Ny-Ålesund column thermodynamic structure, clouds, aerosols, radiative effects

E02

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1 Summary

Continuous Characterization of the Ny-Ålesund Column and Radiative Effects from Ground-based Remote Sensing (CONCORD)

- Thermodynamic structure, clouds, aerosols, trace gases, and their radiative effects
- Implementation of integrated profiling methods (incl. uncertainty estimates) to quality controlled measurements by established and new instrumentation
- Long-term characteristics, temporal variability, connection to meteorological patterns
- Representativeness across other Arctic sites (supersites, campaigns)

Hypothesis

Ny-Ålesund, located in the warmest part of the Arctic, exhibits distinct radiative effects by clouds and aerosols and complements the information from other Arctic supersites.

2 Research rationale

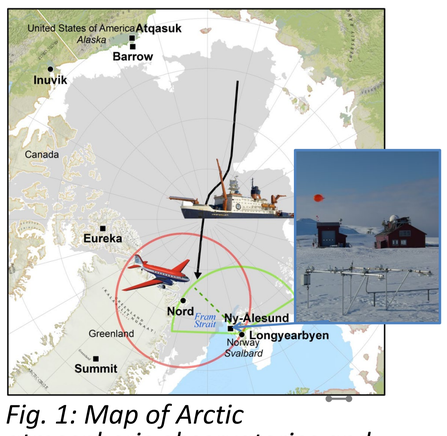


Fig. 1: Map of Arctic atmospheric observatories and $(AC)^3$ campaign activities.

Motivation

- Ny-Ålesund, Spitsbergen (Fig. 1), has a substantial history in thermodynamic, trace gas (Fig. 3), aerosol, and surface radiation observations
- Extension of instrumentation and observing techniques (CONCORD, Fig. 2) will allow to exploit the unique potential for deriving a whole suite of essential Arctic climate variables, including cloud macro- and microphysics (Fig.4)

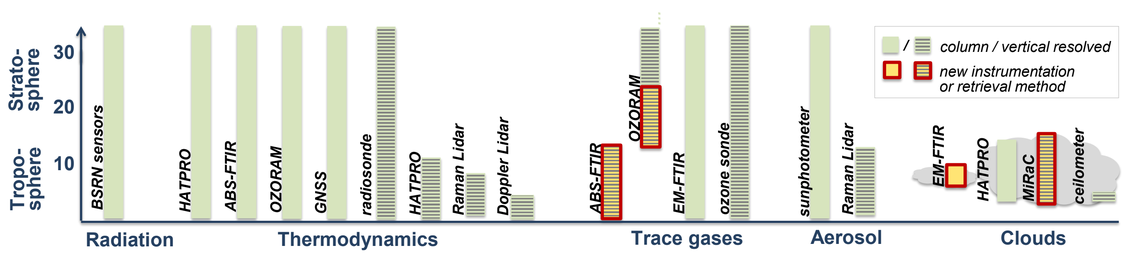


Fig. 2: Schematic of Ny-Ålesund extended instrumentation and retrieval methods.

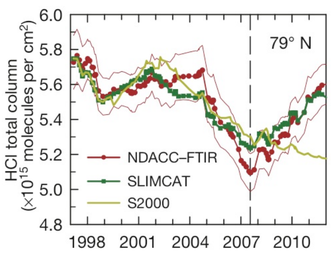


Fig. 3: Rising HCl trend observed since 2007 at Ny-Ålesund by ABS-FTIR (from Mahieu et al., 2014, Nature).

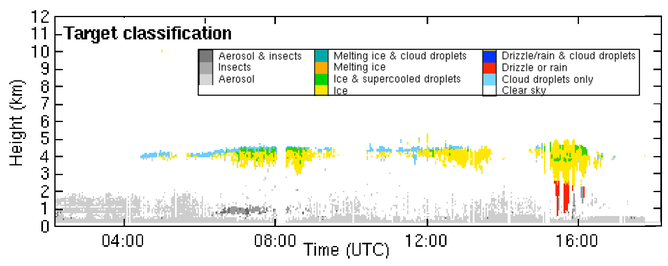


Fig. 4: Example of Cloudnet classification product on November 1, 2014, based on the IGM measurements at the Jülich Observatory for Cloud Evolution.

Scientific questions:

- To what extent and with which accuracy can we gain insight into the thermo-dynamic, trace gas, aerosol and cloud properties at Ny-Ålesund?
- What is their impact on the radiation and energy budget throughout the vertical extent from the surface to the lower mesosphere?
- How representative are the Ny-Ålesund observations across other Arctic sites?

3 Research plan

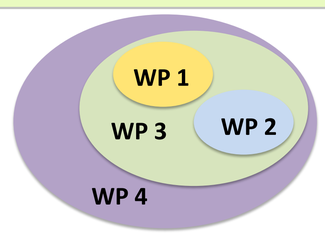


Fig. 5: Schematic concept of the work package structure of project E02.

WP1: Improved ozone measurements and thin cloud products

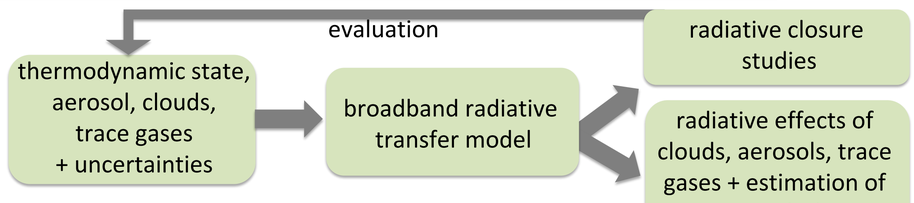
- Extendend EM-FTIR observations → aerosol amount and composition; cloud optical depth and effective radius
- Extended OZORAM observations → O_3 profile down to ~20 km
- Combination of ABS–FTIR and OZORAM to retrieve a single O_3 profile → full O_3 profile from ground to mesosphere

WP2: Improved thermodynamic, cloud and aerosol products

	Input/Tools	Retrieved product
Improved T, q and LWP estimates	HATPRO, MiRAC, radiosonde + regression-based retrieval	• best estimate T and q profiles • LWP, IWV • best estimate LWP
Cloud macrophysics	synergistic analysis of thermodynamic profiles NWP model, MiRAC, MPL, KARL, LWP	vertically resolved • cloud mask • cloud phase information
Cloud microphysics	cloud classification, LWP, MiRAC, HATPRO, MiRAC spectra analysis (E03) + empirical / 1D variational retrieval techniques	• liquid water content & droplet effective radius profiles • ice water content & ice particle diameter profiles
Aerosol properties	KARL, sunphotometer, ceilometer, MPL + inversion technique	aerosol • size distribution • refractive index • optical depth

WP3: Radiative effects of clouds, aerosols and trace gases

- Aerosol closure
- Cloud radiative effects and closure



WP4: Representativeness

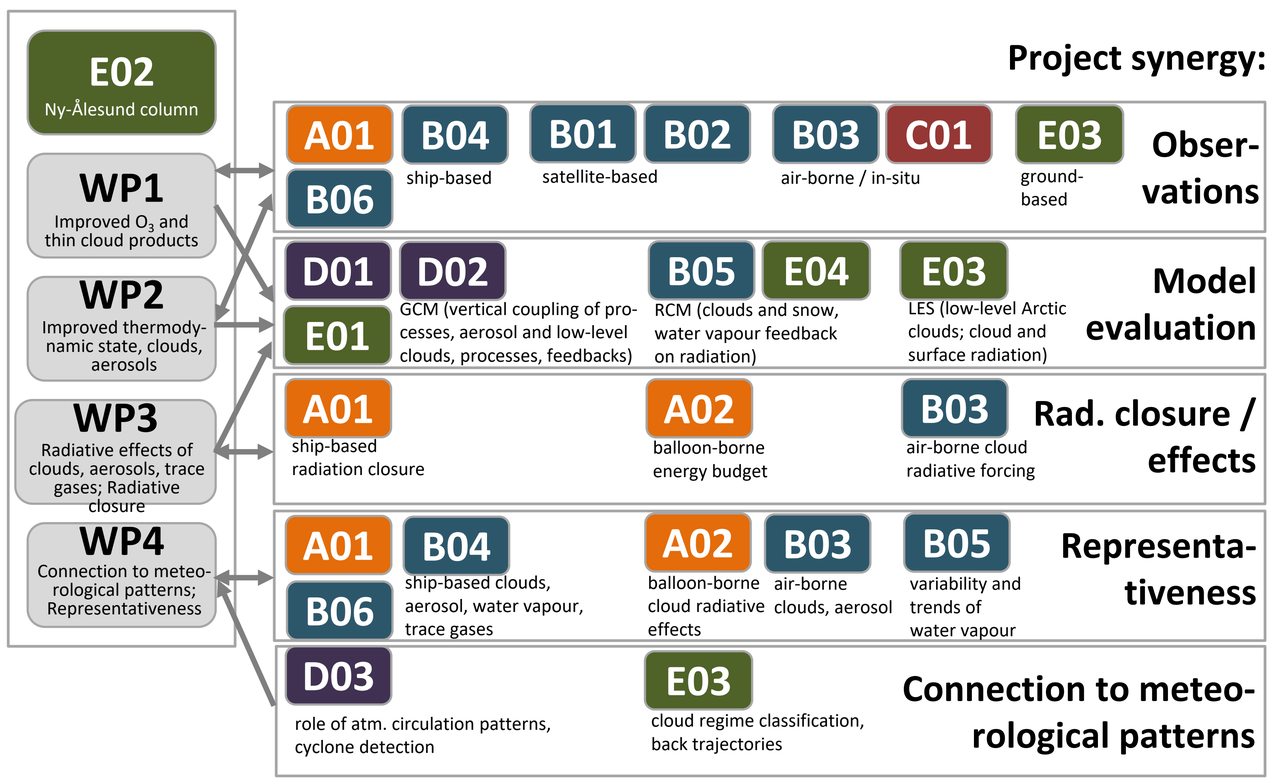
Connection to meteorological patterns

- Ny-Ålesund thermodynamic state, aerosol, trace gases, cloud properties:
  processes on local and synoptic scales, physical feedback processes

Representativeness across Arctic sites

- Ny-Ålesund meteorology and trace gases
  comparison: campaigns, supersites, satellite data

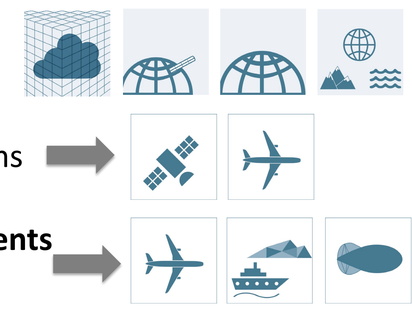
4 Role within $(AC)^3$ & perspectives



Collaboration within $(AC)^3$

CONCORD observations and retrievals

- as **benchmark for model evaluation** (B05, D01, D02, E01, E03, E04)
- as **reference and validation data set** for satellite and airborne retrieval algorithms (B01, B02, B03, C01)
- to **complement and tie campaign experiments** (A01, A02, B03, B06)



Perspectives

- **Continuation** of Ny-Ålesund measurements **during $(AC)^3$ and beyond**
- **Value Added Products**, e.g. long-term statistical analysis → model parameterizations
- Development and application of **enhanced retrieval methods**, e.g. combined FTIR and MWR retrieval for T, q, and clouds; combined ground-based/satellite retrieval
- Application of retrieval methods to **MOSAiC campaign** observations

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