Latitudinal variability of water vapour, aerosols, and optically thin clouds

B06

Justus Notholt, Roland Neuber,
Mathias Palm, Christoph Ritter

TRANSREGIO TR 172 | LEIPZIG | BREMEN | KÖLN

UNIVERSITÄT LEIPZIG | Universität Bremen | University of Cologne | TROPOS Leibniz Institute for Tropospheric Research | AWI

1 Summary

- Investigating spatial fine structure of important atmospheric components along the latitudinal gradient from northern Europe via Svalbard into the Arctic Ocean
- Connecting ship and airborne measurements with long term station data (AWIPEV Research station, Svalbard)
- Latitudinal variability of water vapour, aerosols, and clouds
- Using novel methods for FTIR spectroscopy, allowing source appointment by isotopic analysis

Hypothesis

The latitudinal variability of water vapour, aerosols, and thin clouds from midlatitudes to the high Arctic impacts on Arctic climate changes.

2 Research rationale

- Water vapour shows a high variability with both, temporal and spacial gradients.
- FTIR isotopic water vapour data allow attribution to sources due
- to different fractionations of the water isotopes
- FTIR emission spectroscopy provides quantities of aerosols and thin clouds.

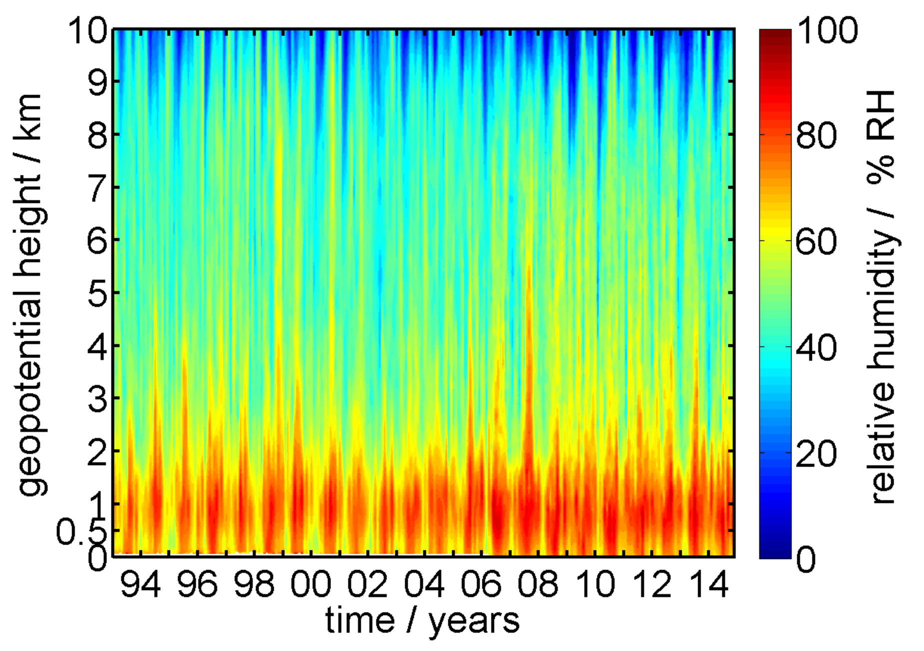


Fig. 1 Water vapour development over Spitsbergen, homogenized radio sonde data 94 -14

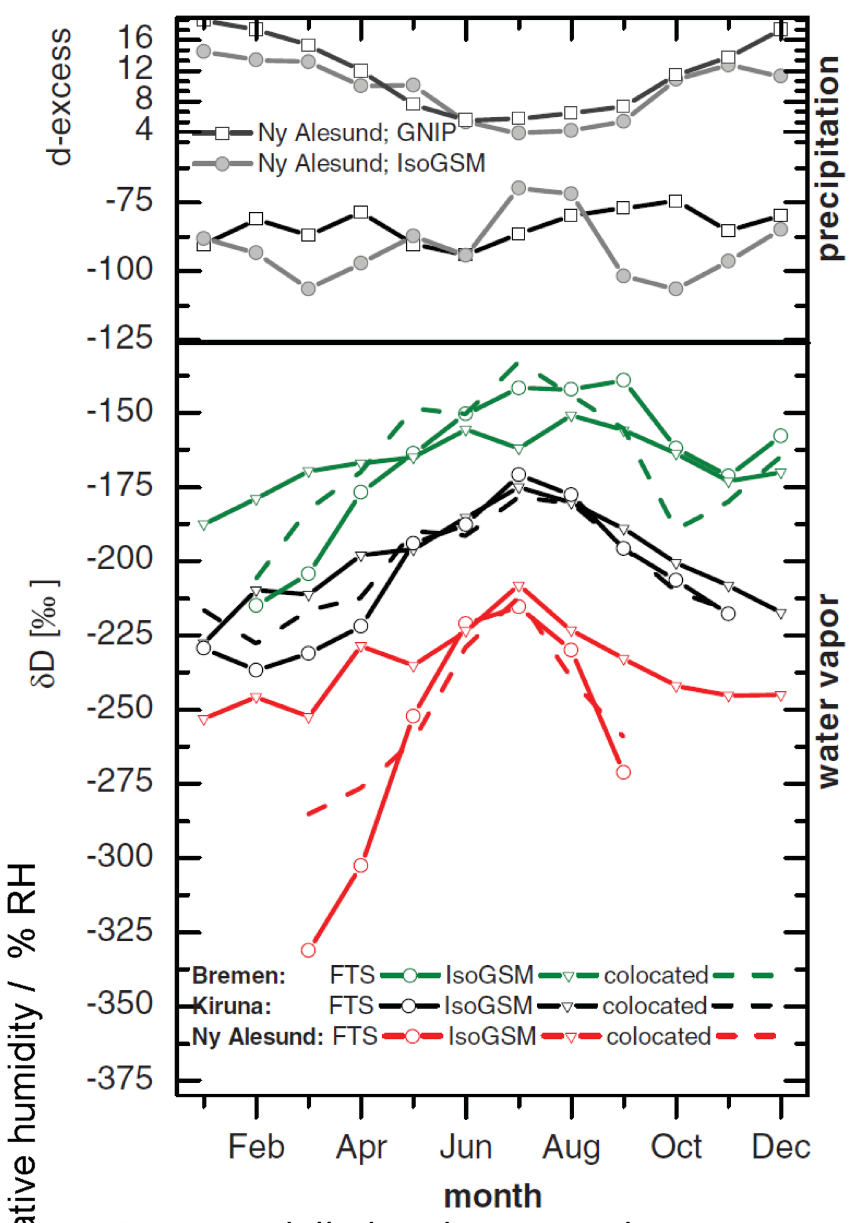


Fig. 2 Modelled and measured precipitation δD and d-excess monthly averages at high Arctic Ny-Ålesund (top), and latitudinal dependence of modelled and retrieved δD (bottom) (Frankenberg et al., 2009, Science)

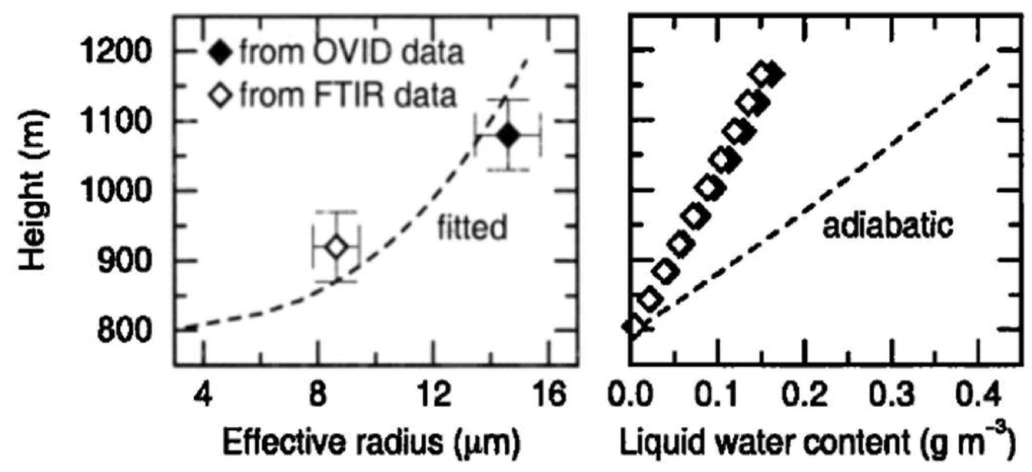


Fig. 3 cloud quantities from FTIR spectra in comparison with another method (OVID), (Rathke et al., 2000, GRL.)

3 Research plan

Study latitudinal variability of water vapour, aerosols, and optically thin clouds by using FTIR spectrometry, microwave radiometry, and lidar.

WP 1: Operate a mobile FTIR (MOFTIR) on a dedicated ship cruise in 2017

- Measurements of thin clouds and aerosols by emission spectroscopy
- Measurements of trace gases by solar absorption

WP 2: Analyse the ship borne MOFTIR measurements for atmospheric water content and its isotopic composition as well as thin clouds

WP 3: Perform combined analyses and interpretation of ship–borne observations and at AWIPEV station on Svalbard, in particular for the microwave radiometer measurements, the ABS-FTIR -observations, and the lidar data

- Validation of water vapour profiles
- Microphysical aerosol properties
- Comparison of ship–based and Ny–Ålesund measurements

Example of lidar data analysis:

aerosol properties before / after clouds, consideration of multiple scattering, aerosol and humidity

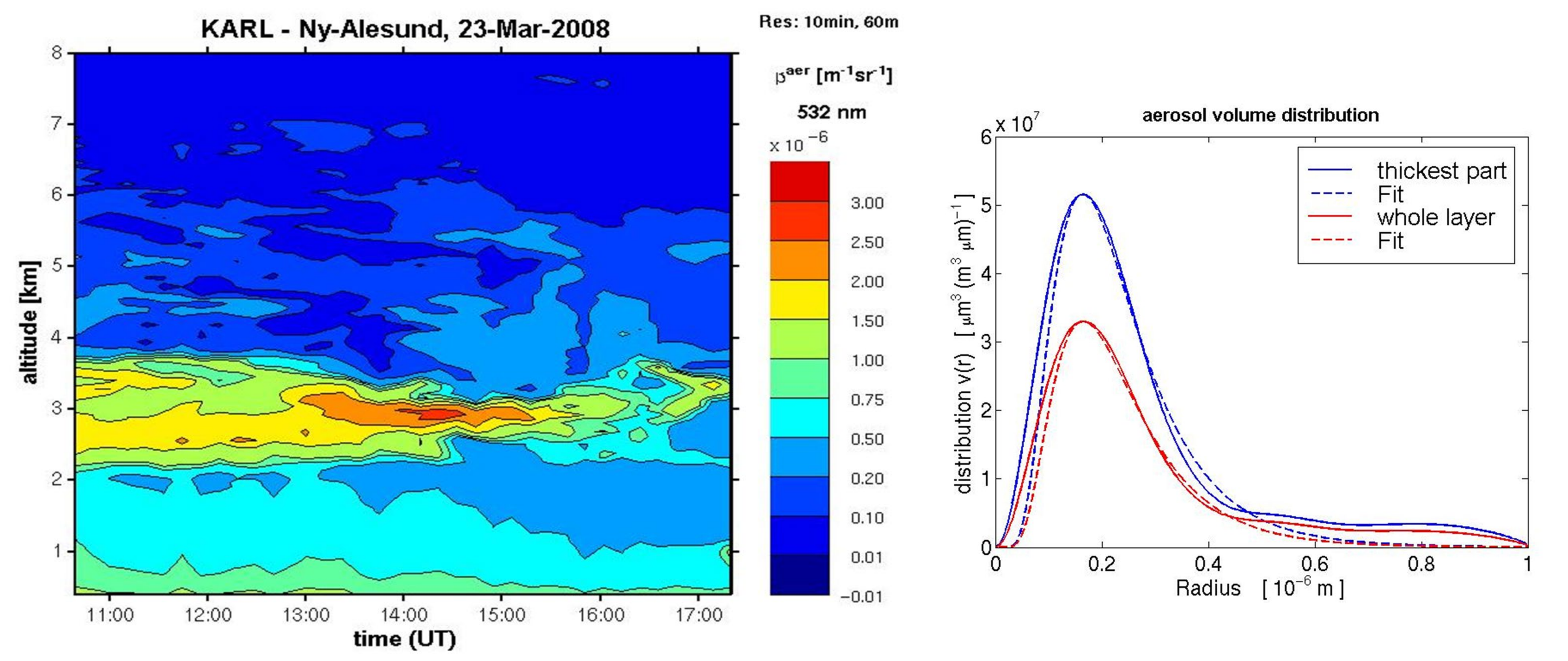
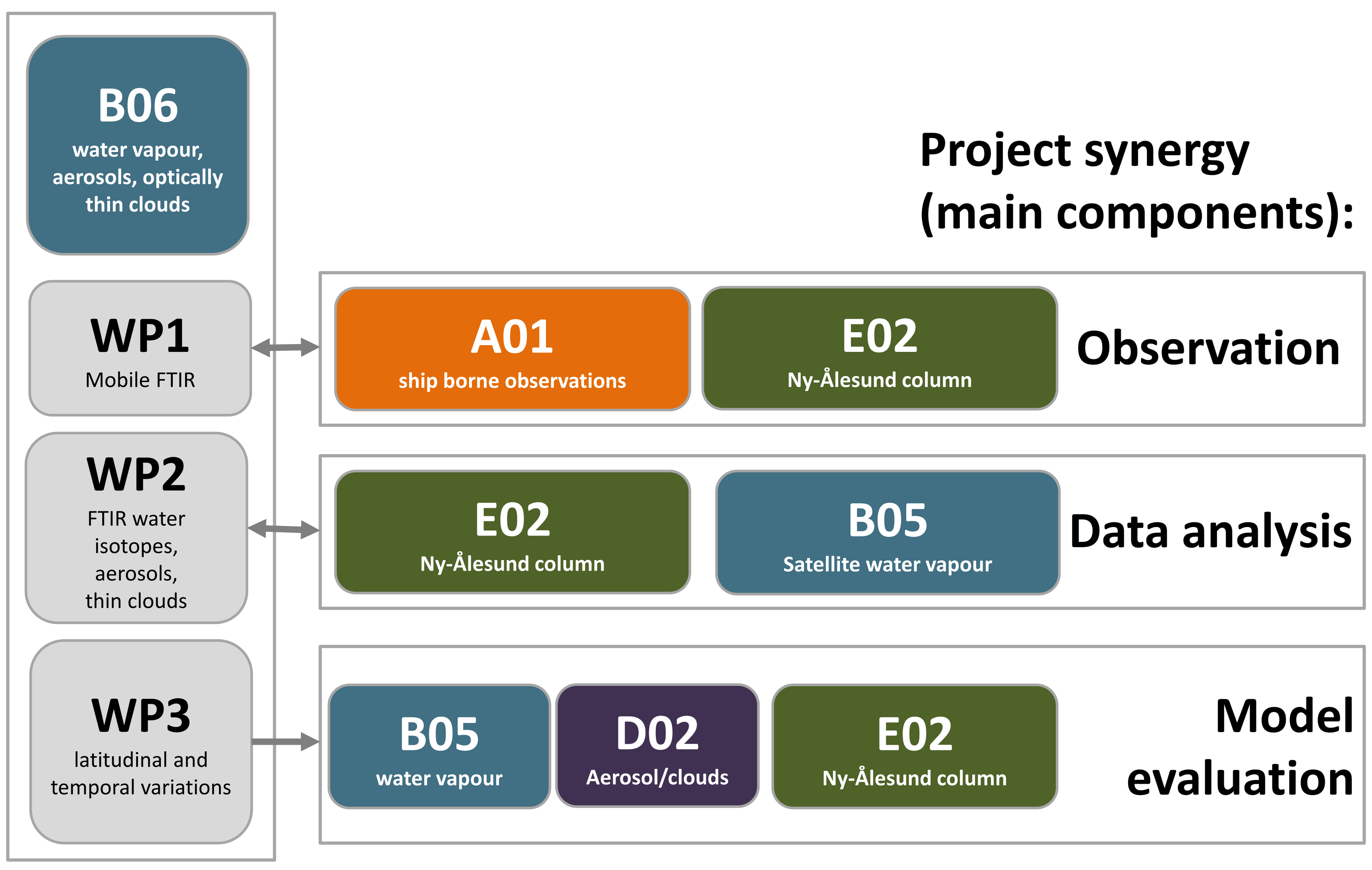


Fig. 4 Left: Arctic Haze backscatter (β) as seen by lidar. Right: derivation of a size distribution from the whole aerosol layer (red curves) and the densest part (blue), dashed: fitted log-normal distribution. Lidar yields aerosol size distribution (and index of refraction).

4 Role within (AC)³ & perspectives



Collaboration within (AC)³

- B06 **complements observations** in A01 with ship borne FTIR measurements and Ny-Ålesund long term data.
- **Data retrieval** with E02
- **Data analysis and interpretation** with A01, B05, and E02, particularly on the radiative budget.
- Data provision for **model evaluation** in B05, D01, D02, E01, and E02
- **Satellite validation** in B01, B05
- **Airborne** measurements in B03 supported by ground testing and intensive observational periods in Ny-Ålesund.

Perspectives

- Utilization of methods, algorithms, analyses procedures in coming expeditions.
- Developing and contributing to **MOSAiC** campaign
- Analysing and interpreting ground based data sets in support of satellite (**EarthCARE**) and airborne missions (**HALO**).

printed at Universitätsrechenzentrum Leipzig