Ny–Ålesund column thermodynamic structure, clouds, aerosols, trace gases and radiative effects

E02

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1. Summary

- improved and extended Ny-Ålesund column observations
- linking campaign activities, satellite observations, process studies and modelling

advection of warm and moist air masses, trace gases, aerosols → corresponding effects of clouds and radiation

\+ interplay with surrounding Arctic environment on different spatial scales

Hypothesis

Ny–Ålesund, located in the warmest part of the Arctic, exhibits distinct dynamic and radiative effects that are indicative for the transition from polar to maritime climate.

Research Questions:

Q1 How is the Ny–Ålesund atmospheric column affected by sea ice, ocean and other environmental parameters?

Q2 How do circulation patterns and atmospheric transport pathways modify the radiative properties of the atmospheric column on various temporal and spatial scales?

2. Achievements phase I

Technical Achievements

- Update of retrieval software SFIT4 for IWV from infrared spectra (Buschmann et al., in prep.)

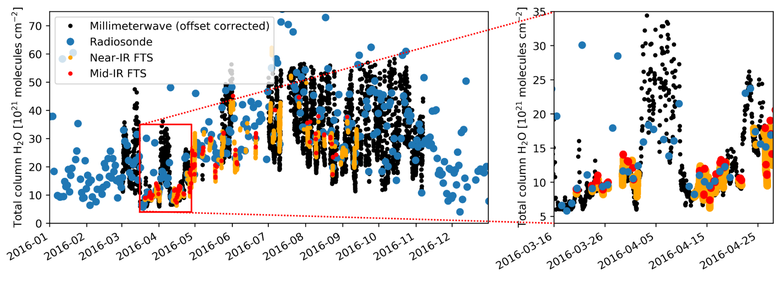


Fig. 1: Total water vapour obtained from different sensors at Ny-Ålesund. The combined sensors ensure high quality measurements during all conditions.

- Continuous emission infrared FTS measurements since summer 2019
- Installation and continuous operation of a new FMCW cloud radar
- Retrieval of improved T, q, IWV and LWP estimates from MWR
- Operational application of cloud macrophysical and microphysical retrievals

Scientific Achievements

- Analysis of vertically resolved cloud properties for 1 year (Nomokonova et al., 2019)

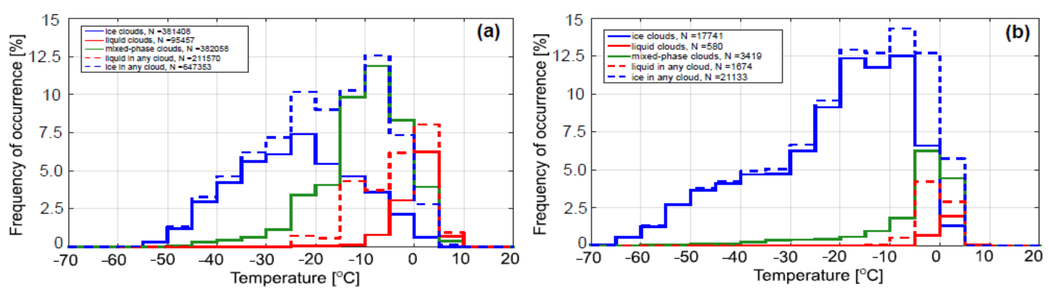


Fig. 2: Distribution of in-cloud temperature for different types of single-layer clouds for (a) observations and (b) the NWP-ICON model over Ny-Ålesund.

- Retrieval of aerosol microphysical properties and radiative impact of biomass burning event (Ritter et al., 2018)
- First assessment of cloud radiative forcing at Ny-Ålesund in combination with a broadband radiative transfer model (Ebell et al., in revision)
- Quantification of advective contribution to warming in the North Atlantic region of the Arctic (Dahlke and Maturilli, 2017)

3. Research plan phase II

WP1 Local Conditions

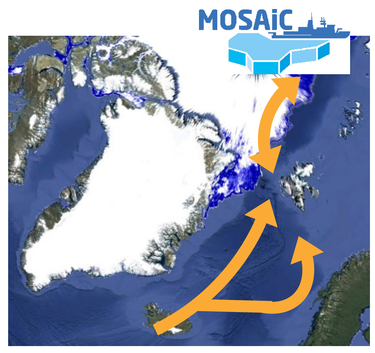
Extending observations of phase I to allow long-term climate analysis:

- Added value datasets (statistical information) → Z03/INF
- Local scale influence
  - Ocean – atmosphere link
  - Spatial variability of moisture and cloud LWP
- Cloud properties and thermodynamic conditions
- Multi-year assessment of radiative effects
  - radiative transfer model + cloud products + trace gases in clear sky

WP2 Advective Connection

Exploiting Ny-Ålesund's location in the Atlantic gateway to the Arctic:

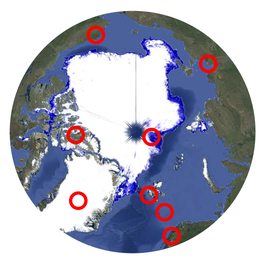
- Link between North Atlantic and Central Arctic
  - Marine cold air outbreaks
  - Lower latitude intrusions
  - (Extreme) cyclone events
- Oceanic heat advection affecting the tropospheric column
  - Analysis including West Spitsbergen Current data
- Cloud and LWP observations
  - Comparison with MOSAiC and COMBLE sites
- Water isotope fraction δD long-term analysis
  - Monitoring changes in atmospheric transport patterns



WP3 Pan-Arctic Context

Linking the North Atlantic Arctic to other Arctic key regions:

- Ny-Ålesund atmospheric state and connection to large scale atmospheric patterns
- Variability of clouds across Arctic sites
  - Including ground-based and satellite data



4. Role within (AC)³ & perspectives

Collaborations within (AC)³

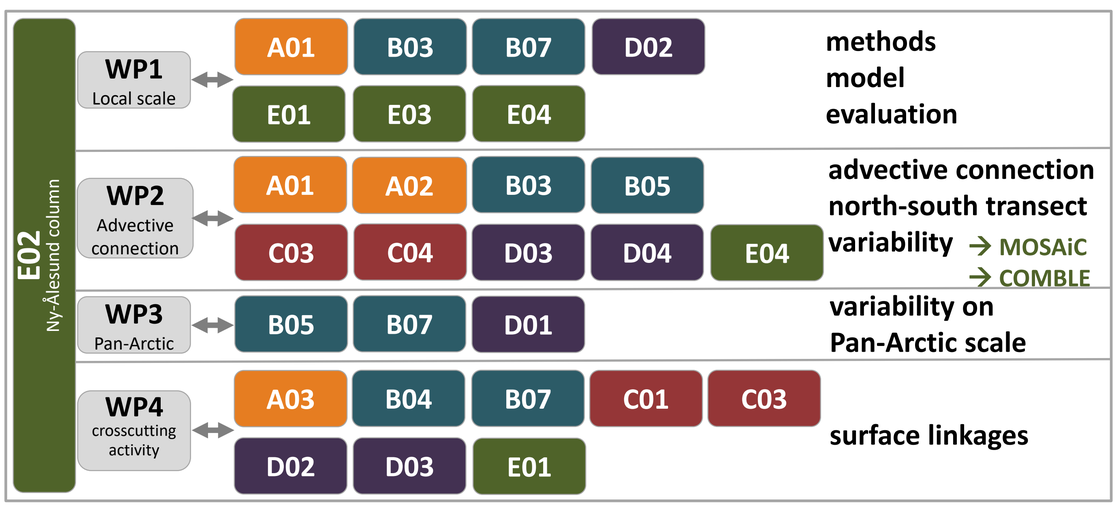
Strong links with other sub-projects, e.g.:

- Airborne observations in [B03]
- High-resolution modeling studies [E03]
- Atmospheric transport studies [E04]

WP4 Crosscutting Activity

Coordination of **CCA2 Surface Linkages**

- Integrative approach to study the effects of heterogeneous Arctic surface properties on atmospheric processes
- Contribution to all other CCAs



Perspectives

- Continuation and homogenisation of Ny-Ålesund data sets for detection and attribution of trends
- Characterisation of the radiative effect of clouds, aerosols, trace gases and thermodynamic changes in context of similar measurements in other Arctic subregions
- Broadening the perspective by including e.g. GHG release from sub-Arctic permafrost regions

TR 172 TRANSREGIONAL COLLABORATIVE RESEARCH CENTRE

(AC)³ ArctiC Amplification: Climate Relevant Atmospheric and SurfaCe Processes, and Feedback Mechanisms

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