Environmental conditions in the North Atlantic sector of the Arctic during the HALO–(AC)³ campaign

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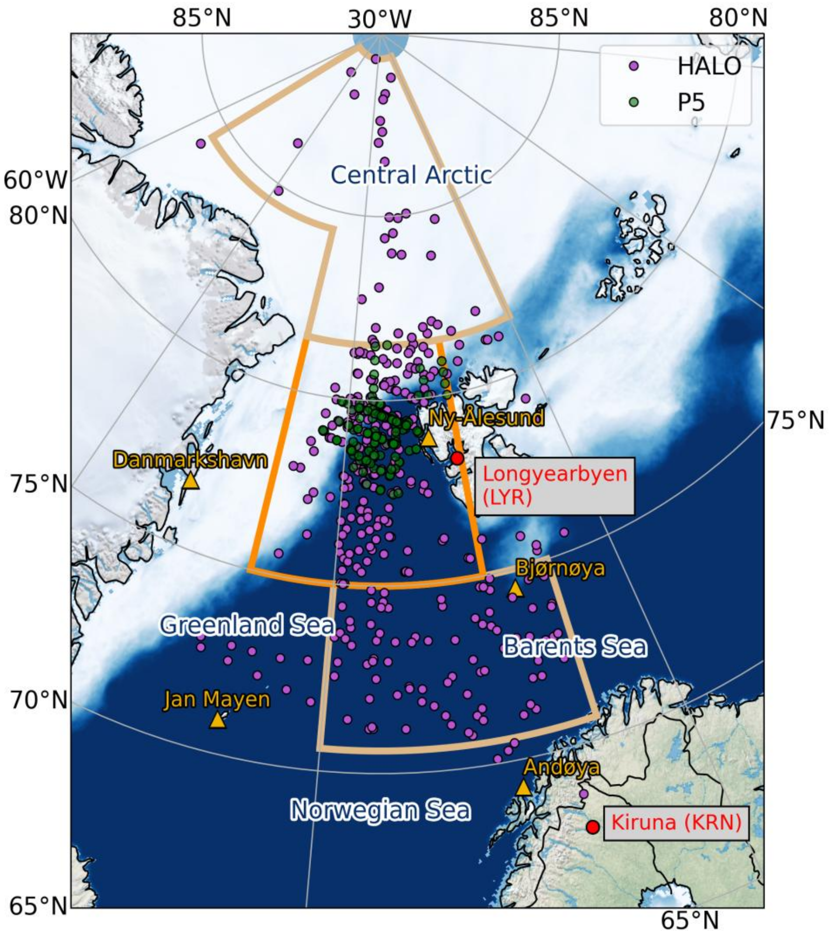
Measurement regions

- Selection of measurement regions was based on flight track coverage:
  - Southern region
  - Central region
  - Northern region
- Central region also includes flights from P5 and P6

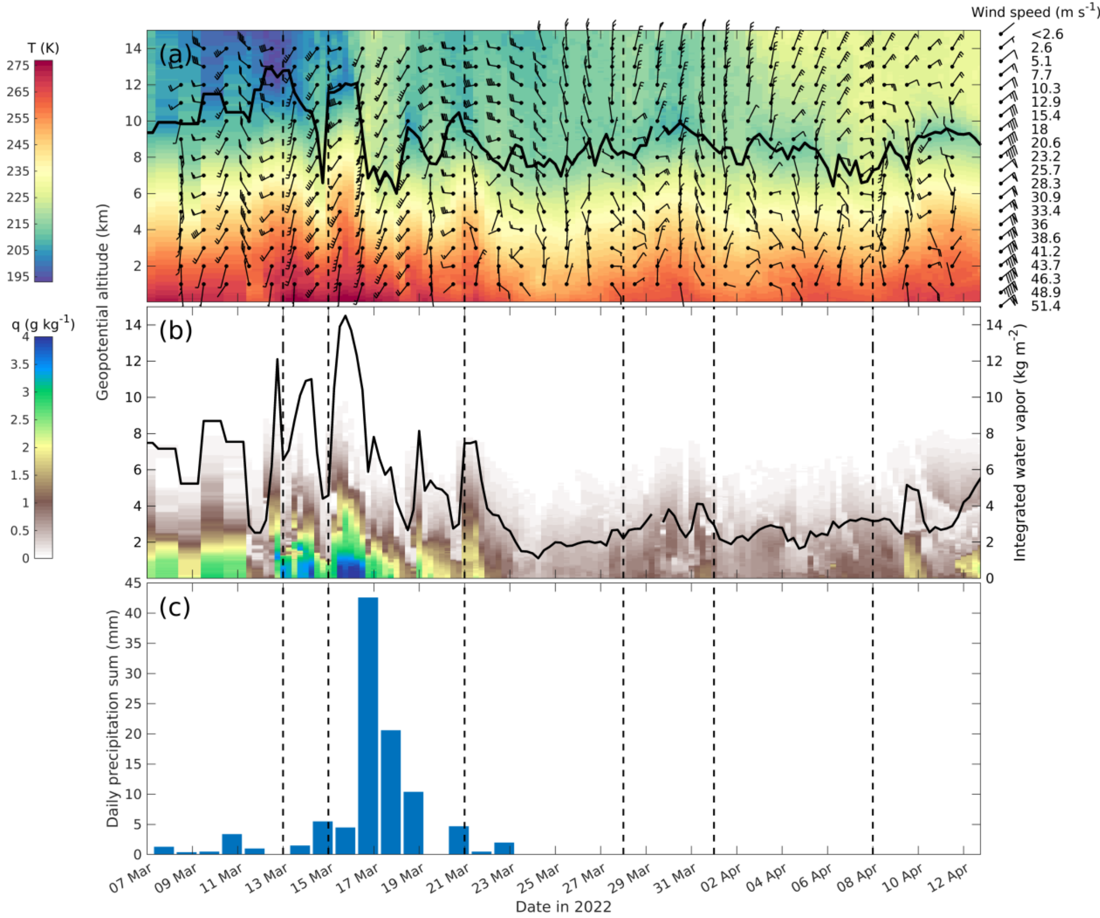
Data

- Observations at Ny-Ålesund
- Sea ice concentration from satellites
- ERA5:
  - ERA5 data was averaged over measurement regions
  - Land grid points were excluded
  - ERA5 climatology years: Satellite era (1979-2022)



Overview of the campaign period: Observations at Ny-Ålesund

- Large variability of temperature and humidty within just 5 weeks
- Two Atmospheric Rivers passed over Ny-Ålesund
- Record temperatures and daily precipitation for March since the beginning of measurements
- During the second half of the campaign, cold and clear sky conditions prevailed



Separation into warm and cold period

- Integrated water vapour transport (northwards):

$$\mathrm{IVT_{north}} = \frac{1}{g} \int_{p_{\mathrm{sfc}}}^{p_{\mathrm{top}}} q v dp$$

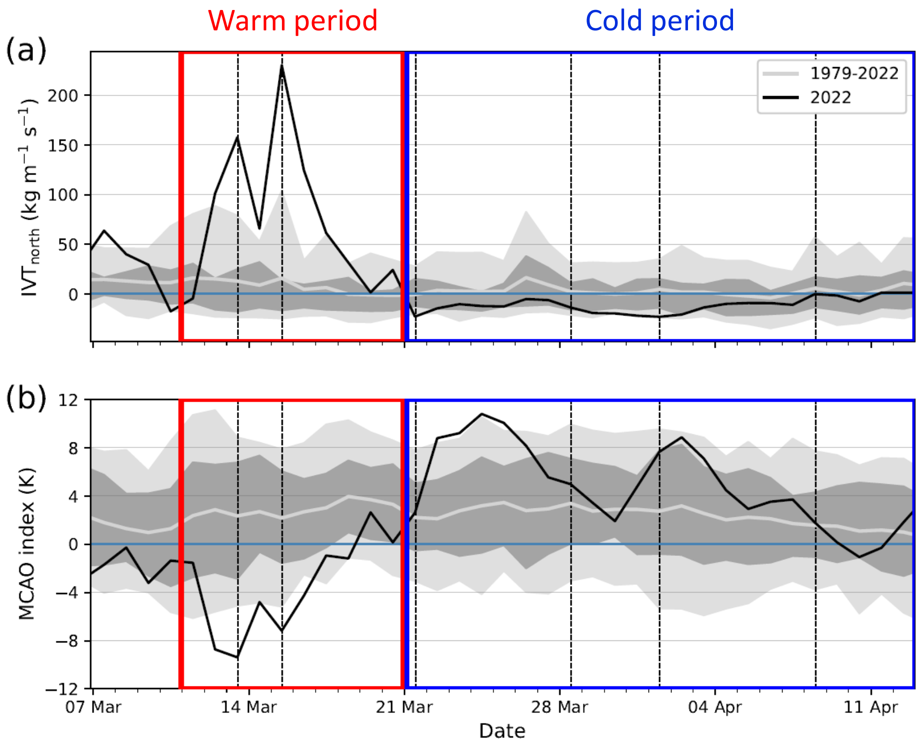
q : specific humidity
v : meridional wind
dp : pressure increment

- Marine Cold Air Outbreak index (MCAO index):

$$M = \theta_{\mathrm{SKT}} - \theta_{850}$$

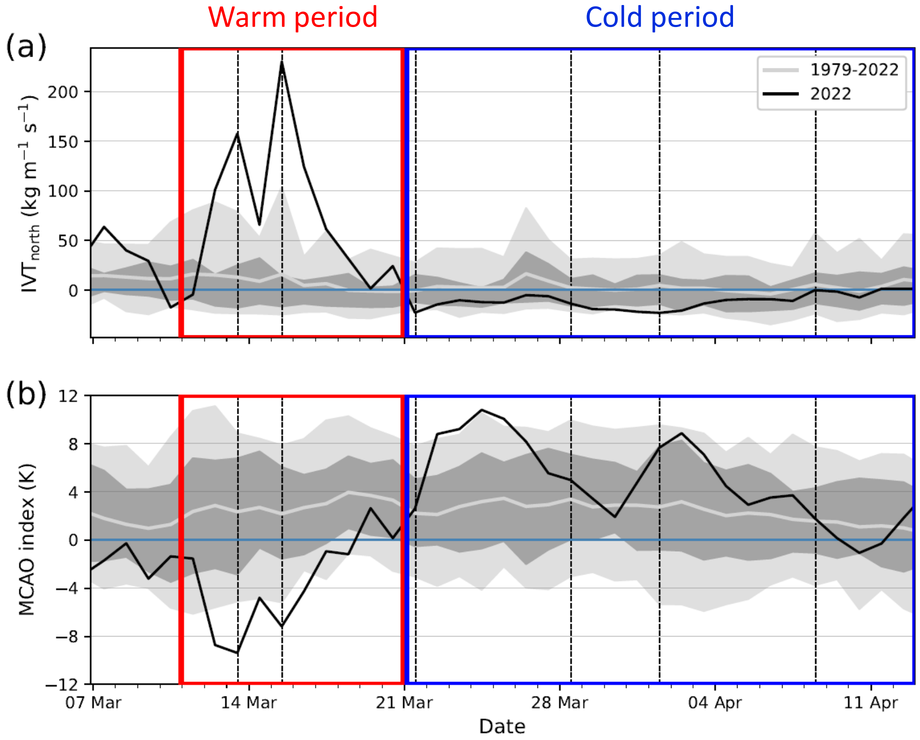
θ_{SKT} : potential skin temperature

θ_{850} : potential temperature at 850 hPa



Separation into warm and cold period

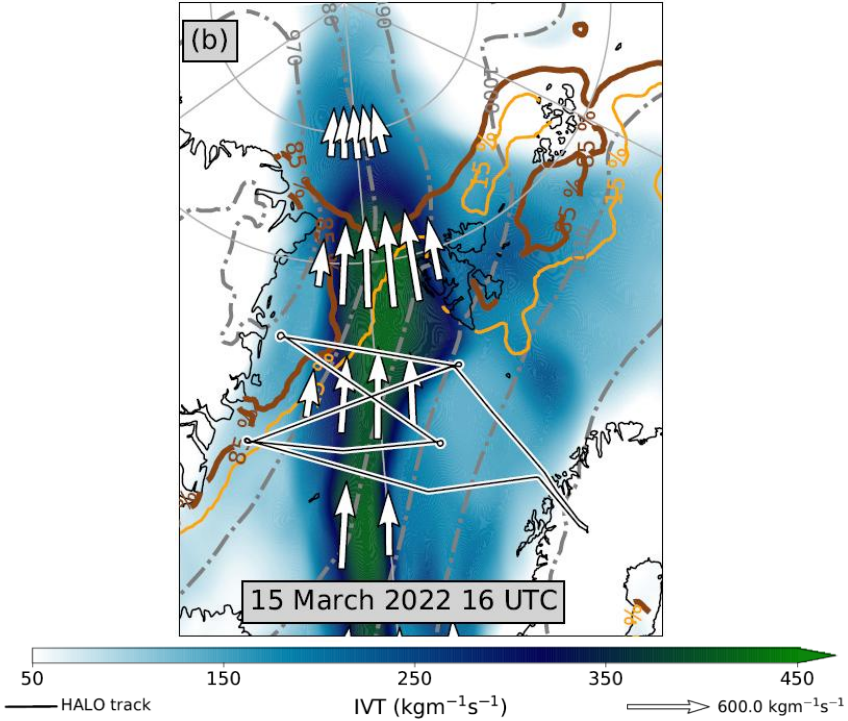
- Warm period:
  - Moist and warm air intrusions
  - Atmospheric Rivers (ARs)
- Cold period:
  - MCAOs
  - Polar Low
  - Arctic Cirrus

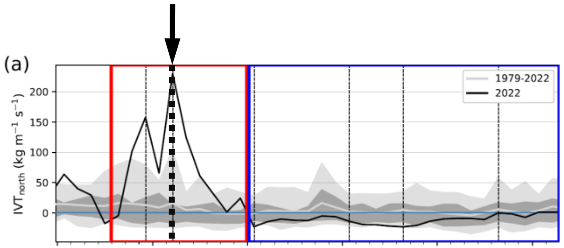


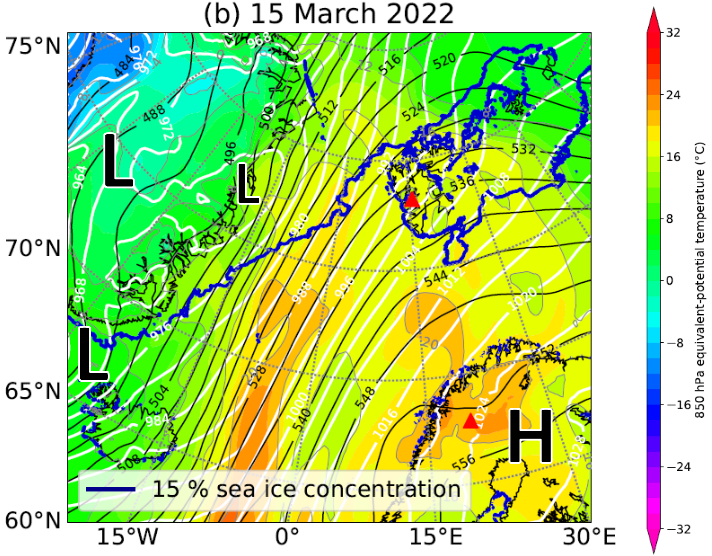
Warm period: Warm air intrusions & Atmospheric Rivers

- 15 March: Moist and warm air intrusion + AR

Total IVT, 15 March 2022



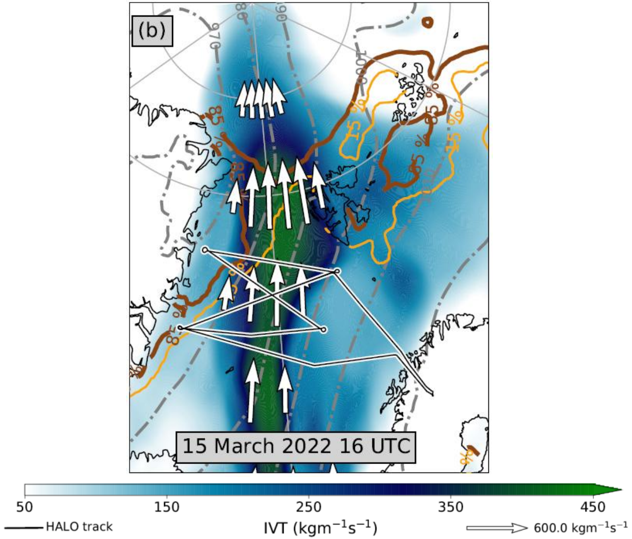




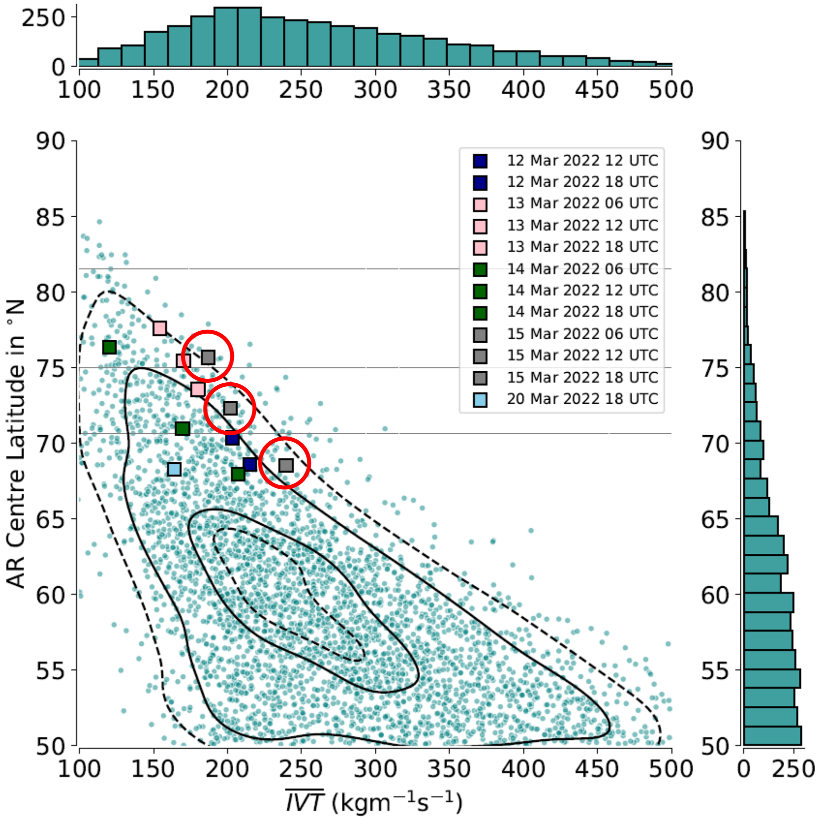
Climatological context: Record breaking warm air intrusion

- 15 March: Moist and warm air intrusion + AR

Total IVT, 15 March 2022

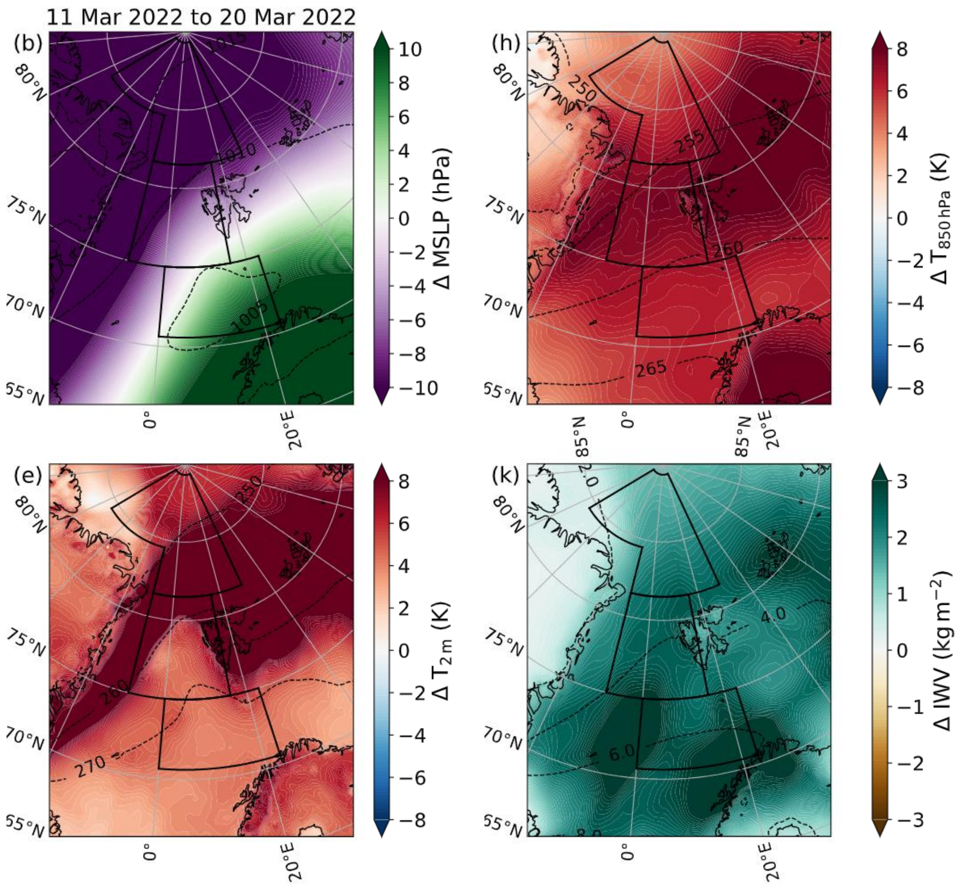


Climatology of Atmospheric River strength and position

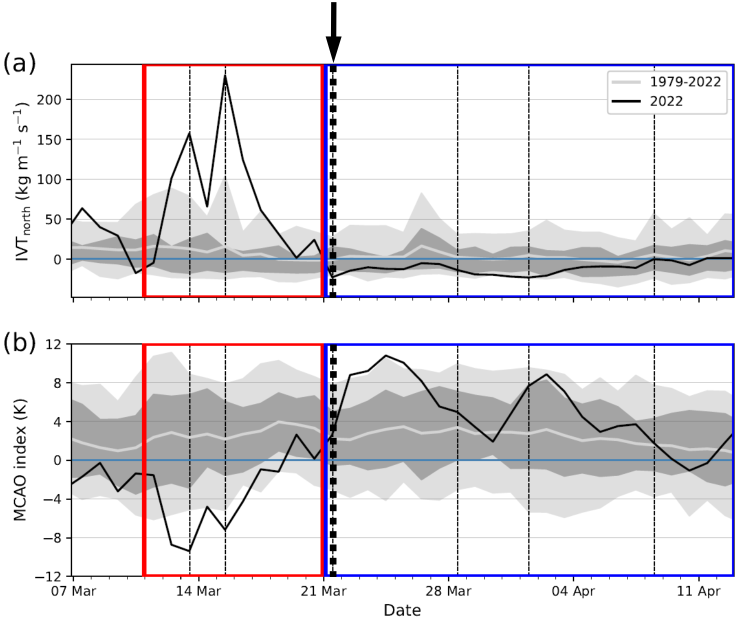


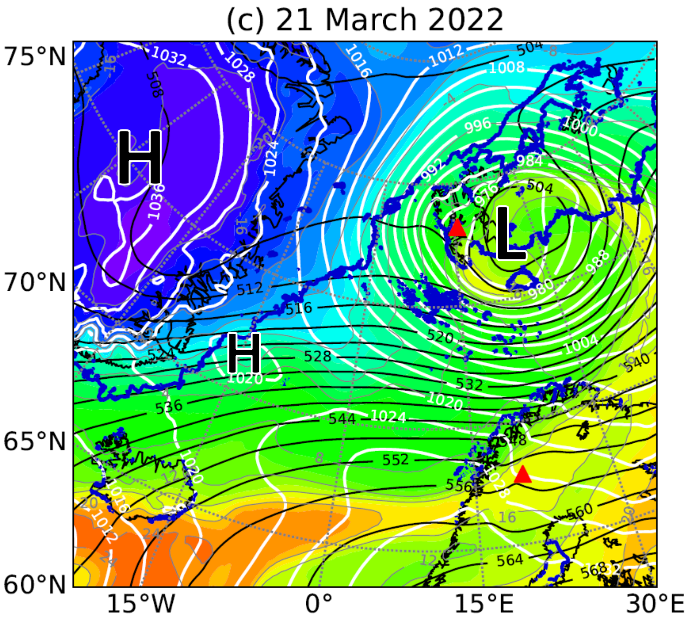
Climatological context: Deviations from climatology (1979-2022)

- Strong pressure anomalies led to the persistent southerly flow
- Highest temperature anomalies are over sea ice
- Highest integrated water vapour (IWV) anomalies are found in the southern region



Transition to cold period

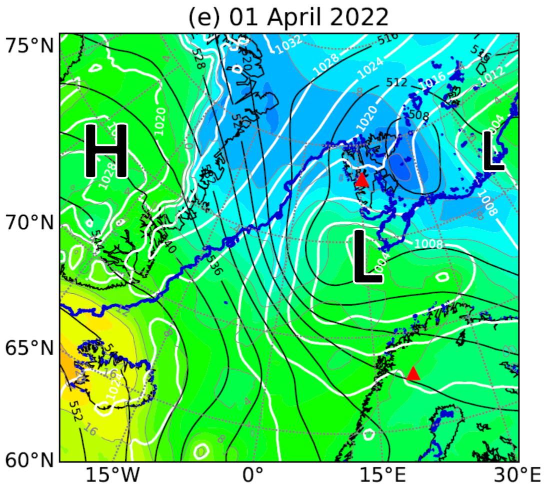




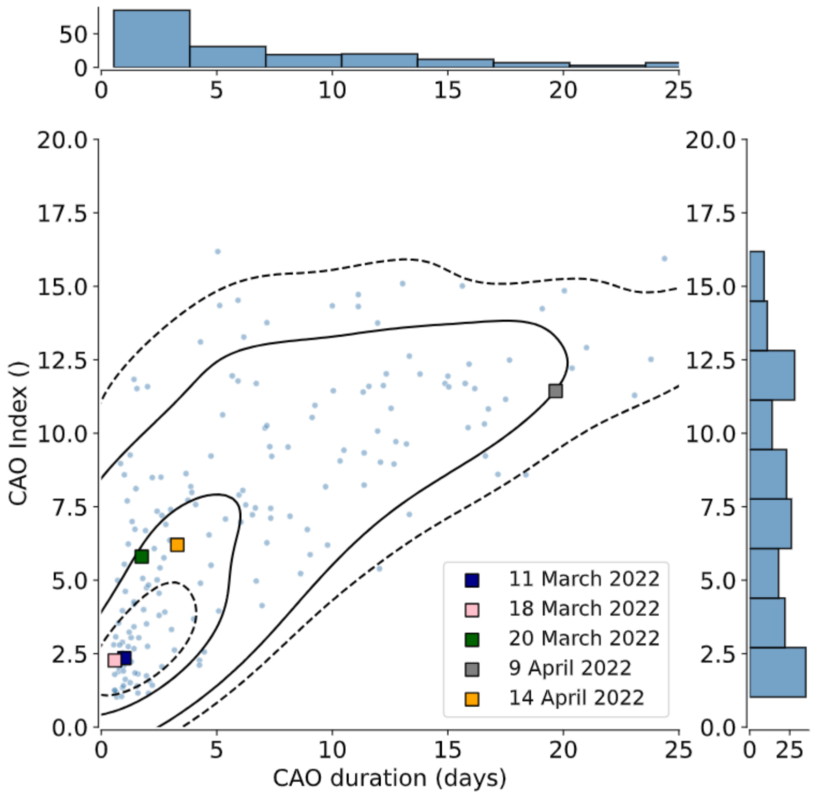
- Cyclone bomb: Shapiro-Keyser cyclone moved through central region
- High pressure formed over Greenland

Cold period: Several MCAOs occured in the Fram Strait

Typical pressure constellation during cold period

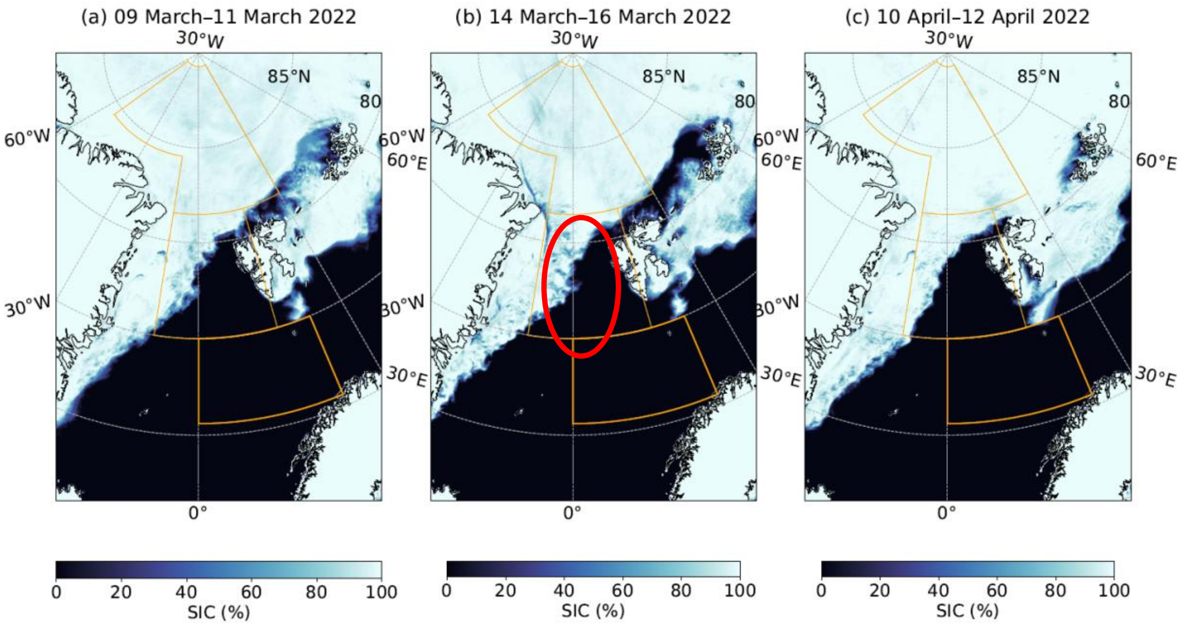


Climatology of MCAO strength and duration



Impact of the weather events on sea ice

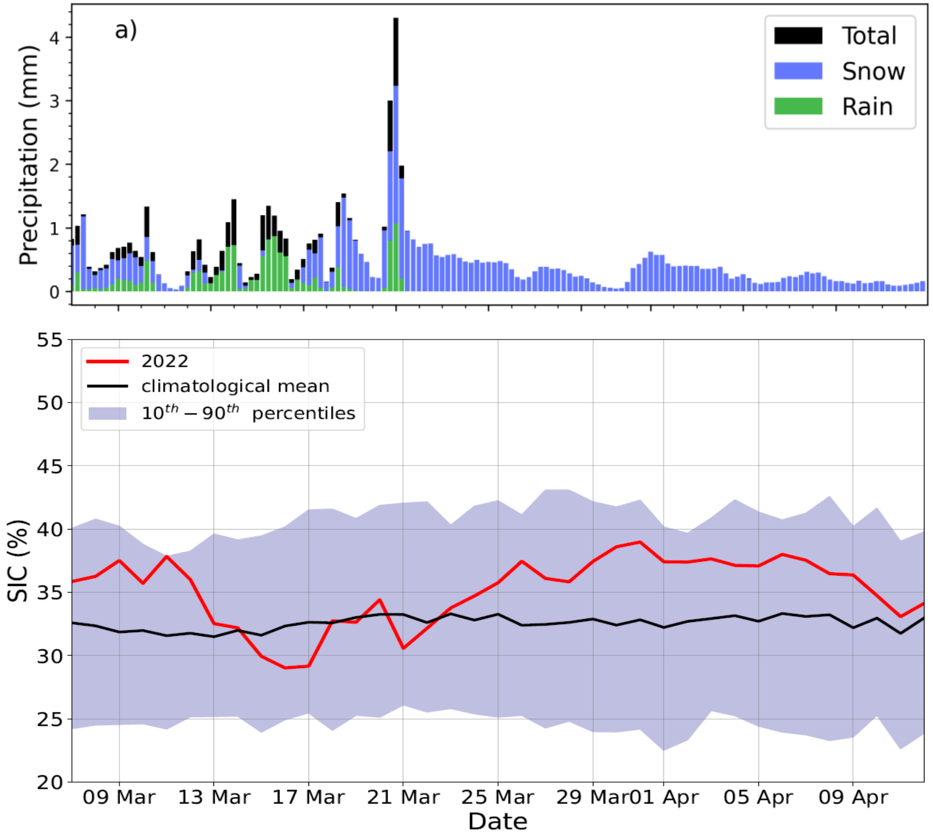
- A large polynya was opened between Svalbard and Franz-Josef-Land
- Many leads formed in the sea ice in the Fram Strait
- Reduction in sea ice cover was probably mainly caused by strong winds



Impact of the weather events on sea ice

- A large polynya was opened between Svalbard and Franz-Josef-Land
- Many leads formed in the sea ice in the Fram Strait
- Reduction in sea ice cover was probably mainly caused by strong winds
- Time series shows that liquid precipitation correlates well with reduced sea ice coverage

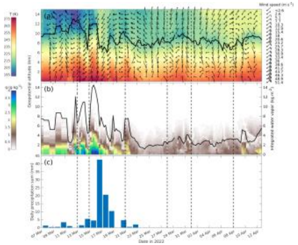
Precipitation and sea ice concentration in the Central Region



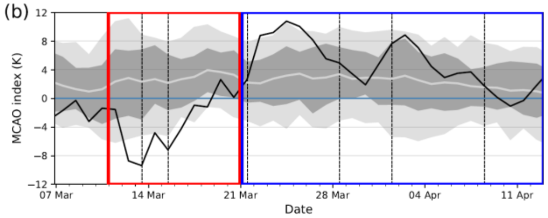
Summary

HALO-(AC)³ featured…

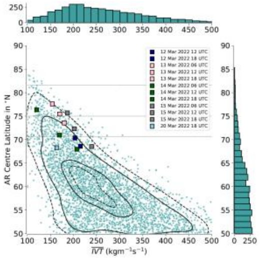
- Record temperatures and precipitation at Ny-Ålesund

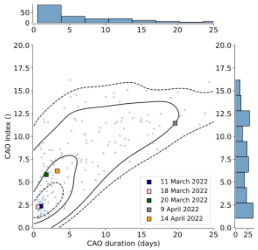


- Two distinct periods:
    - Warm period with strong Atmospheric Rivers and high positive temperature anomalies



    - Cold period with several Marine Cold Air Outbreaks





Thank you for your attention!

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