

HALO-(AC)³ – 2022/03/30 – Polar6 research flight RF07

Objectives:

Two racetrack patterns one over the sea ice and one over the ocean have been conducted with Polar 6 in the vicinity of the HALO flight track, aiming for low level in-situ cloud, aerosol and trace gas measurements. In addition, the vertical structure of the boundary layer was sampled over the ocean as a function of the distance to the sea ice edge.

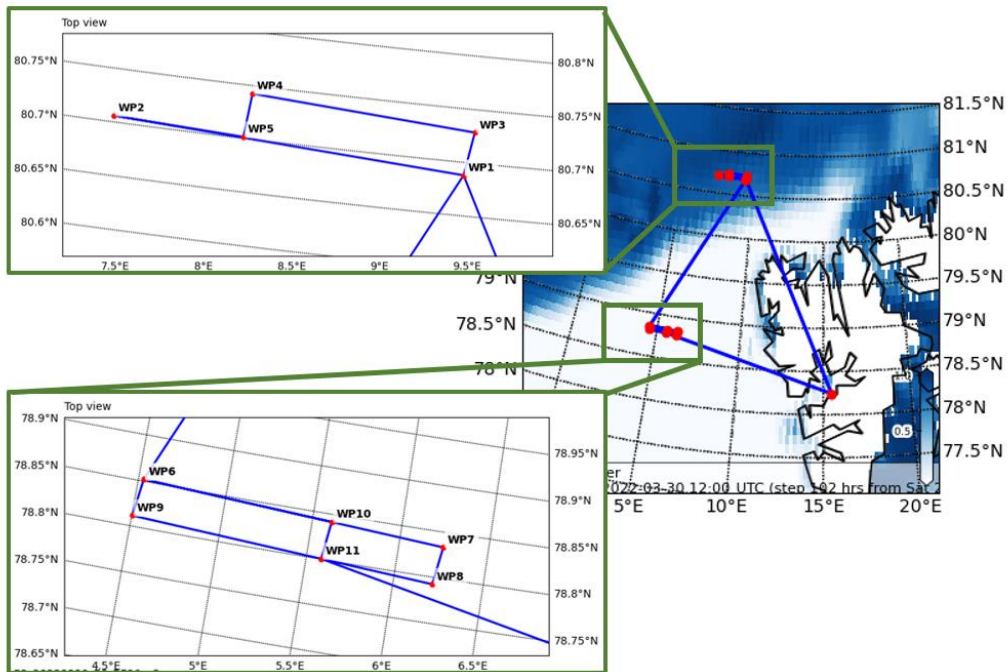
Mission PI P6:

Manuel Moser (manuel.moser@dlr.de)

Polar 6 Crew	
Mission PI	Manuel Moser
Basis Data Acq.	Maximilian Stöhr
CVI	Philipp Joppe
ALABAMA/Trace gas	Hans Christian Clemen
Microphysics	Elena De La Torre Castro
HERA/Aerosol	Sarah Grawe

Flight times:

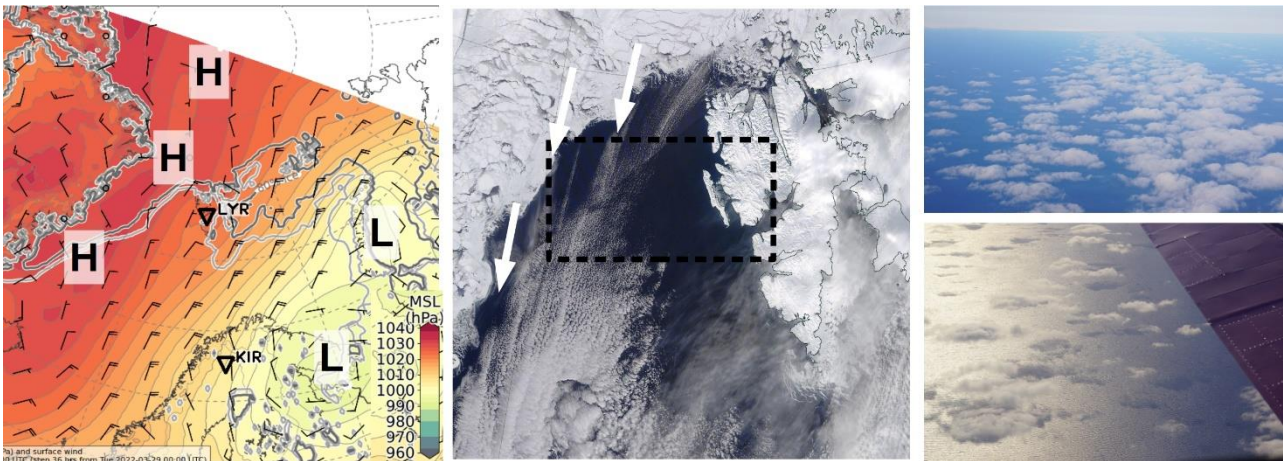
Polar 6	
Take off	10:28 UTC
Touch down	15:28 UTC



Weather situation:

Weather situation 2022-03-30 (by Janosch Michaelis):

As already in the days before, the large-scale weather pattern was characterized by a low pressure system over the Northwest of Russia and by a ridge of high pressure systems ranging from the central Arctic to the East of Greenland. Between these two pressure regimes, northerly winds caused the formation of cloud streets in the measurement area over Fram Strait on the present day. The corresponding clouds were not as thick as on the days before. This was caused by a strongly pronounced dry layer on top of the temperature inversion in that region. In addition, a cloud-free area was observed directly West of Svalbard presumably due to lee effects downwind of the mountains in the Northwest.



Left: Mean sea level pressure from ECMWF for 2022-03-30, 12 UTC (forecast from 2022-03-29, 00 UTC). Middle: Satellite picture for Wednesday around noon (Aqua MODIS, corrected reflectance, retrieved from: <https://worldview.earthdata.nasa.gov/>), including the approximate location of the measurement area (black dashed rectangle) and the approximate near-surface wind direction (white arrows). Right: Two pictures of the clouds taken from Polar 5.

Cloud situation observed during the flight (reported from Polar 6):

No clouds were observed at the northern racetrack. Clouds appeared shortly after the sea ice edge over the ocean. Cloud base elevated and clouds got denser the more we flew to the south, but still remained thin and broken. From some 'mini cumuli' large precipitating snow crystals were reported. Cloud base and top was observed between 1800 – 2200ft.

Overview:

This research flight with Polar 6 aimed for low-level in-situ measurements over the fully covered sea ice and over the open ocean collocated with the two northern circle from the flight plan of the HALO research aircraft. Shortly after HALO finished with the circle pattern over the sea ice we started our first racetrack pattern in the north. First we flew 25min at 200ft for INP measurements. No clouds were observed in this region, we conducted several further legs for aerosol measurements below temperature inversion, at the altitude of temperature inversion and above. Different number concentrations of aerosol particles at each altitude were reported.

On our way to the southern racetrack originally a sawtooth pattern was planned. As no clouds were found we stayed at 200ft altitude until reaching the sea ice edge (well defined edge, only a couple of km). After the surface transition zone, clouds evolved and we started our sawtooth pattern. The further we flew to the south, the larger and higher the clouds were observed, but still remain broken and thin.

At the racetrack pattern over the ocean, we conducted 25min INP measurements at 200ft, followed by in-situ legs just below cloud top, above cloud top and inside the clouds. On our way back to Longyearbyen we flew some short legs at higher altitudes for trace gas measurements.

Instrument Status:

Polar 6	
Basis data acquisition	
Nose Boom	
CVI	
ALABAMA	
Trace gas	
Aerosol	
HERA	
Polar nephelometer	
2D-S	
CCP	
PIP	
BCPD	

Table S5.1: Instrument status as reported after the flight for all instruments on Polar 6.

Comments: None

Detailed Flight Logs (Time in UTC):

Note: T.O. delay of 28 min

LYR – W1:

- **10:28 UTC:** Take Off



- **10:48 UTC:** All instruments seem to work without any problem
- **10:57 UTC:** Clear sky over Spitzbergen with some cirrus



- **11:06 UTC:** Some low-level scattered cloud over the ocean visible at the end of Spitzbergen
- **11:10 UTC:** Seeing cloud streets and the sea ice, clear sky above (Note: these cloud streets were only seen close to the vicinity of Svalbard due to orography of the island; not observed further west)



- **11:19 UTC:** Start our descent now to WP1 @200ft
- **11:19 UTC:** Just above the MIZ, no clouds seen over the sea ice, but large lead structures



- **11:29 UTC:** Fly over a refrozen lead, very calm, surface is fully covered sea ice
- **11:30 UTC:** Now @200ft

Stacked/racetrackpattern over sea ice (W1, W2, W3, W4, W5):

- **11:32 UTC:** Reached W1; we head now to WP2; start of 25min INP leg @200ft; No clear temperature inversion, between 600m – 1200m temperature stays at a constant value (data from vertical profile before W1)
- **11:42 UTC:** At W2 now, we do procedure turn
- **11:43 UTC:** Going back to W1 @200ft



- **11:56 UTC:** Back at W1; climb to 650ft leg
- **11:xx UTC:** Next leg was planned at 1200ft but spontaneously changed to 960ft as HALO evaluated dropsondes from our position: Boundary height @320m



- **12:17 UTC:** Now leg @2000ft; Aerosol scientist report different Aerosol concentration at each altitude in this racetrack pattern
- **12:26 UTC:** Start last leg over sea ice @4000ft

Transfer to W6: Sawtooth

- **12:32 UTC:** Back at W1 start heading to W6; we see clouds in the south



- **12:40 UTC:** Reaching 200ft - no clouds, we stay at 200ft for aerosol measurements
- **12:44 UTC:** HALO reports lowest temperature inversion altitude at $(467 \pm 190)\text{m}$

- **12:44 UTC:** Still @200ft, small leads appear in the sea ice
- **12:51 UTC:** Reaching sea ice edge - from now fog escapes from the surface



- **12:52 UTC:** Some little clouds right above us



- **12:54 UTC:** Start sawtooth pattern, climb to 1700ft
- **12:55 UTC:** Top of sawtooth, low level 'mini cumuli' with very low density



- **12:59 UTC:** Reaching bottom; sampled one small cloud before; these 'mini cumuli' seem to precipitate large ice particles



- **13:11** UTC: Reaching top of sawtooth - while descent chase some clouds which are slightly off track
- **13:19** UTC: Cloud bottom 1600ft; cloud top 2200ft; clouds get denser, but still broken
- **13:25** UTC: Descent to 200ft, cloud bottom 1700 - 1800ft

Stacked/racetrack pattern over ocean (W6, W7, W8, W9, W10, W11):

- **13:xx** UTC: Starting INP measurements @200ft between W6 – W7 – W8 – W9



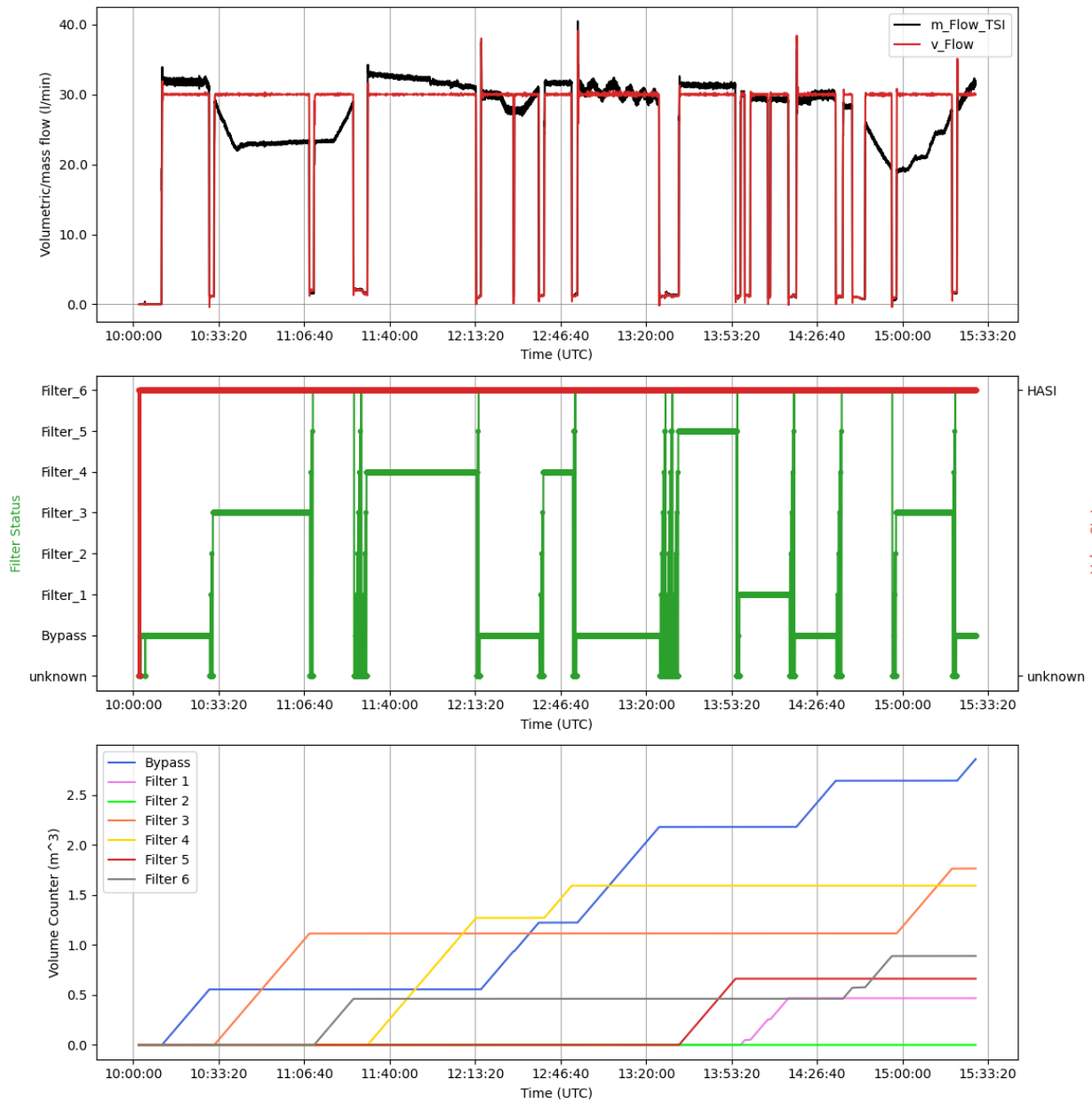
- **13:39** UTC: Surface: ocean with white waves; pilots are fighting against the wind
- **13:43** UTC: Turn @200ft to W9, outside temperature is -4°C
- **13:55** UTC: Finished with INP leg with a small overshoot @W9 to sample longer @200ft
- **13:56** UTC: Climb to cloud top 1200ft (in the overshoot of the INP leg, here cloud base is lower)
- **14:59** UTC: Leg between W6 - W10 @1900ft (just cloud base)
- **14:07** UTC: Climb to next leg in cloud @2100ft (W11 - W9)
- **14:20** UTC: Another leg just above cloud 2300ft (W6 - W10)
- **14:26** UTC: Aerosol leg just below the clouds (@1600ft)
- **14:33** UTC: Finished with leg @1600ft, now climb to 3200ft
- **14:40** UTC: Climbing to 14000ft
- **14:57** UTC: Reached leg @14000ft for trace gas
- **15:06** UTC: leg @12000ft for trace gas
- **15:13** UTC: leg @8000ft for trace gas measurement



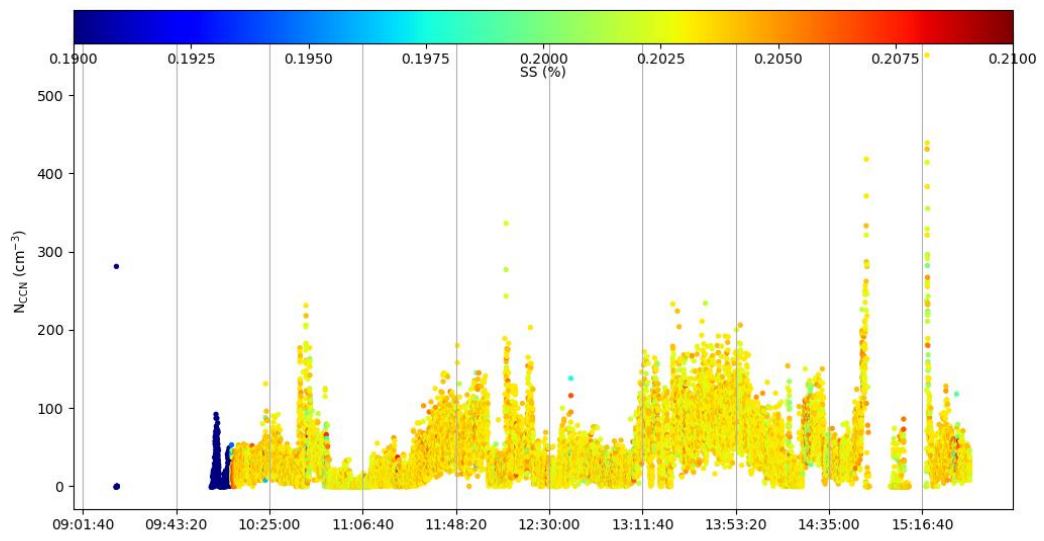
- **15:16** UTC: done with science – go back to LYR
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Quicklooks:

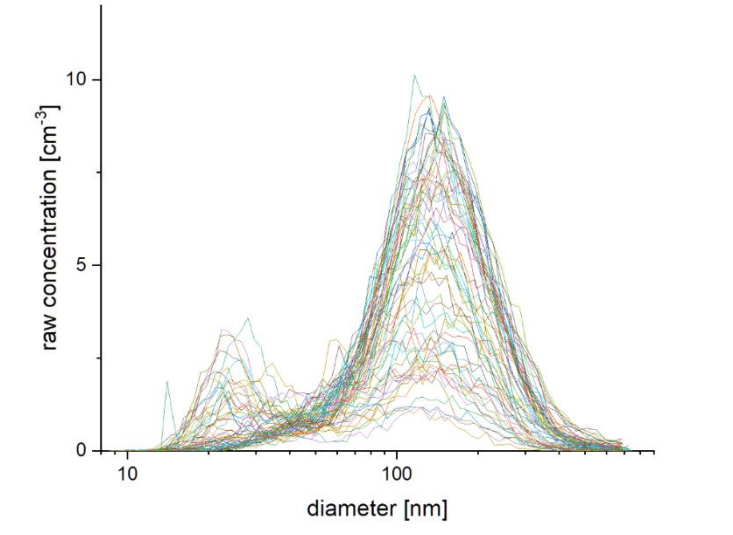
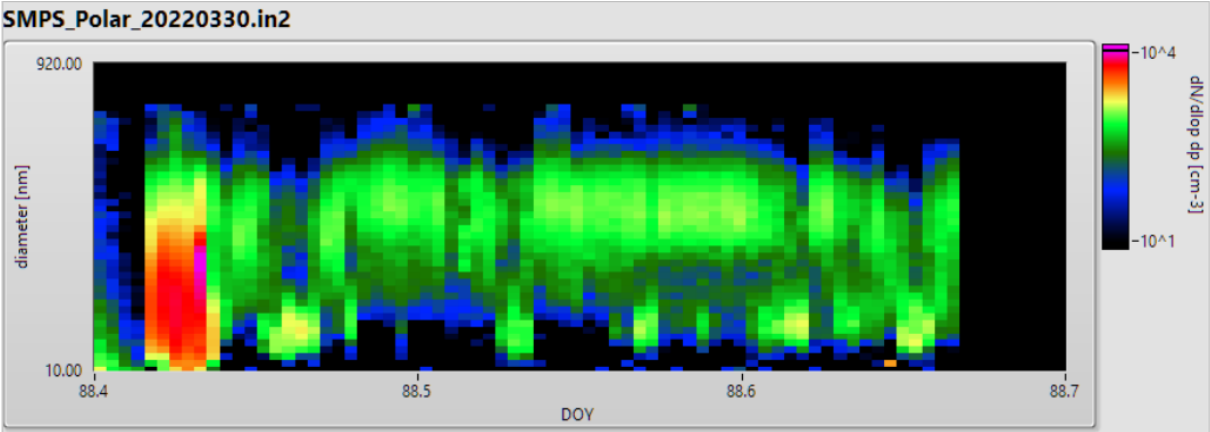
HERA



mCCNC

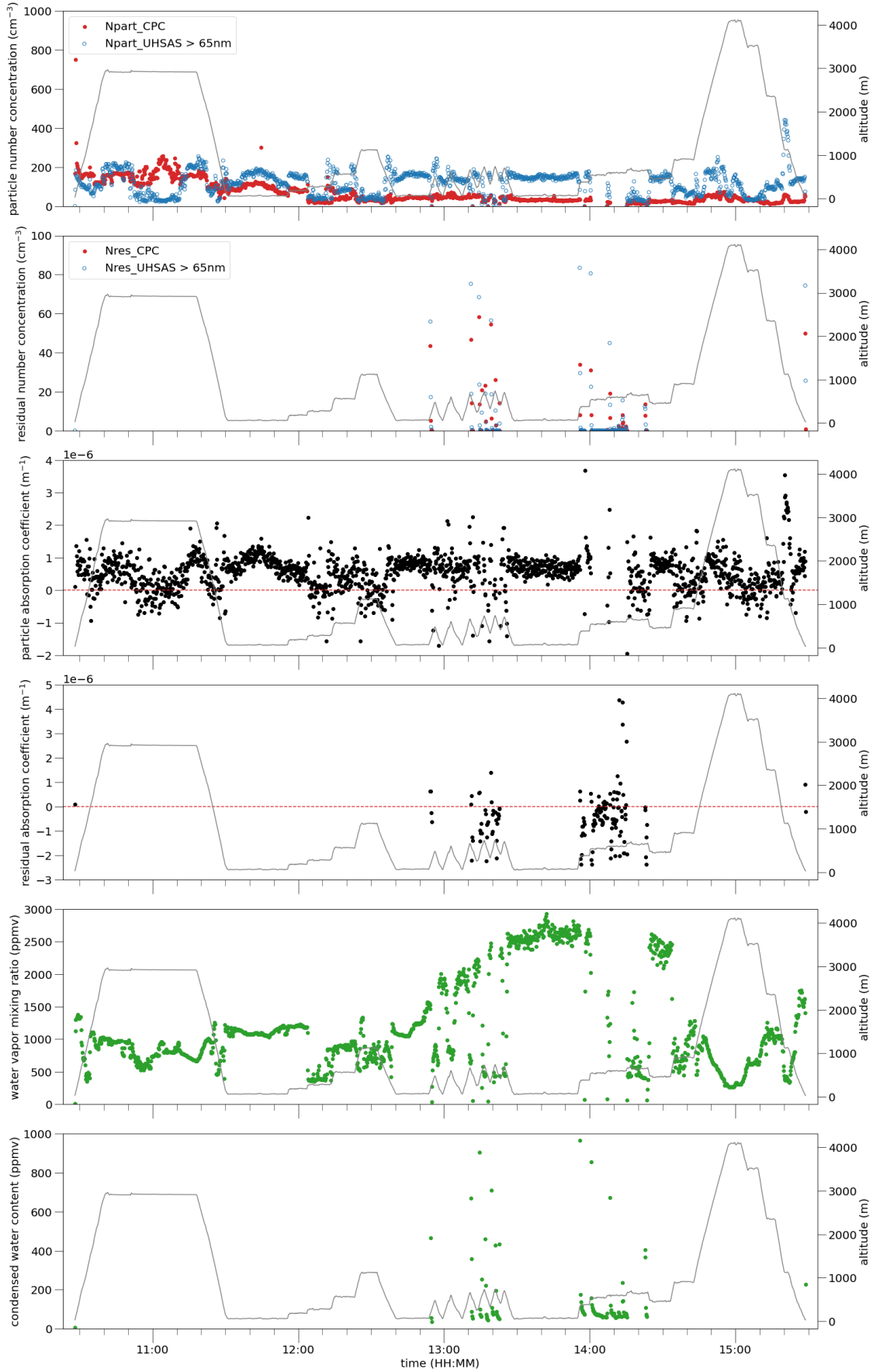


SMPS

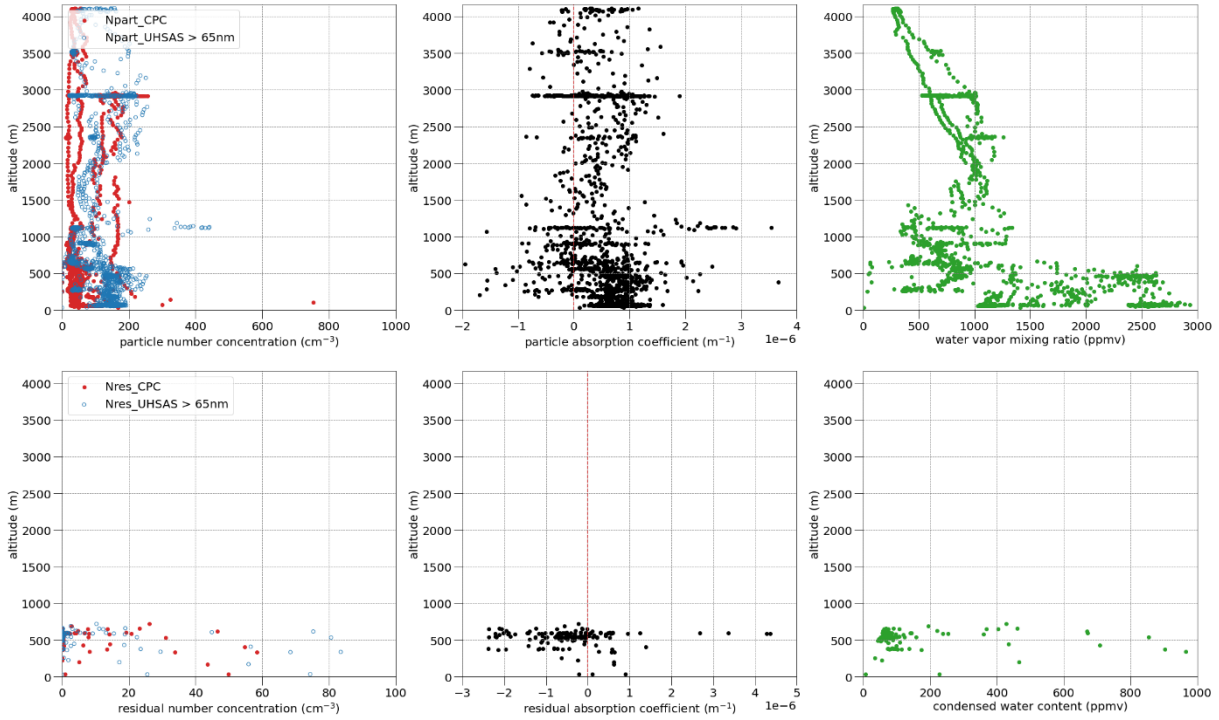


CVI

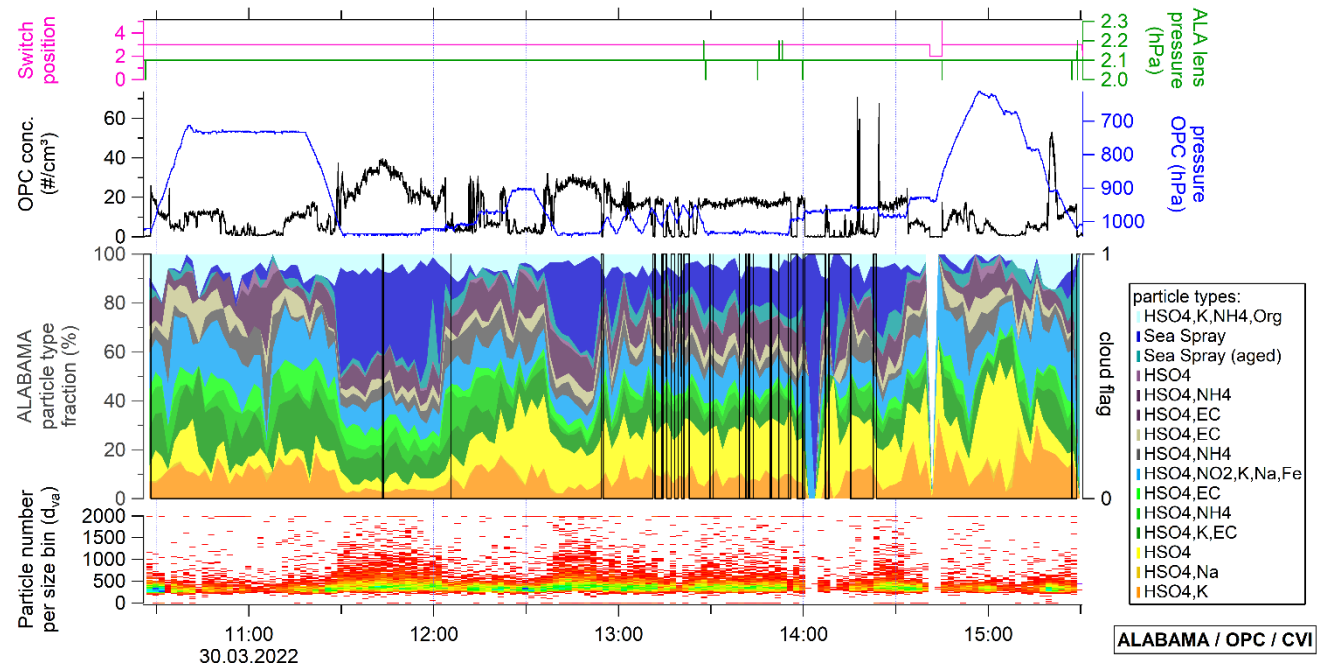
Quicklook ARCTIC-CVI Timeseries from 30.03.2022
10 second mean (residual measurements not enrichment corrected)



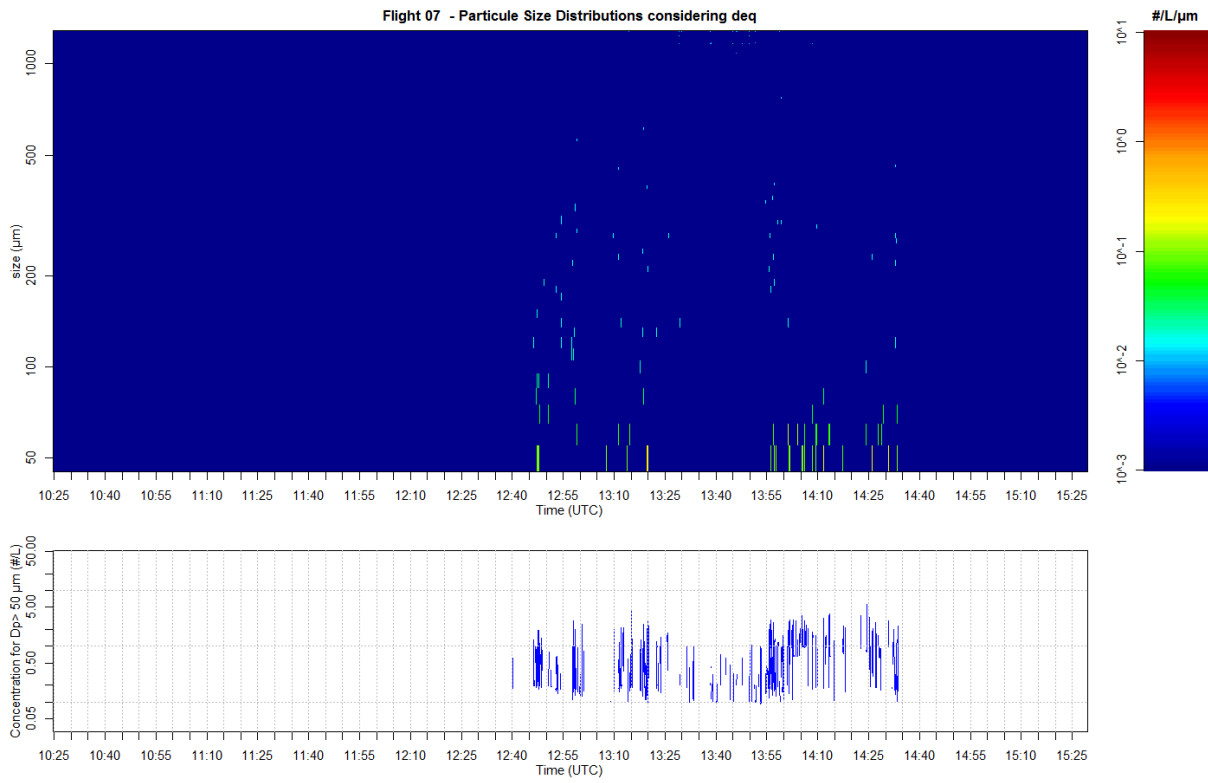
Quicklook ARCTIC-CVI Vertical Profile from 30.03.2022
10 second mean (residual measurements not enrichment corrected)



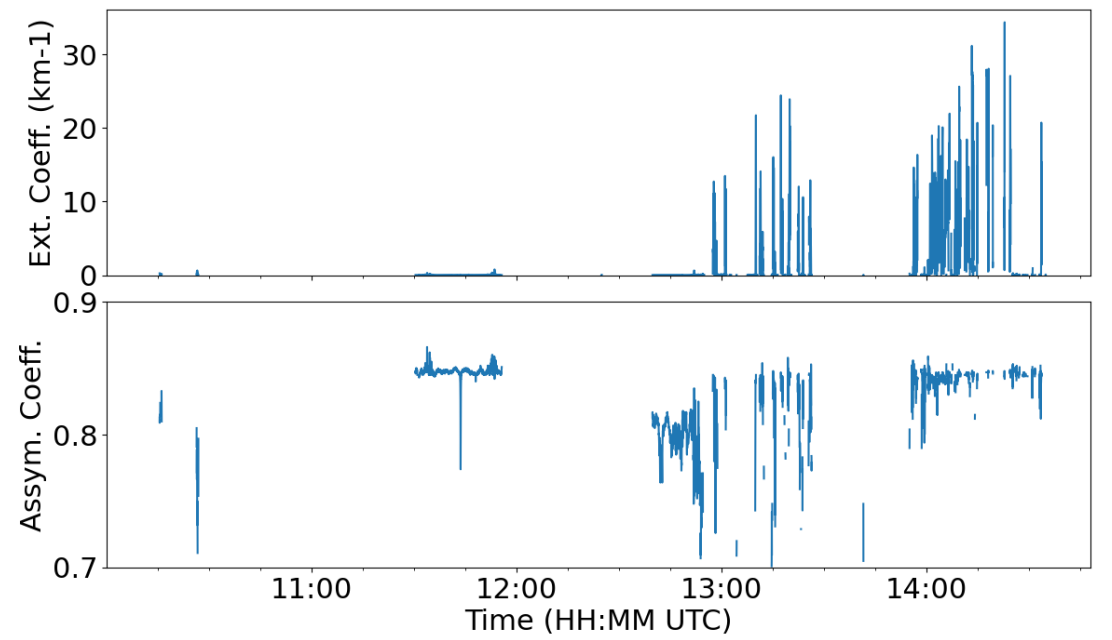
ALABAMA



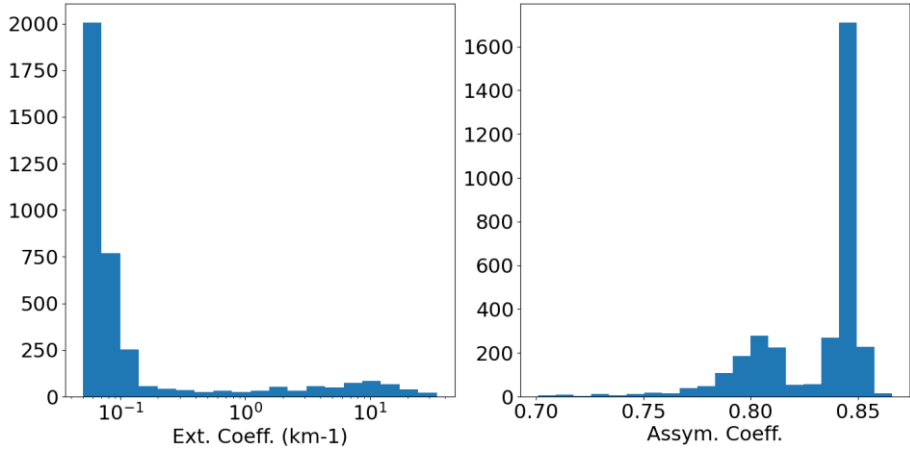
PMS-LaMP



Polar Nephelometer Timeseries - Polar 6 - preliminary data RF07 - 220330



Polar Nephelometer Histogram - Polar 6 - preliminary data
RF07 - 220330



PMS – DLR

