Observations from the COMPEX Campaign for EarthCARE Validation in the Arctic

F. Goy[1], M. Mech[1], J. Panton[1], L. van Gelder[1], and S. Crewell[1]

[1]Institute of Geophysics and Meteorology, University of Cologne

UNIVERSITY OF COLOGNE

EUROPEAN SPACE AGENCY

Intro

In the framework of the "**ArctiC Amplification: Climate Relevant Atmospheric and SurfaCe Processes, and Feedback Mechanisms (AC)³**" project, a series of **airborne campaigns** has been conducted in recent years in the Arctic. The suite of remote sensing instruments packed on the AWI Polar research aircraft matches quite good the set operated on **EarthCARE**.

Polar 5 - Alfred Wegener Institute operated by Kenn Borek Air (CDN) Basler BT-67 (former DC-3 build in 1943) one-way range ~900 km, height < 5 km; 2 pilots, max. 6 scientists/engineers

Cloud radar (MiRAC-A) (Mech et al., 2019)
Microwave Radar/radiometer for Arctic Clouds
94 GHz, FMCW, reflectivity, Doppler velocity, 89 GHz passive, liquid water path, 1 Hz, 25° backwards
⇨ **Cloud Profiling Radar (CPR)**

Airborne Mobile Aerosol Lidar (AMALi)
Attenuated backscatter signal at 355 and 532 nm (+depol)
Profiles of aerosol, cloud layers, mask, and top height
⇨ **Atmospheric Lidar (ATLID)**

AISA HAWK/FOX (LIM)
Imag. spectro., push broom sensor, 2D field of upward radiance, EAGLE (400-1000 nm), HAWK (930-2550 nm)
⇨ **MultiSpectral Imager (MSI)**

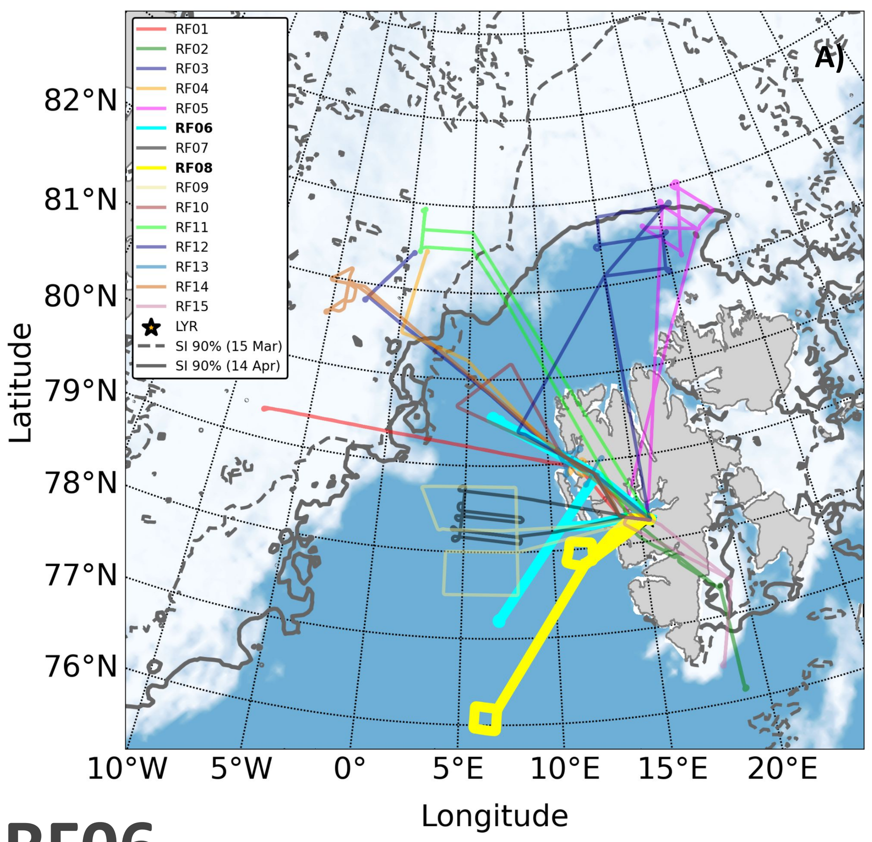
Broadband and spectral radiation (LIM)
Pyranometer (0.2-3.6 µm), Pyrgeometer (4.5-42 µm), SMART-Albedometer (300-2300 nm @ 2 Hz)
⇨ **BroadBand Radiation (BBR)**

New instrument! G-band Radar for Water vapor and Arctic Clouds (GRaWAC)
G-band radar for water vapor and Arctic clouds differential absorption radar (Schnitt et. al, 2025)
167.3 and 174.7 GHz, FMCW, reflectivity, Doppler velocity, differential absorption, in-cloud water vapor profiles and integrated water vapor, differential reflectivity G-W band for microphysics

COMPEX

Where, when, and what?

- Clouds over cOMPlEX environment
- Polar 5 campaign out of Longyearbyen
- **13 March - 15 April 2026**
- 15 research flights
- 60 flight hours
- **2 EarthCARE underflights**
- **75 dropsondes** available



A) All 15 research flights of COMPEX out of Longyearbyen. Highlighted flights (RF06 and RF08) include EarthCARE collocations. **B)** RF06 path on 25.03.2026 over MODIS satellite image.

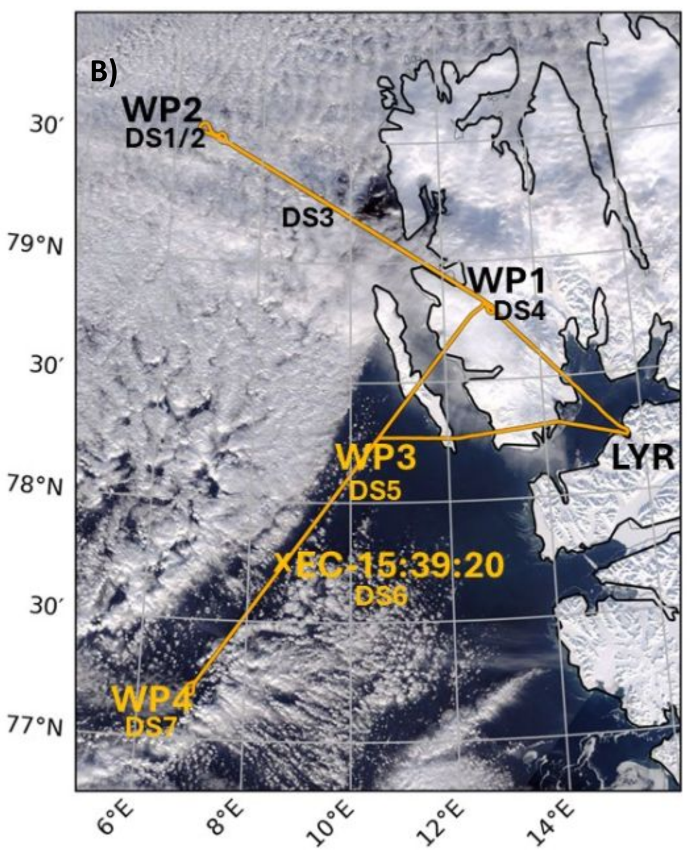
COMPEX March 25, 2026 - RF06

Flight objectives:

1) Study cloud evolution perpendicular to wind field from Ny-Ålesund westward to the open ocean between WP1 and WP2
2) Measure along the EarthCARE track between WP3 abd WP4 and meet satellite at 15:39:20 UTC

Weather situation encountered during flight:

Weather maps showed a low pressure system south east of Svalbard and a high over Greenland, which caused a northerly flow west of Svalbard. During the flight, almost no clouds over Ny-Ålesund were noticed. Along the flight to the west between WP1 and WP2 low level clouds showed up becoming thicker towards WP2. There were also mid-level clouds above flight level. During the second part of the flight, between WP3 and WP4 low-level clouds and cloud-free conditions above flight level were observed.



COMPEX March 25, 2026 - RF06

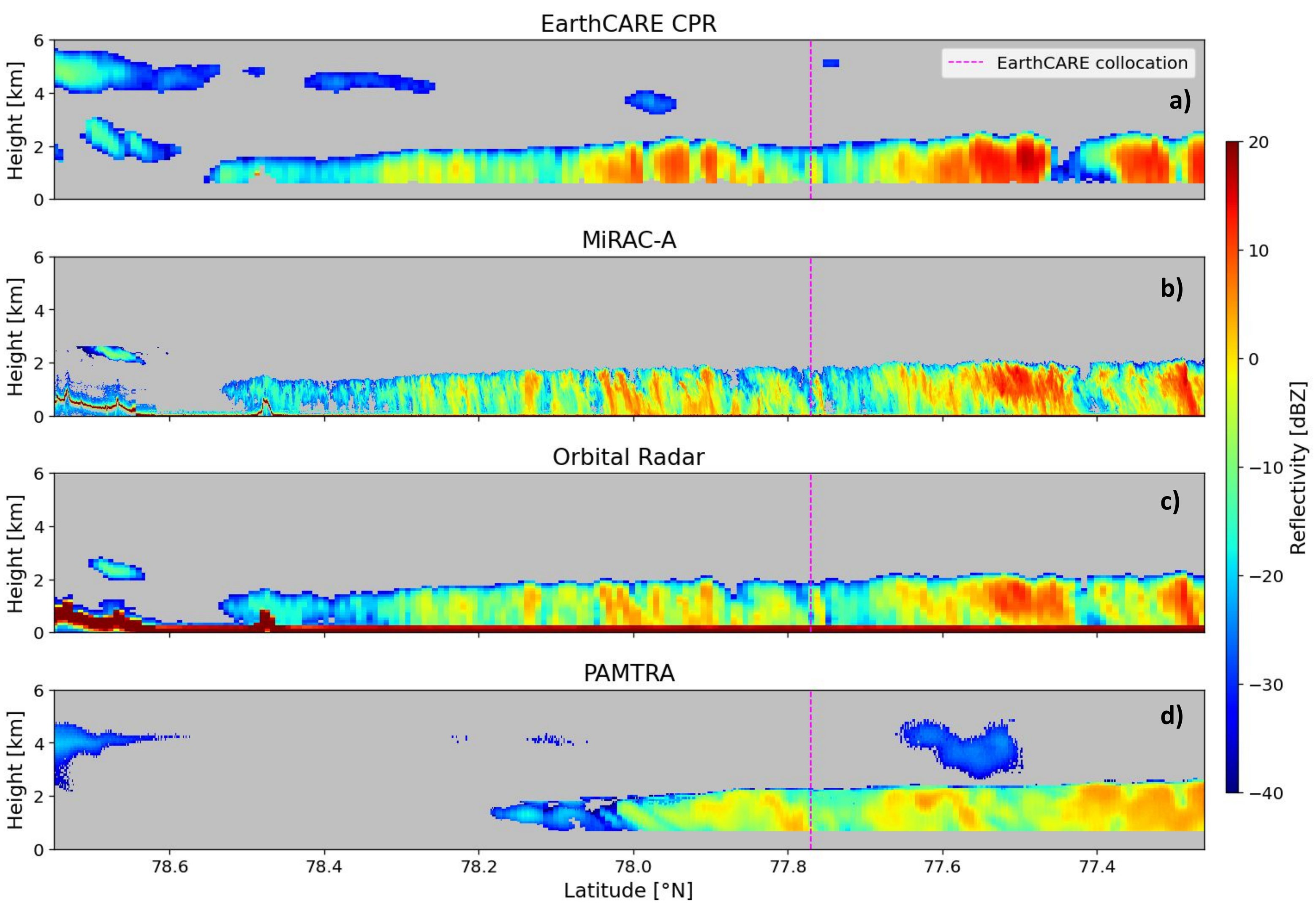


Fig. 1: Reflectivity from **a)** EarthCARE CPR; **b)**MiRAC-A; **c)** MiRAC-A transformed to EarthCARE CPR with Orbital-Radar (Pfitzenmaier et al., 2025) ; **d)** simulated ICON-LEM and PAMTRA (Mech at al., 2020)

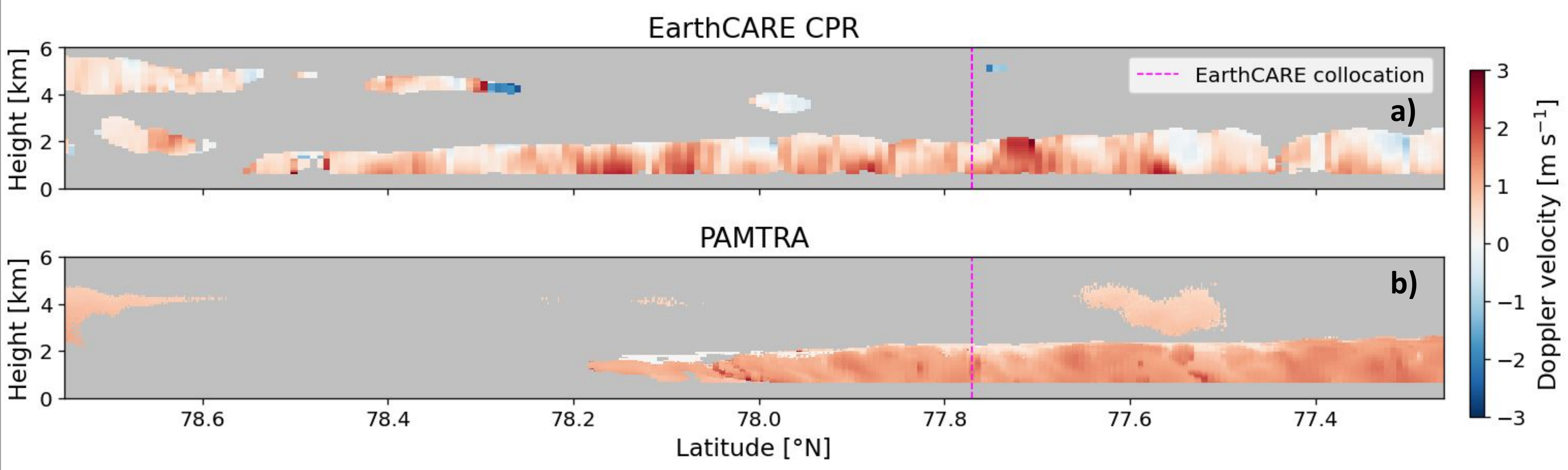


Fig. 2: Doppler Velocity from **a)** EarthCARE CPR; **b)** simulated ICON-LEM and PAMTRA (Mech at al., 2020)

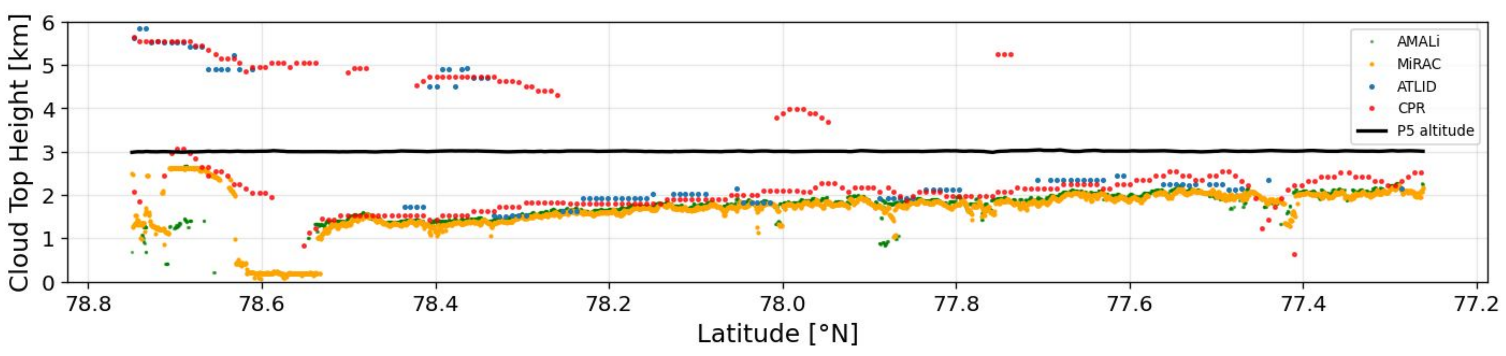


Fig. 3: Cloud Top Height (CTH) comparison between EarthCARE **CPR**, EarthCARE **ATLID**, P5 **MiRAC-A** and P5 **AMALi**. The flight altitude of P5 is shown in grey.

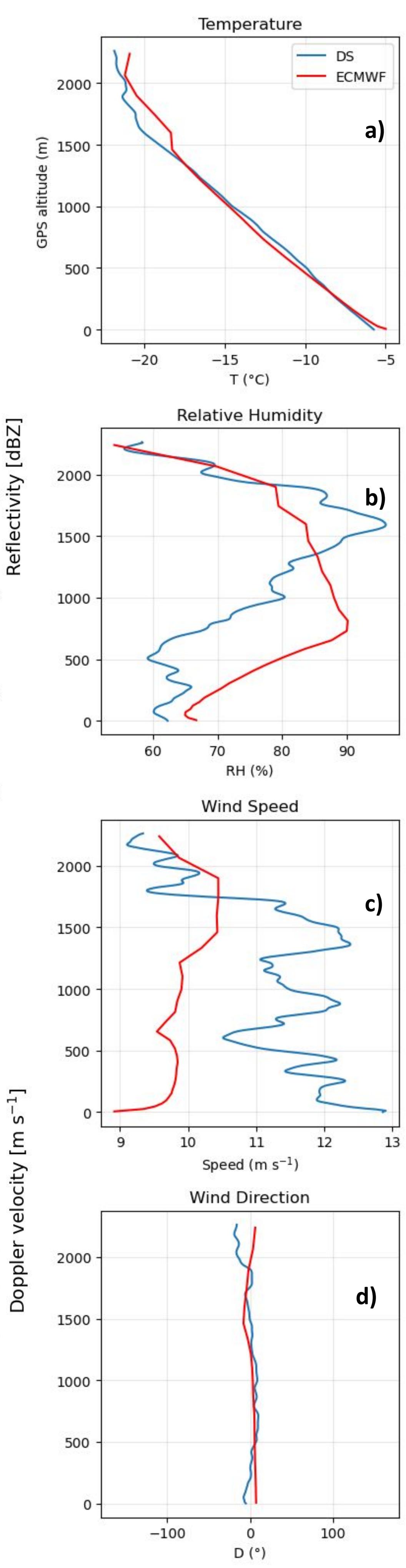


Fig. 4: Dropsonde released at EarthCARE overpass time vs. ECMWF X-MET. **a)** Temp.; **b)** Relative Humidity (RH); **c)** Wind speed; **d)** Wind dir.

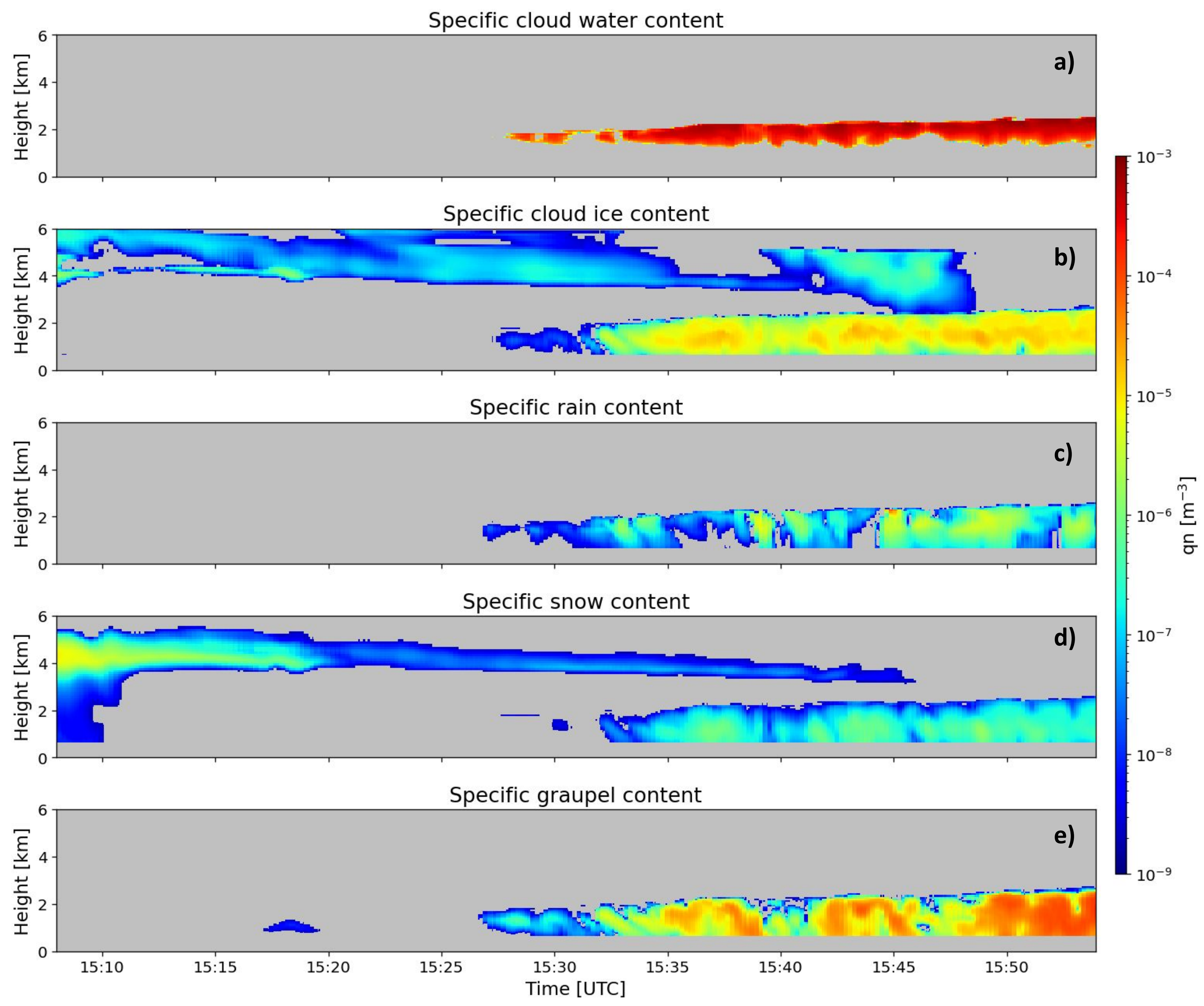


Fig. 5: Simulated hydrometeor mixing ratios from ICON-LEM for **a)** cloud water; **b)** cloud ice; **c)** rain; **d)** snow; **e)** graupel

References

Mech, M., Kliesch, L.-L., Anhäuser, A., Rose, T., Kollias, P., and Crewell, S.: Microwave Radar/radiometer for Arctic Clouds (MiRAC): first insights from the ACLOUD campaign, Atmos. Meas. Tech., 12, 5019–5037, https://doi.org/10.5194/amt-12-5019-2019, 2019.

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Pfitzenmaier, L., Kollias, P., Risse, N., Schirmacher, I., Puigdomenech Treserras, B., and Lamer, K.: Orbital-Radar v1.0.0: a tool to transform suborbital radar observations to synthetic EarthCARE cloud radar data, Geosci. Model Dev., 18, 101–115, https://doi.org/10.5194/gmd-18-101-2025, 2025.

Schnitt, S., Mech, M., Goliasch, J., Rose, T., and Crewell, S.: G-band Radar for Water vapor and Arctic Clouds (GRaWAC): novel insights on Arctic water vapor, clouds and precipitation, EGUsphere [preprint], https://doi.org/10.5194/egusphere-2025-5563, 2025.

Data availability and usage

All data available through the ac3airborne python toolbox. Usage and description in "How to ac3airborne".

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