Recent developments in observing the Ny-Ålesund atmospheric column and beyond

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1. Motivation

- Continuous observations of the thermodynamic structure, clouds, aerosols, trace gases and radiative effects crucial for a better understanding of the Arctic atmosphere

→ exploit detailed information from the various remote-sensing and in-situ instrumentation at Ny-Ålesund, Svalbard

- Here, we highlight:

→ recent developments in observing the Ny-Ålesund atmospheric column (sec. 2)

→ variability of atmospheric variables on the local scale (sec. 3)

→ large scale links (sec. 4)

3. Local variability of water vapor and cloud liquid water

Seasonality

Microwave radiometer (MWR) measurements continuously since 2011

- Integrated water vapor (IWV) reaches highest values in summer
- Liquid water path (LWP) largest in late summer/early autumn (July-September), second maxima in late winter (February)

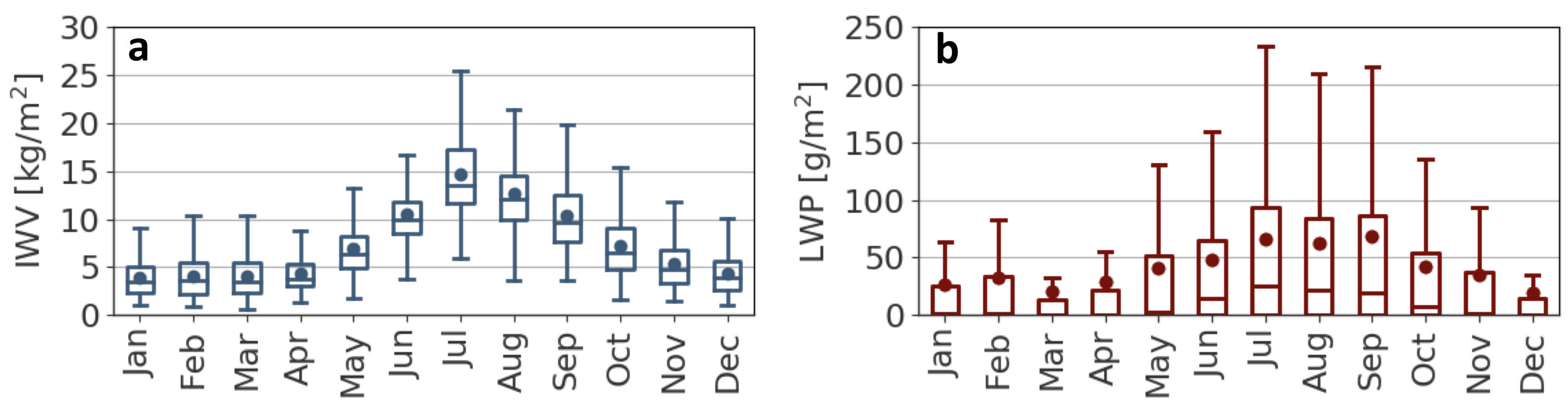


Fig. 4: Distributions of 10-min-mean values in each calendar month in 2012-2020 for a) integrated water vapor and b) liquid water path

Spatial variability

Evaluation of local scale variability in integrated water vapor and liquid water path utilizing MWR azimuth scans at 30° elevation angle

→ Local processes modifying IWV and LWP?

→ Representativity?

- Atmospheric river event on 6 June 2017: rapid increase & decrease in IWV
- Increase (decrease) in IWV is seen first in S-SE direction, corresponding to the movement of the atmospheric river over Ny-Ålesund

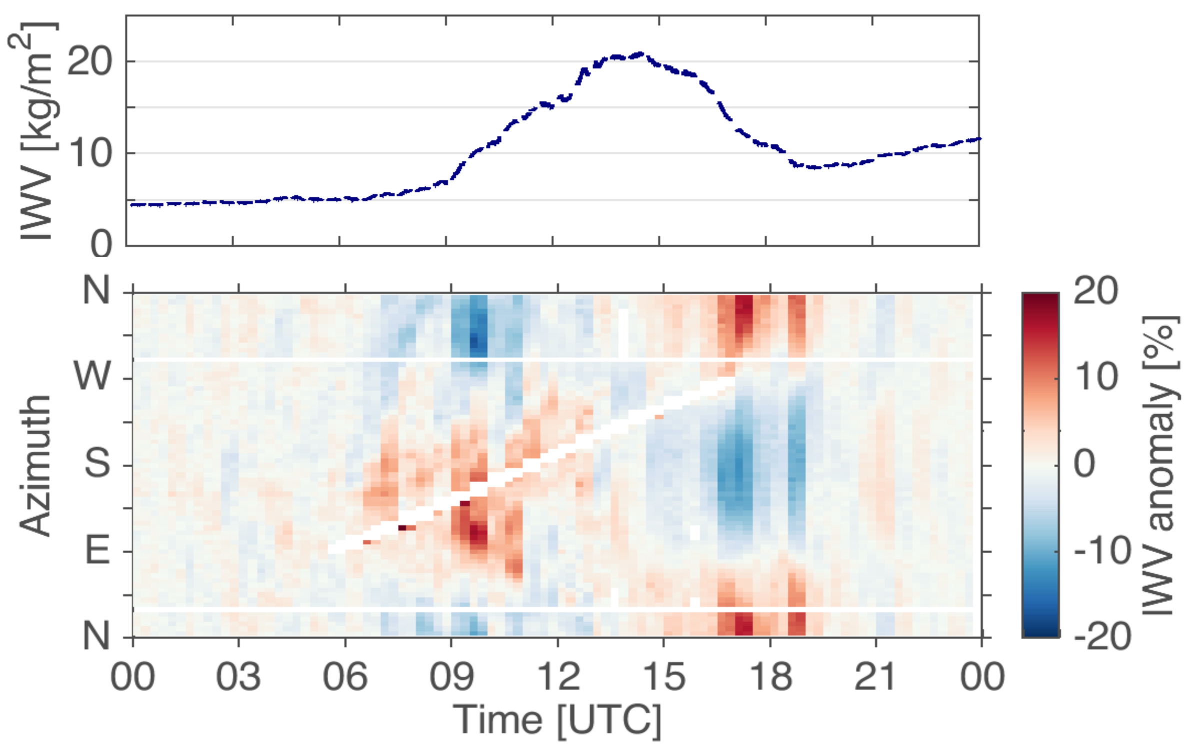


Fig. 5: Top: Time series of integrated water vapor (zenith pointing measurements) for the atmospheric river event on 6 June 2017. Bottom: IWV anomaly at a given measured azimuth angle for each azimuth scan

5. Conclusions & Outlook

- Aerosol composition above Svalbard affected by local emissions and transport of emissions from Europe
- Atmospheric river passing over NYA can be seen in spatial distribution of humidity
- Fram Strait / Svalbard region: increasing MCAO trend in spring found

Perspectives

- Analysis of aerosols on other Arctic stations
- Evaluation of spatial patterns of moisture around Ny-Ålesund using long-term data
- Analysis of vertical fluxes during MCAO events + impact on atmospheric column
- Joint analysis of fluxes during MCAO effects: impact on ocean [→ C04]

REFERENCES

- Dahlke, S., A. Solbés, M. Maturilli (2021): Cold air outbreaks in Fram Strait: climatology, trends, and observations during an extreme season in 2020. *JGR*, under review

2. Chemical composition and origin of aerosols

Chemical Composition of Aerosols

- Sea salt and sulfate are significant in the aerosol events in Ny-Ålesund
- Aerosol enhancements of dust and BC happen more frequently in spring time

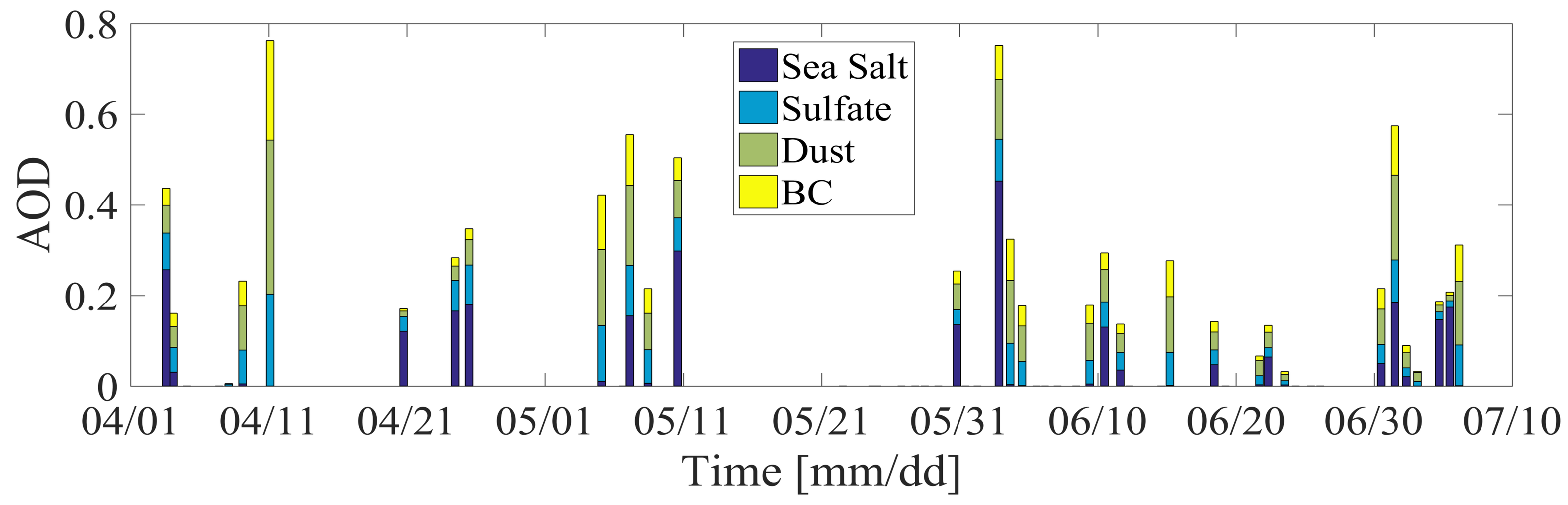
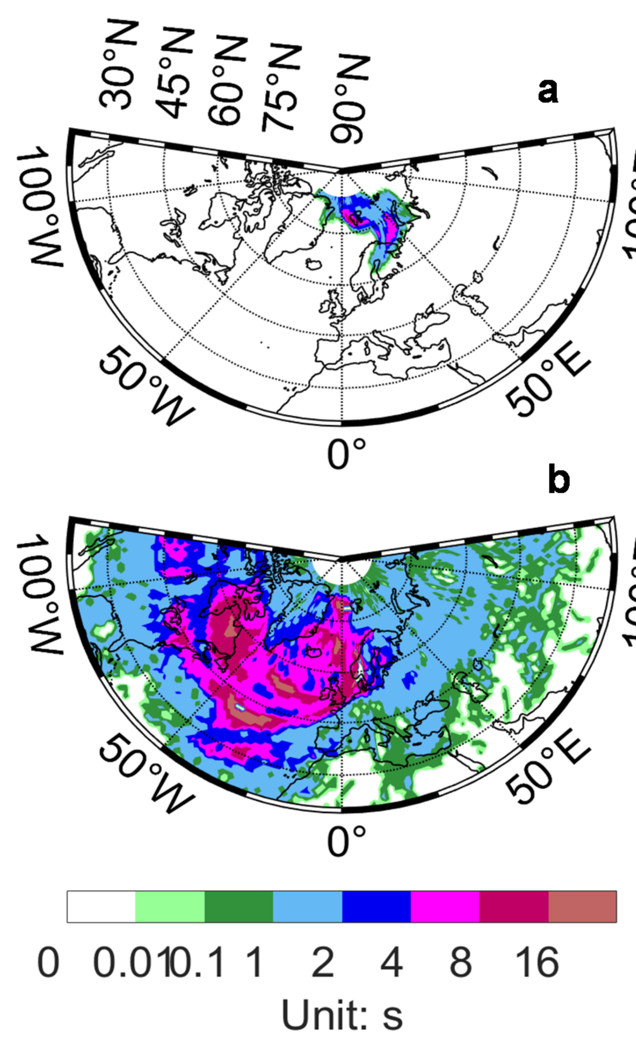


Fig. 1: The chemical composition derived from NYAEM-FT in 2020

Origin of Aerosols

- Backtrajectory analysis and lidar measurements on 10 June 2020 in Ny-Ålesund
- Aerosol signal is obvious in the boundary layer below 500 m
- Aerosols in the boundary layer mainly come from the local area, and that in free troposphere mainly came from Europe



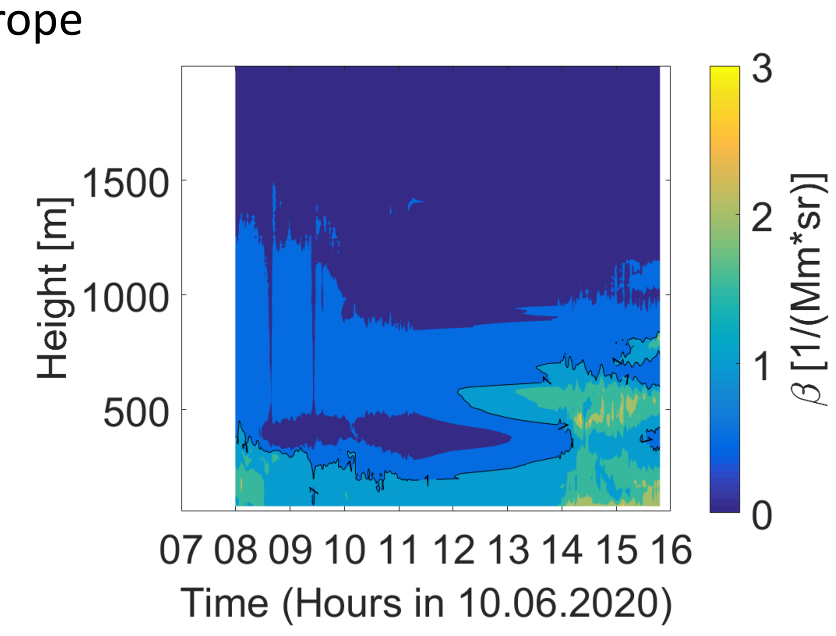


Fig. 2: LIDAR backscatter coefficient measurements on 10 June 2020

Fig. 3: (a) 3 days backtrajectory (footprint) initiated on 10 June 2020 at Ny-Ålesund (500 m) (b) 20 days backtrajectory (footprint) initiated on 10 June 2020 at Ny-Ålesund (3000 m)

4. Large scale links

Regional Modulation of Amplified Warming

The North Atlantic / Svalbard region is affected by atmospheric advection with seasonal dependence

- decrease in MCAO index in December and January appears to be related to the vertical structure of atmospheric warming rather than to circulation changes
- MCAO increase in March over Fram Strait related to trend in northerly winds

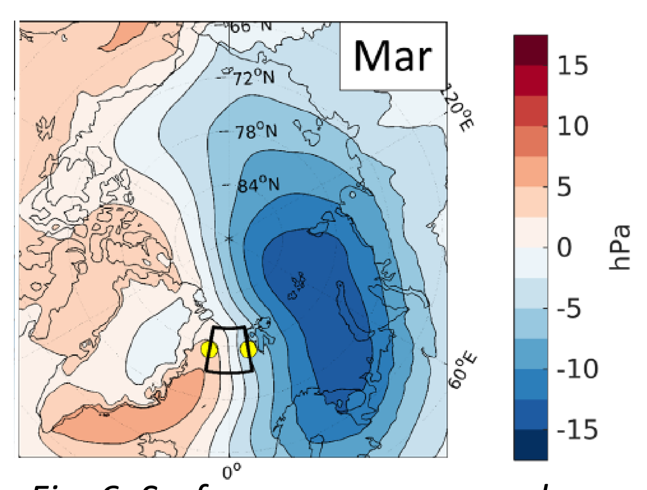


Fig. 6: Surface pressure anomaly composite for the 95[th] percentile of strongest Fram Strait MCAOs in March

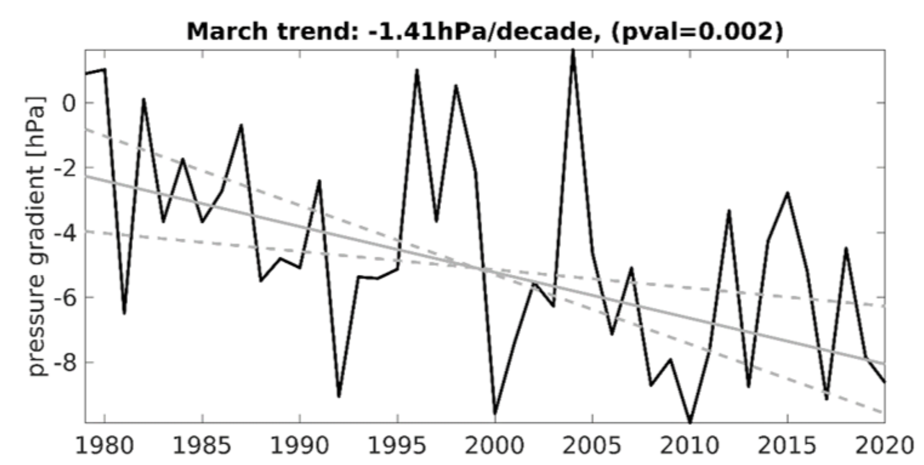


Fig. 7: Zonal surface pressure gradient across Fram Strait (yellow dots in Fig. 6) for March, with linear trend using the Theil-Sen slope and uncertainty limits

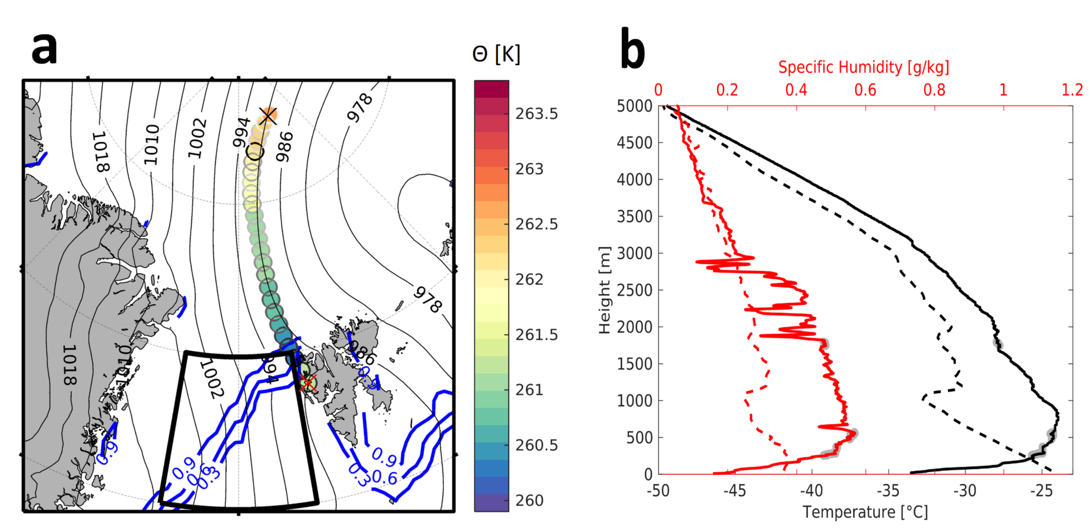


Fig. 8: (a) Backtrajectory initiated on 11 March 2020 at Ny-Ålesund (1800 m) linking with MOSAiC. The color-code indicates temperature, blue lines the sea ice edge. (b) Radiosonde temperature (black) and specific humidity (red) measured at Ny-Ålesund (dashed lines) and MOSAiC (solid lines)

Figures 6-8 from Dahlke et al. (2021)

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