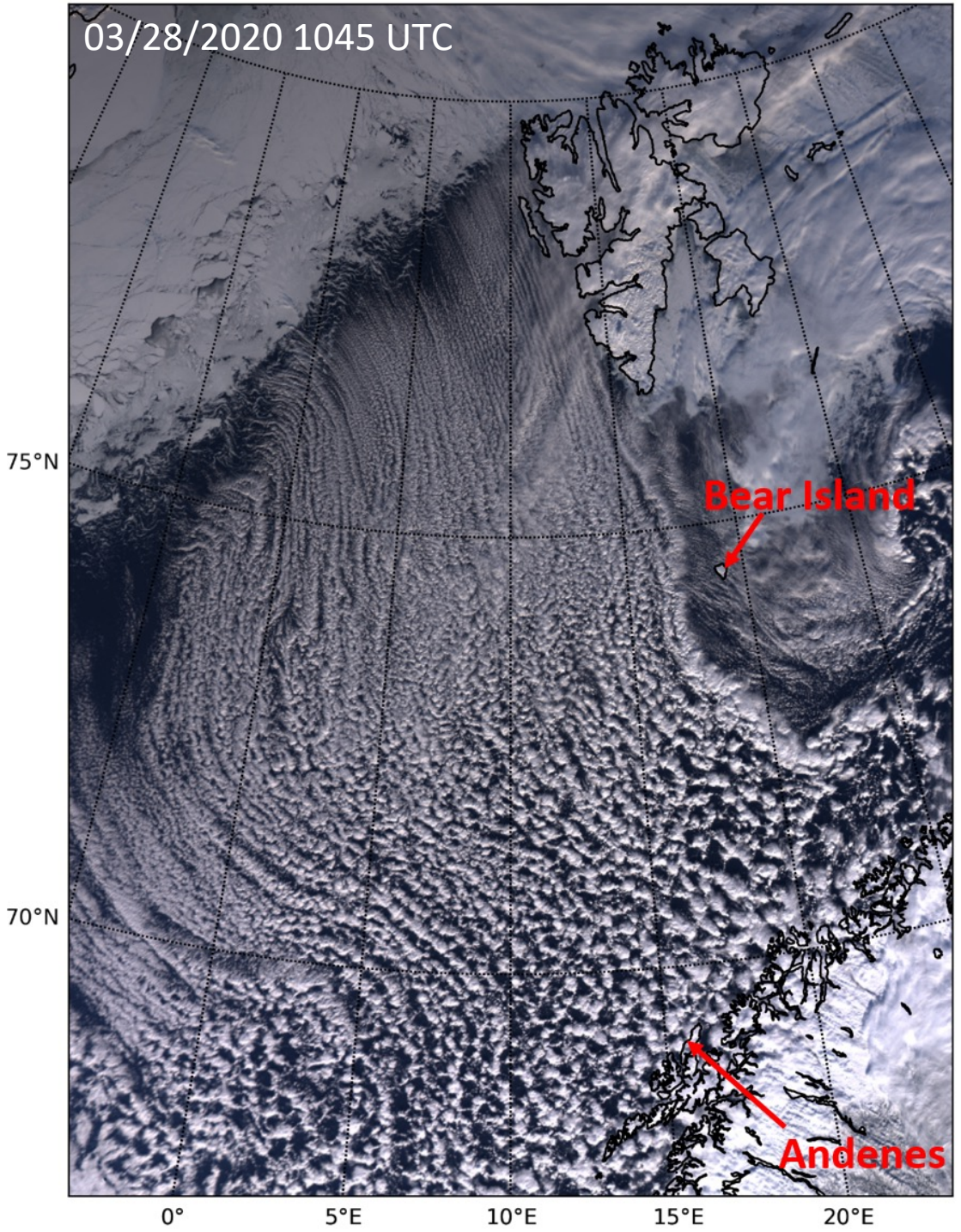
Preface

- COMBLE describes the atmospheric conditions and aerosol, cloud, and precipitation characteristics in the marine boundary layer during high-latitude cold-air outbreaks

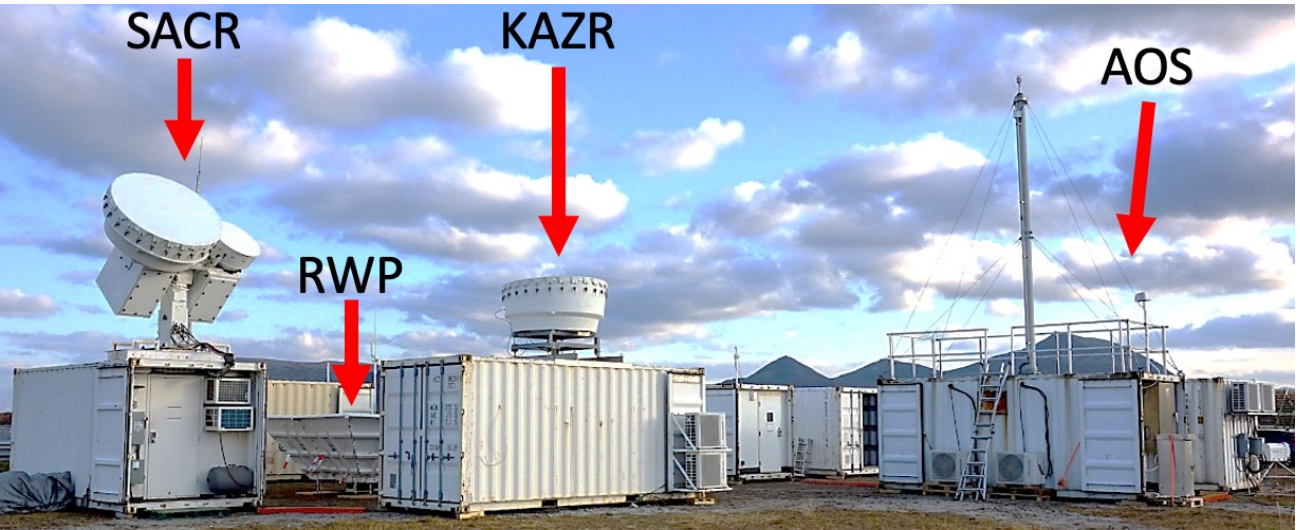
- The marine CAO cloud regime is the product of surface fluxes, BL mixing & entrainment, aerosol, cloud and precipitation processes, and mesoscale circulations

- COMBLE provides a powerful modeling test bed for improving the representation of mixed-phase cloud processes in large-eddy simulations and large-scale models



ANX (Nordmela Harbor, near Andenes)

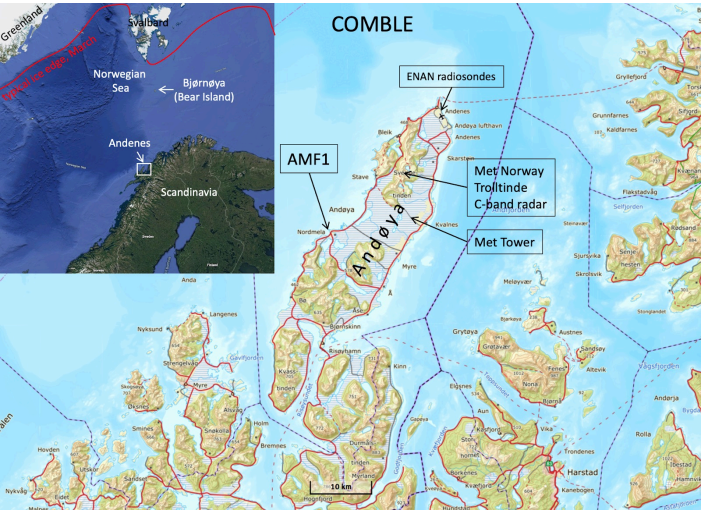
Bjørnøya (Bear Island, S2)

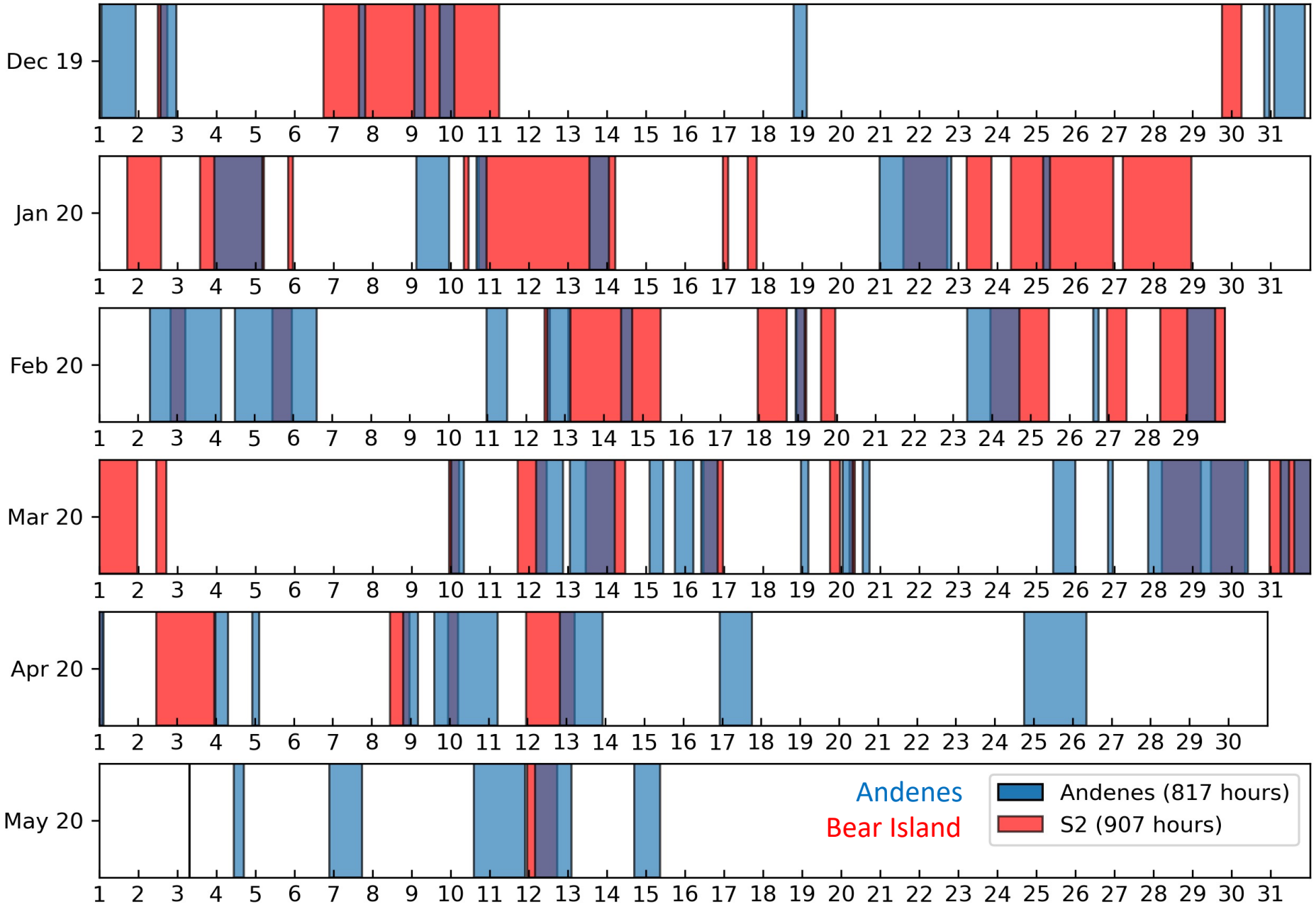


- DL
- CEIL
- MPL
- MWR-2C
- LDIS
- TSI
- ECORE/SEBS
- AWS
- BBSS
- MRR (U. Cologne)

Identification of marine Cold-Air Outbreaks

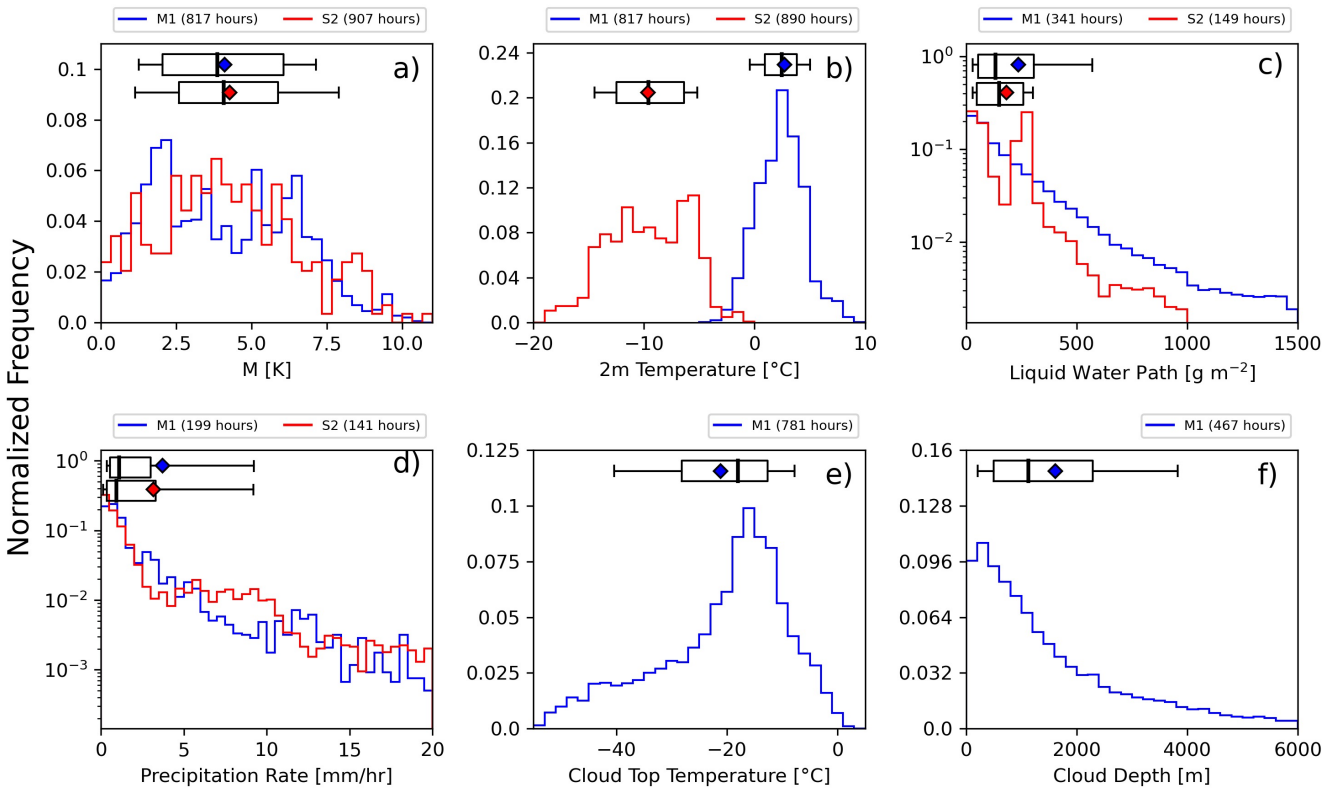
- Identification based on the following environmental conditions:
  - MCAO-index: $M = \theta_{SST} - \theta_{850hPa} > 0$ K
  - Wind speed: $|\vec{u}| > 10$ kt
  - Wind direction must be onshore:
    - Between 250° and 30° at Andenes
    - Between 270° and 110° at Bear Island
- SST is taken ~10 km off the coast and ranges between 5 – 8 °C at Andenes during COMBLE
- Three hour running-means are applied to the atmospheric conditions; CAO events and gaps between CAO events shorter than 3 hours are filtered out

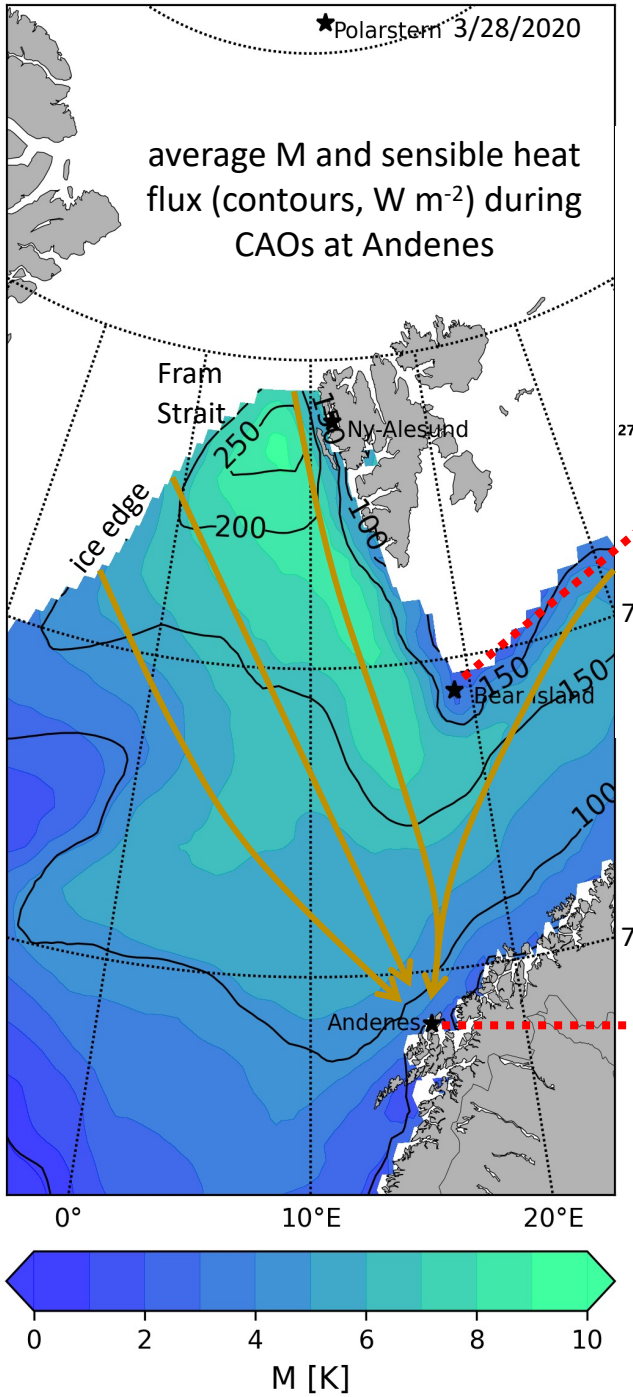




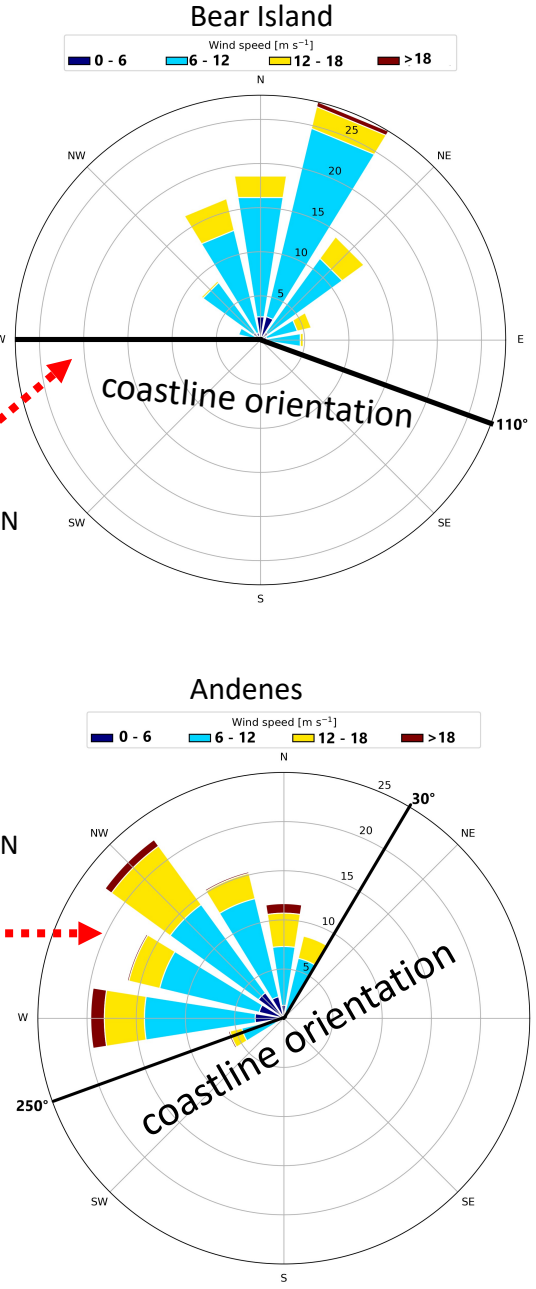
Environmental conditions

Andenes
Bear Island

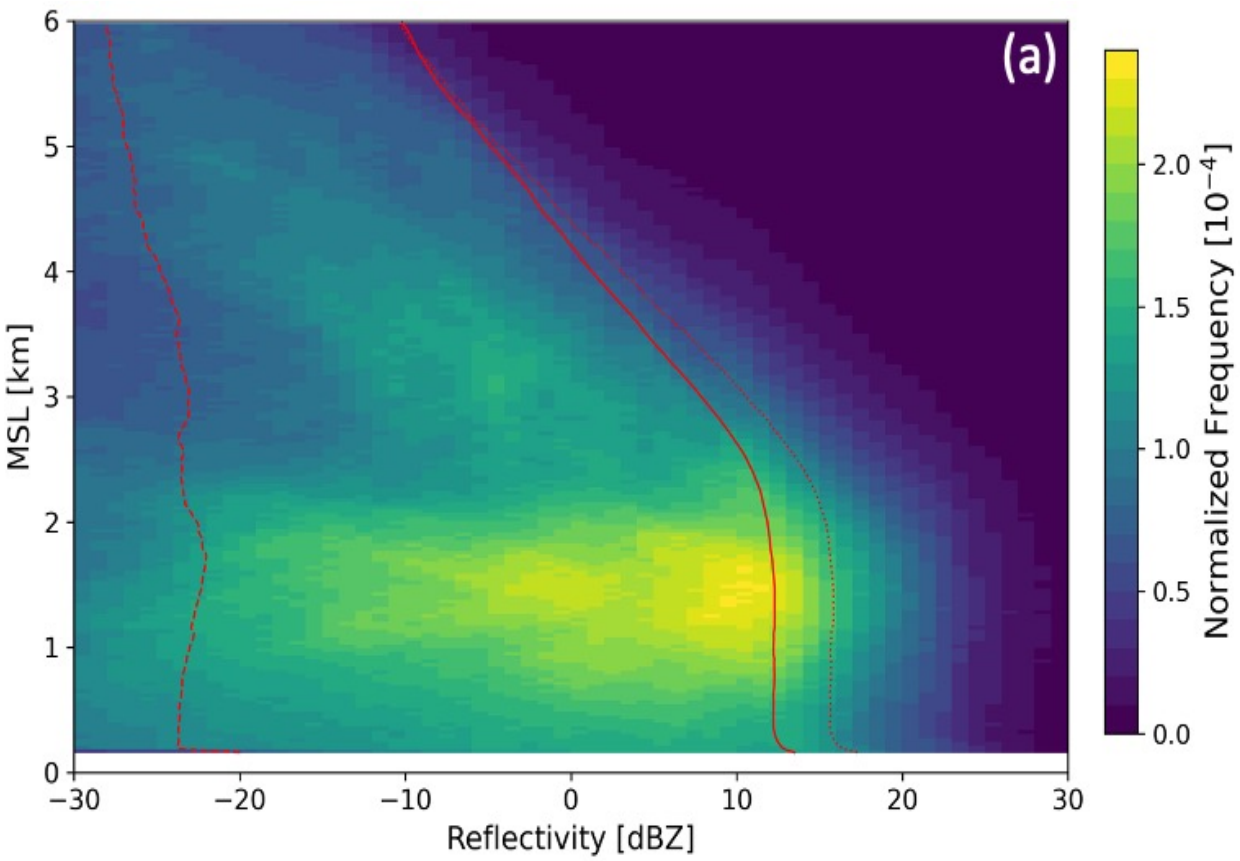


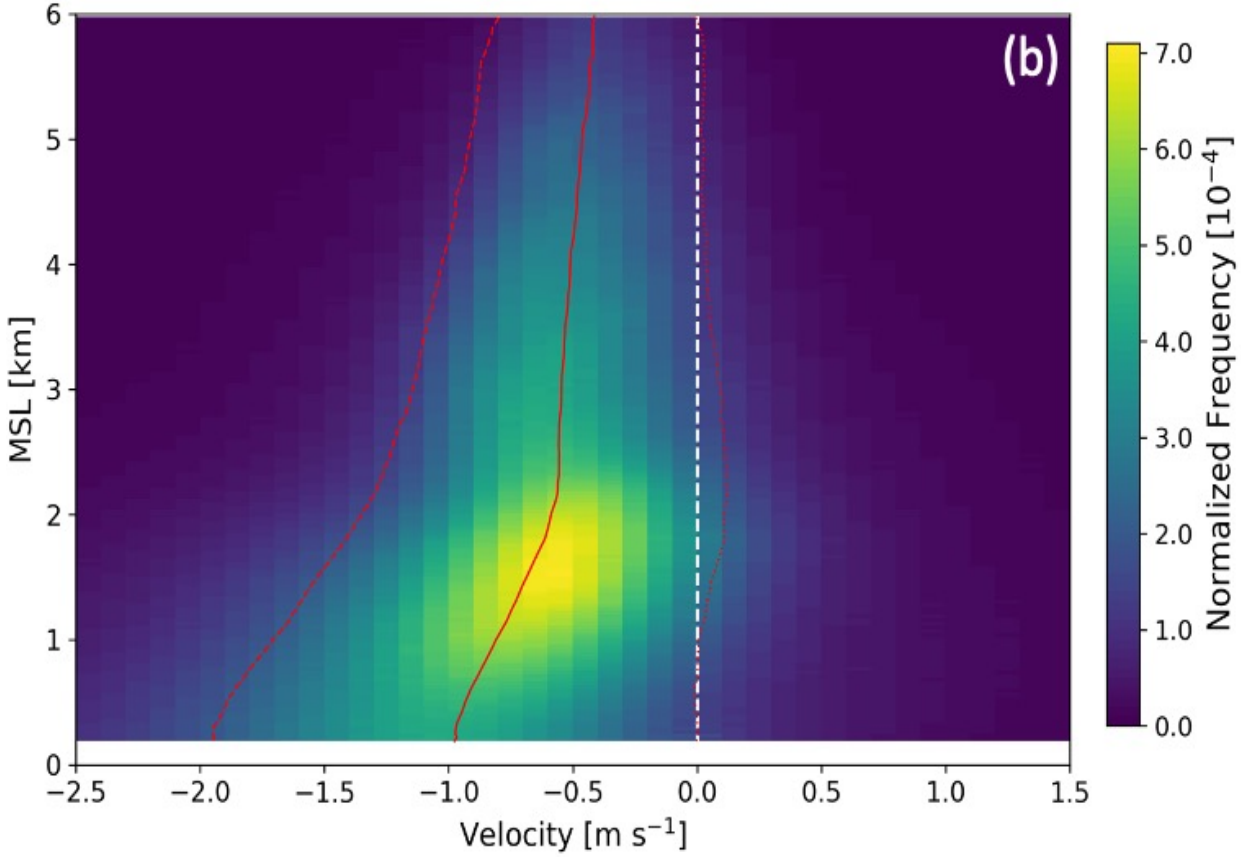


wind roses during COMBLE CAOs



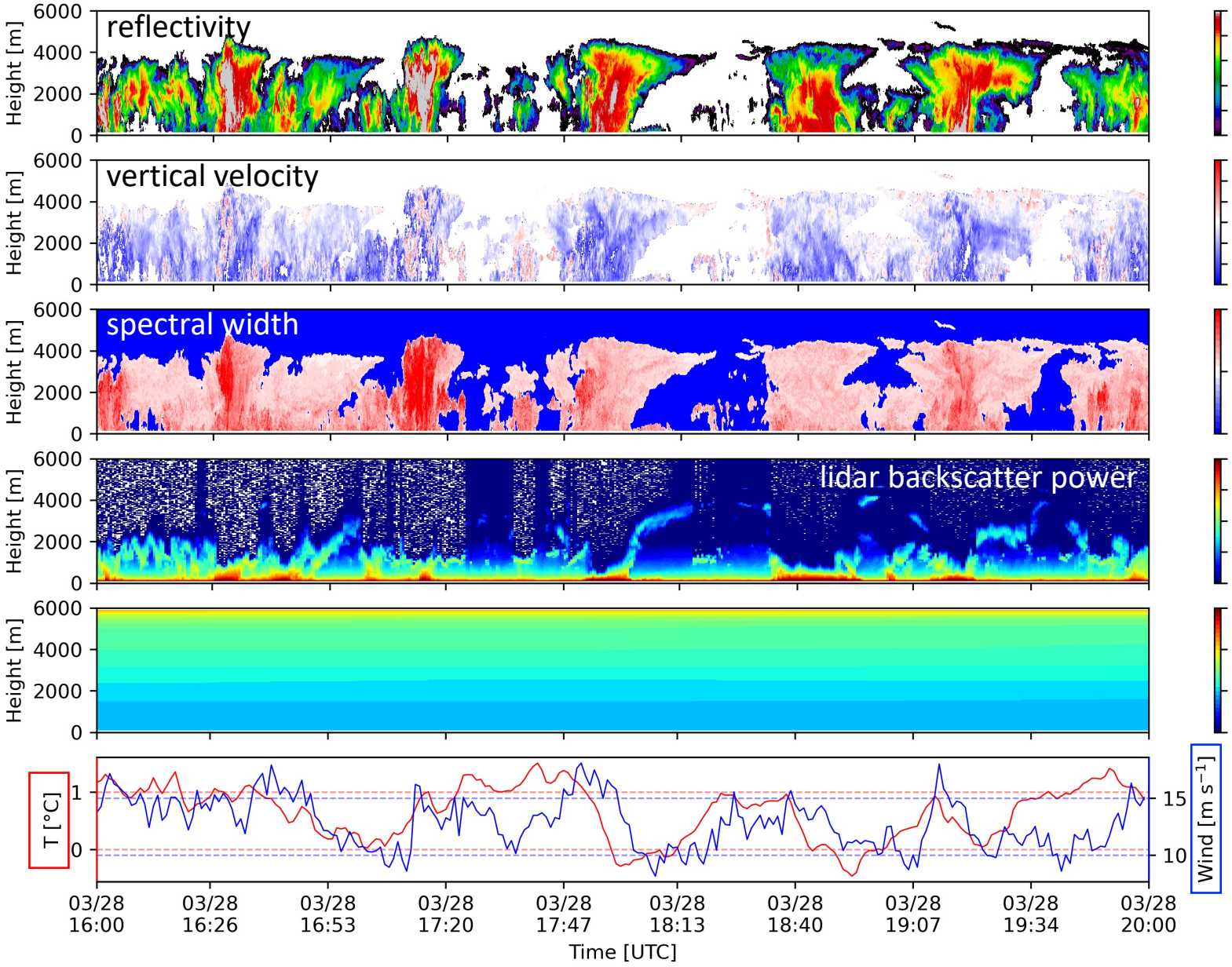
Composite vertical cloud structure

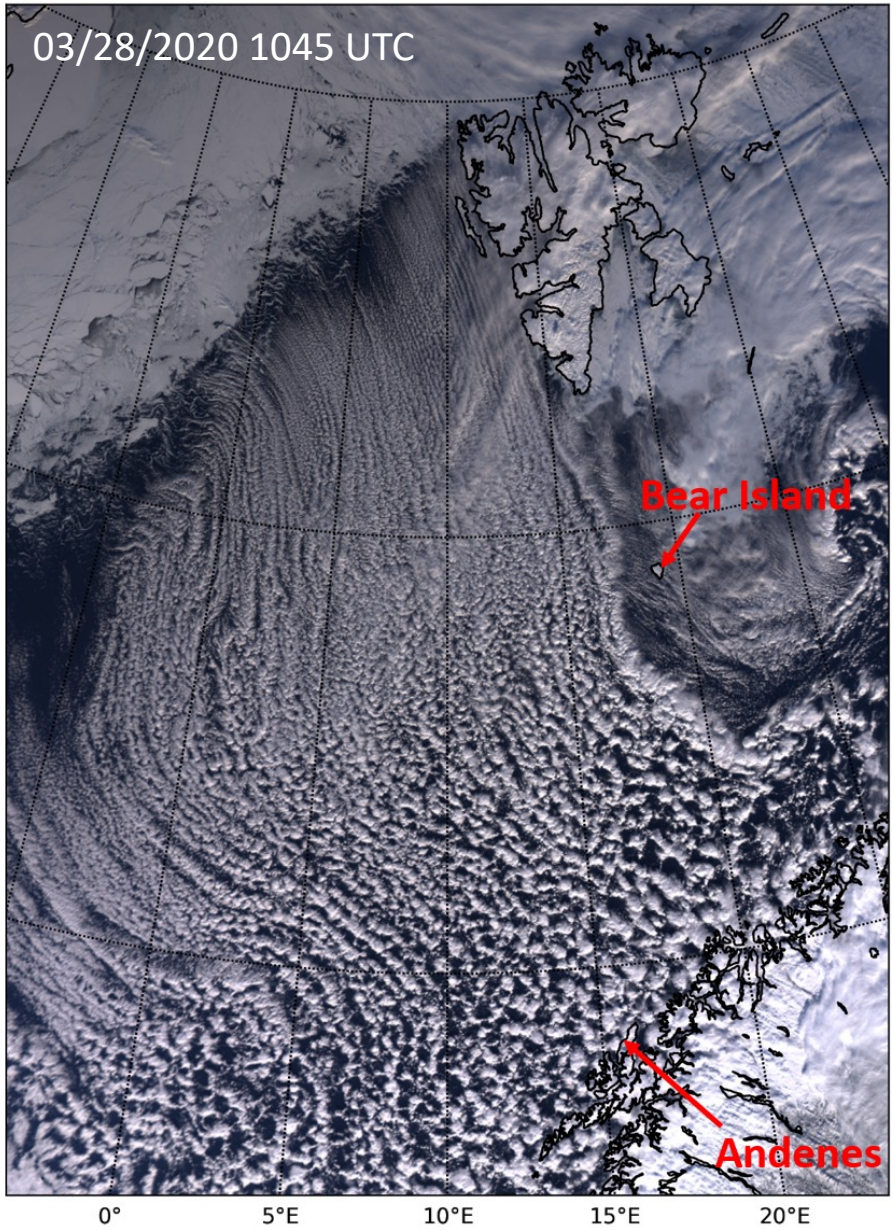




Frequency by altitude display of KAZR reflectivity and Doppler velocity at Andenes. From left to right, the red lines are the 10th percentile, the mean, and the 90th percentile

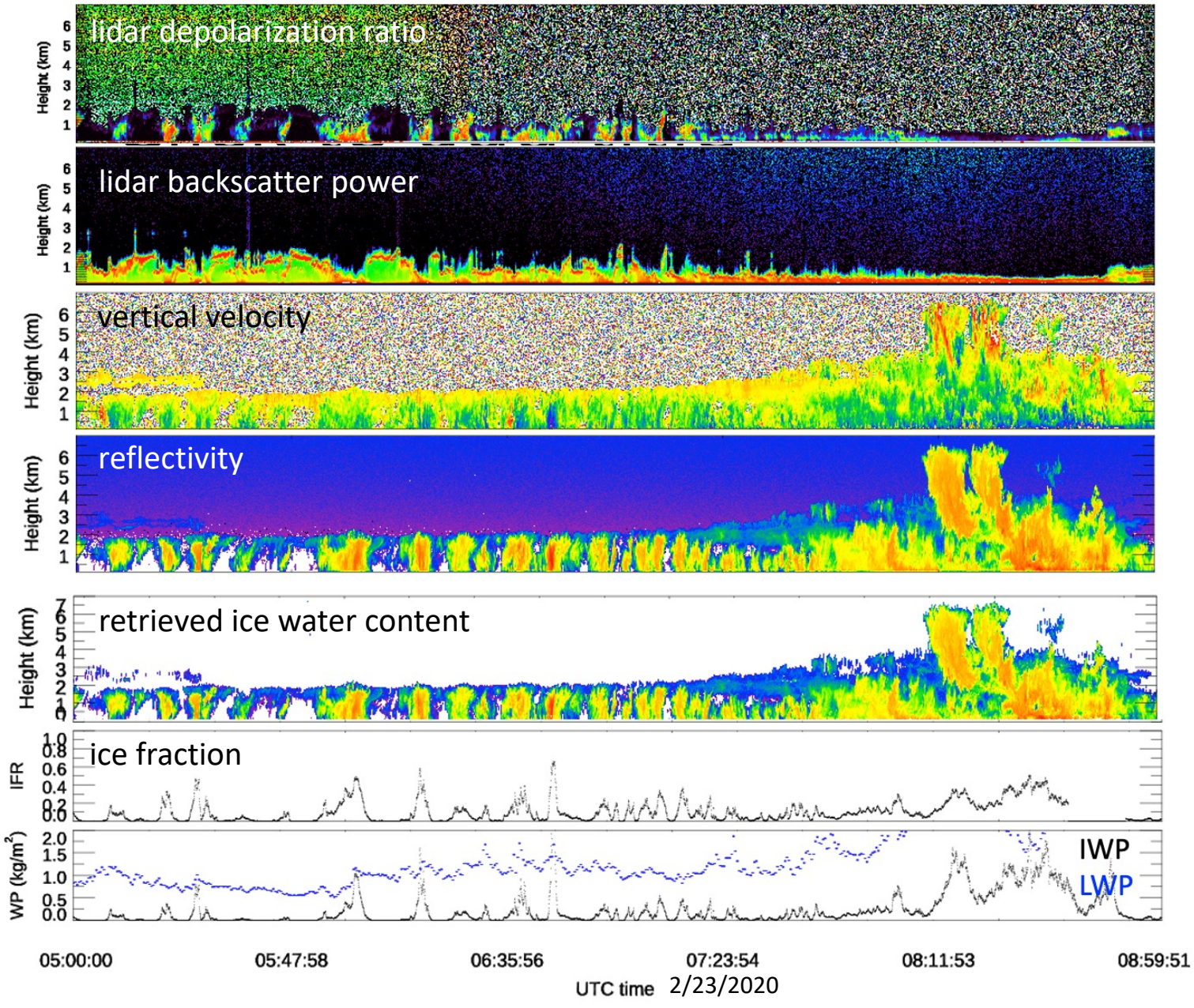
Example 1: 28-29 Mar 2020

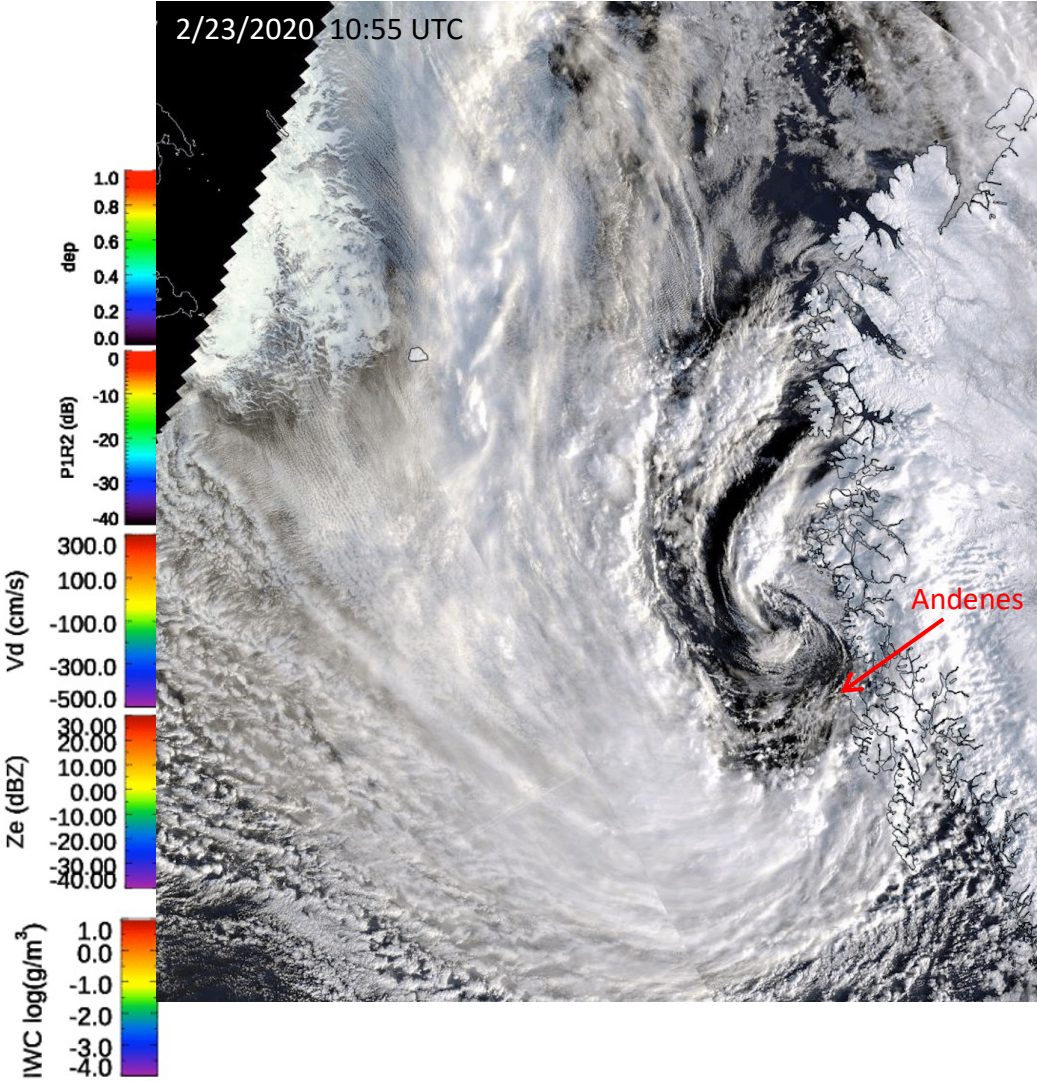




Look for the poster by Tim Juliano et al on this case, showing 1 km WRF simulations

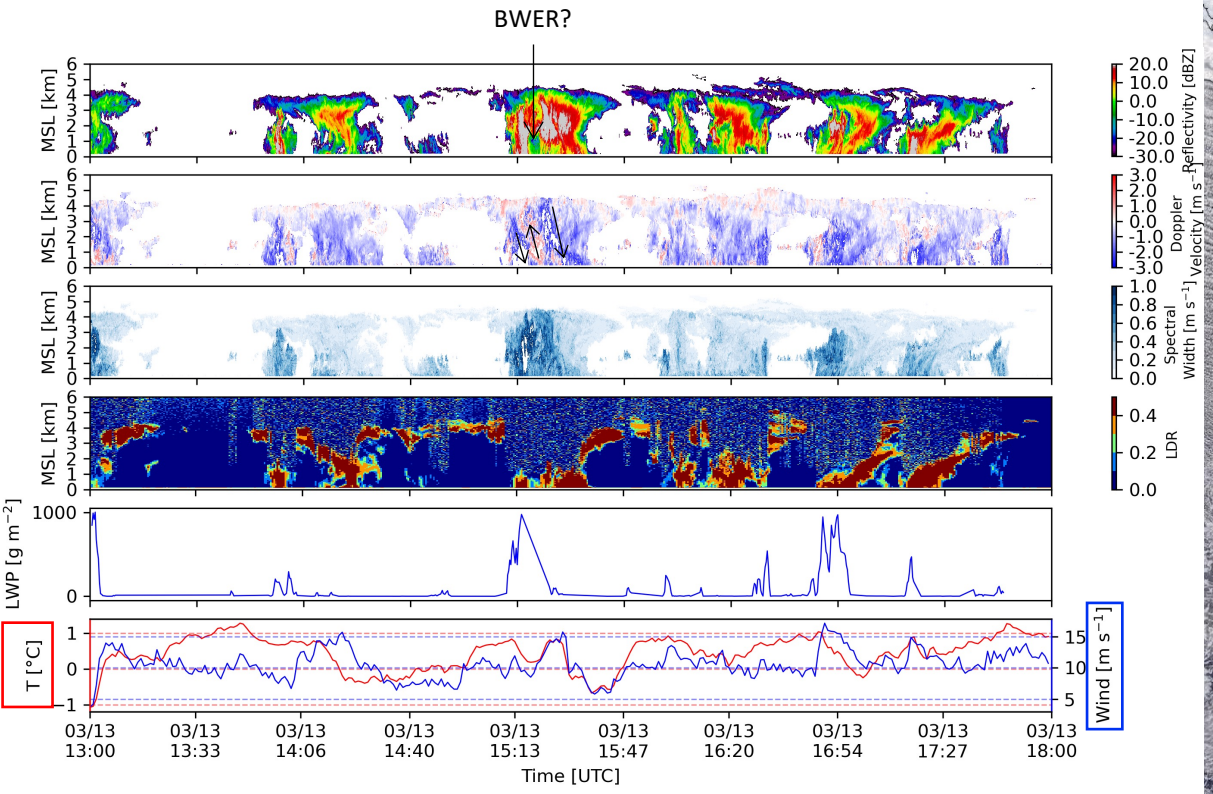
Example 2: 23-24 Feb 2020

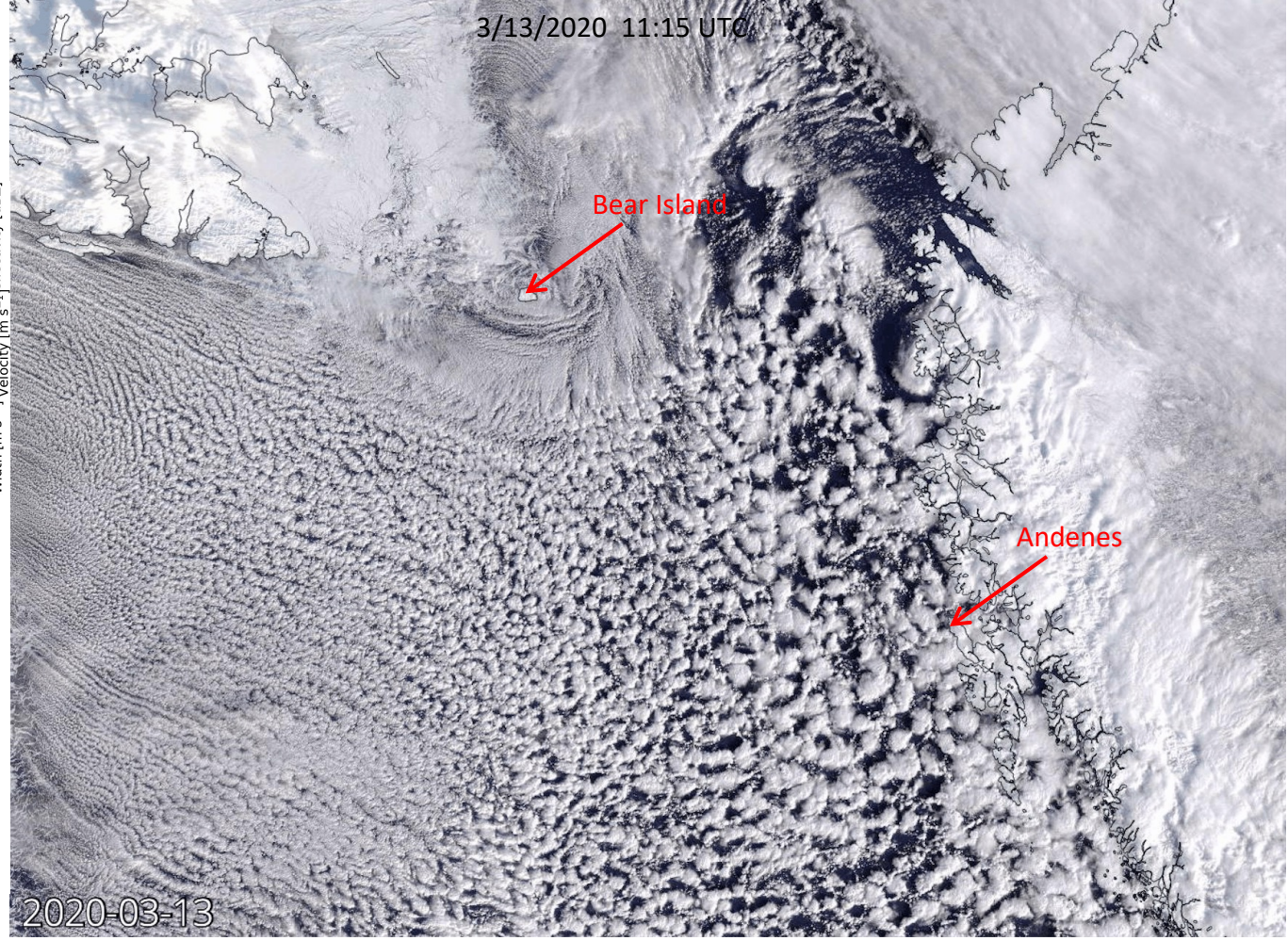




The 40-day global SCREAM simulation produces a similar MCAO (see poster by Xue Zheng and YunYan Zhang)

Example 3: 13 Mar 2020





This case is analyzed in the poster by Peng Wu and Mikhail Ovchinnikov

conditions at Andenes

start	end	duration (hrs)	mean M (K)	mean wind speed (m/s)	mean wind dir (°)	mean T (°)	description
20/03/27 23Z	20/03/29 12Z	37	6.6	8.0	314	0.5	long-lived, trajectories via Fram Strait, echo tops 3-6 km
20/03/12 18Z	20/03/14 02Z	32	7.8	7.6	336	-0.9	extreme M, trajectories via Fram Strait, echo tops 4-5 km
20/02/22 21Z	20/02/24 13Z	40	2.3	7.6	297	2.4	complex trajectory, polar low over ANX, echo tops shallow (~2 km) or deep (~6 km)