Investigating the polar boundary layer and aerosol particles with ALADINA

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Operation of ALADINA in Ny-Ålesund

The **UAS ALADINA** (Application of Light-weight Aircraft for Detecting IN-situ Aerosol) was developed for studying the horizontal and vertical variability of aerosol particles in the atmospheric boundary layer (ABL). The current payload (Bärfuss et al., 2018) consists of fast meteorological sensors, optical measurements and aerosol instrumentation. One aim of the project is the investigation of the new particle formation (NPF, shown in the aerosol particle number concentration of size smaller than 20 nm, $N_{<20}$) in the Arctic environment. Due to harsh conditions, the UAS had to be adapted in design and the inner compartment was constantly heated up to 30°C.

- 24.8 kg MTOW
- 3.6 m wing span
- 40 min flight duration
- 28 m s^{-1} cruising speed
- 4 kg payload
- 1 Hz live data transfer

[1] *fine wire temperature sensor*
[2] *humidity sensor*
[3] *multi hole probe*
[4] *aerosol inlet*
[5] *aethalometer*
[6] *optical particle counter (0.39-10 µm)*
[7] *condensation particle counter (~7 nm- 2 µm)*
[8] *data acquisition*

Fig. 1: ALADINA during take-off

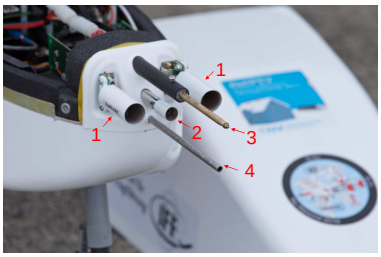


Fig. 2: Meteorological sensors and aerosol inlet

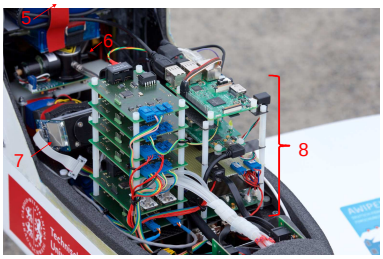


Fig. 3: Payload bay with measurement stack

As part of the AWIPEV project 168, ALADINA was operated at the local airfield in **Ny-Ålesund** during late spring.

- 24 April – 25 May 2018
- 50 measurement flights
- 30 h flight duration
- 220 vertical profiles between 0 and 850 m asl
- Horizontal flights over open water and land

AWIPEV 79°N
Arctic Research Base Ny-Ålesund

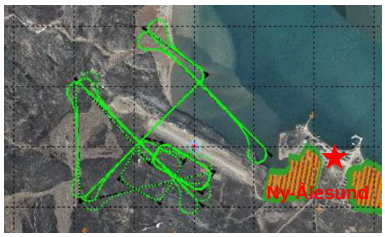
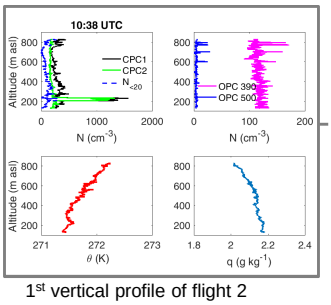


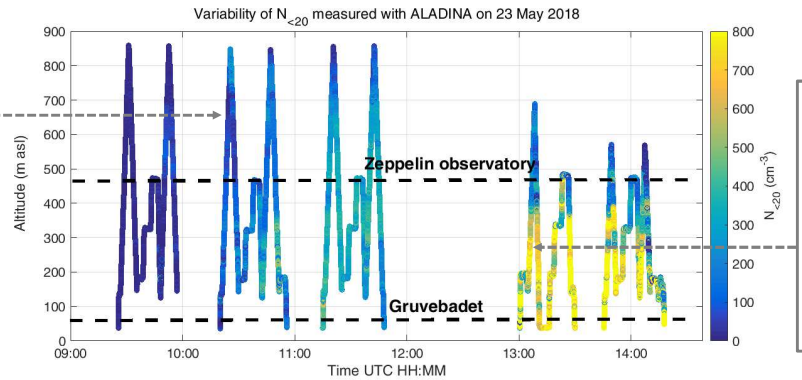
Fig. 4: Flight path above ice surfaces near glacier (SW) and over open water (NE)

Crucial link between surface observations and measurements at the Zeppelin observatory

Horizontal and Vertical Distribution of Aerosol Particles



1st vertical profile of flight 2



1st vertical profile of flight 4

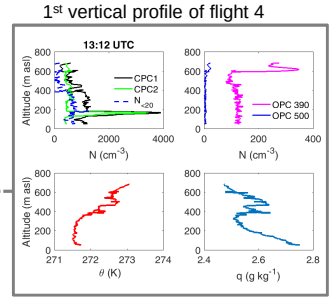


Fig. 5: Observations of the vertical and horizontal distribution of aerosol particles on a day with high local sources due to ship emissions. The grey boxes show the vertical distribution of aerosol particles measured with two CPCs, one OPC in different channels (size bins 0.39 and 0.5 µm), the potential temperature (Θ) and water vapour mixing ratio (q).

Summary and Future Perspectives

A **high variability** of the vertical and horizontal distribution of aerosol particles was observed during the field experiment in **spring 2018**:

- Strong dependence of $N_{<20}$ on the wind direction
- Aerosol particle number concentrations several orders of magnitude higher than measured in previous Arctic studies
- Events with high local pollution by ship emissions and car traffic
- NPF in different layers in relation to multiple inversions
- Effect of small scale orography on the distribution of aerosol particles, like special wind systems along the fjord and from the glacier

The data will be implemented into the **SOSAA model** (e.g. Zhou et al., 2014).

References

Bärfuss, K., Pätzold, F., Altstädter, B., Kathe, E., Nowak, S., Bretschneider, L., Bestmann, U., and Lampert, A.: New Setup of the UAS ALADINA for Measuring Boundary Layer Properties, Atmospheric Particles and Solar Radiation, *Atmosphere*, 9, 1-21, doi:10.3390/atmos9010028, 2018.

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