HALO-(AC)^3 – 2022/03/26 – Polar6 research flight RF04

Objectives:

During RF04 with Polar 6 we focused on low level cloud and aerosol in-situ measurements during a cold air outbreak in the Fram Strait over the marginal sea ice zone and over the open ocean.

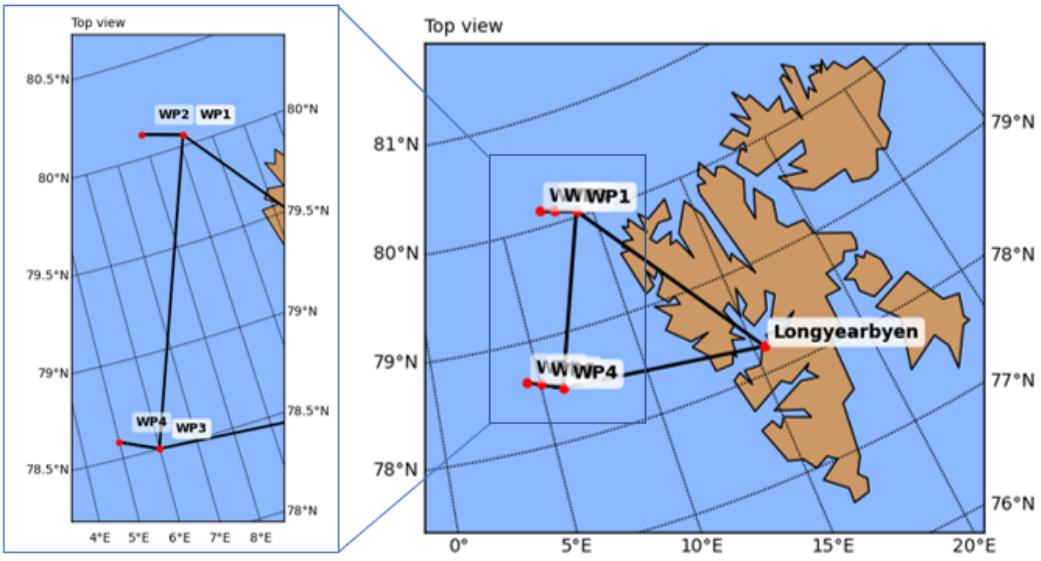
Mission PI P6:

Manuel Moser (manuel.moser@dlr.de)

Polar 6 Crew	
Mission PI	Manuel Moser
Basis Data Acq.	Dennis Ludwig
CVI	Sarah Grawe
ALABAMA/Trace gas	Oliver Eppers
Microphysics	Regis Dupuy
HERA/Aerosol	Frank Stratmann

Flight times:

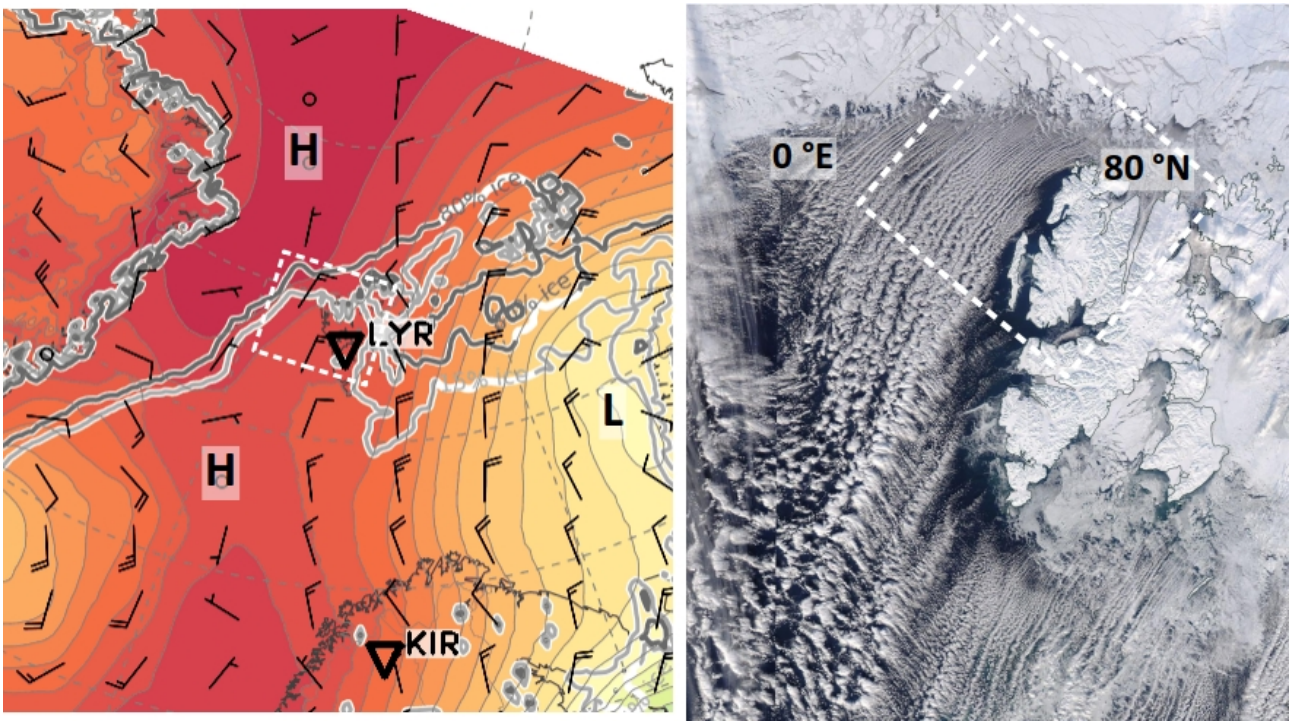
Polar 6	
Take off	12:29 UTC
Touch down	16:29 UTC



Weather situation:

Weather situation 2022-03-26 (by Janosch Michaelis):

Northerly winds and thus cold-air outbreak conditions persisted already for 4-5 days in the measurement area. Thus, cloud streets formed continuously with slight changes in their orientation due to slightly varying wind directions from day to day. Although the cold-air outbreak region over Fram Strait narrowed due to increasing high pressure influence from the West on this day, the cloud streets in the measurement area were still strongly pronounced. As observed, they caused strong precipitation especially near the southern part of the flight. In this area, the number of cloud streets had already decreased while their width had increased.



Left: Mean sea level pressure from ECMWF for 2022-03-26, 12 UTC (forecast from 2022-03-24, 00 UTC). Right: Satellite picture (Aqua MODIS, corrected reflectance) for Saturday around noon. Retrieved from: https://worldview.earthdata.nasa.gov/

Cloud situation observed during the flight:

Clouds over the marginal sea ice zone were shallow (cloud top @750 - 1200ft) and thin. In between ice floes, fog escaped from the ocean. Some parts of the surface in the northern leg were complete frozen and clear sky was observed. On the way to the south cloud top elevated from 750ft up to 4500ft. In the southern stacked pattern, we observed convective broken clouds with heavy precipitation.

Overview:

Original plan was a collocated flight together with Polar5, but due to engine problems the flight plan had to be performed alone. During instrument start up, we realized an instrument inlet was clogged, we delayed our departure and deiced the instrument.

At our northern stacked pattern, we conducted in total 25min low level legs @200ft including a calibration leg for the noseboom. Surface condition were approximately 50% dense broken sea ice and 50% open ocean. Cloud situation changed with the surface from dense fog and clouds over the ocean, to nearly clear sky over sea ice. On our way to the lower stacked flight pattern original a sawtooth pattern was planned to retrieve the vertical structure of clouds as a function of the distance to the sea ice edge. This leg was changed to an additional aerosol leg, flown right above the cloud top. The cloud top elevated from 750ft up to 4500ft on our way south. At the stacked pattern in the south we flew another a 25min INP leg at 200ft over the ocean, continued with in-situ cloud measurements inside the clouds, followed by aerosol legs right below and right above. Cloud base was hard to determine, clouds were broken including heavy precipitation. On our way back to Longyearbyen trace gas measurements have been conducted at higher altitudes.

Instrument Status:

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

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

Comments: After takeoff, power loss in the PMS rack (115V) – this was solved immediately (Anti-ice 2D-S, PWR PIP, PWR PN). Unable to open roller doors, hence BCPD could not be started. This was solved after the first half of the flight. No dynamical pressure from the noseboom. The mCCNC's optics were fogged, no data was collected. Pump system from HERA was too cold at the beginning of the flight. Chemical composition cannot be provided by ALABAMA during this flight, only number concentrations.

Detailed Flight Logs (Time in UTC):

Note: Flight has been delayed by 2:29h because inlet for aerosol measurements was clogged (probably with ice).

LYR – W1:

- **12:32** crossing some clouds right after T.O.

- **12:33** exiting cloud - cloud top @3300ft
- **12:40** UTC: Roller doors won't open (no BCPD)
- **12:51** UTC: Instrument update: CVI, PIP PWR, PN PWR, deicing 2D-S - -> power loss; dynamic pressure not working, ALABAMA works!
- **12:55** UTC: power is back in the PMS rack (115V)
- **13:06** UTC: we start our descent to 200ft
- **13:13** UTC: some aerosol layer reported at 2km altitude
- **13:17** UTC: broken clouds below us

- **13:18** UTC: reaching cloud top 1700ft, further north cloud top is estimated at 1200ft (from cockpit)
- **13:21** UTC: cloud bottom @400ft; foggy but visibility is ok to continue; no icing; surface: MIZ, small size ice floes with mostly frozen water in between

W1 – W2:

- **13:23** UTC: Reaching WP1, now heading to WP2. Start with INP leg; foggy

- **13:24** UTC: we see the sun, clouds get broken
- **13:25** UTC: ice concentration decreases, visibility decreases

- **13:28** UTC: visibility gets worse, more open sea, hardly any ice
- **13:29** UTC: visibility gets very good again, dense ice at the bottom

- **13:31** UTC: frozen sea ice, no clouds
- **13:34** UTC: reaching WP2, exactly over a lead, a lot of fog

W2 – W1:

- **13:37** UTC: finished procedure turn - now heading back @200ft to WP1
- **13:43** UTC: sea fog again and large areas of free ice

- **13:50** UTC: end of INP measurements; ascent to 600ft and procedure turn

W1 ←→ W3: 'stacked pattern'

- **13:53** UTC: here @600ft slightly more clouds compared to leg @200ft; but very thin cloud; foggy
- **14:03** UTC: Original plan from vertical cloud crossing on the way from LYR shortly before W1 was to do next leg inside cloud @1000ft but at this altitude no clouds anymore; we try 750ft – still slightly above cloud
- **14:05** UTC: now change to 700ft inside cloud top
- **14:12** UTC: procedure turn, rise to 800ft
- **14:15** UTC: leg @800ft starts now
- **14:25** UTC: end of procedure turn now ascend to 1700ft
- **14:33** UTC: end of leg at 1700ft and turn

W1 – W4:

- **14:36** UTC: start sawtooth pattern; 1300ft
- **14:38** UTC: reaching 200ft altitude; broken clouds - ascend again, rise through a cloud hole
- **14:43** UTC: cancelation of the sawtooth pattern – some scientists do not feel well; instead we fly an aerosol leg just above cloud top to W4
- **14:45** UTC: cloud top rises, as we want to stay above cloud we ascent to 2800ft
- **14:48** UTC: cloud top rises - ascend to 3500ft
- **14:54** UTC: cloud top rises – ascend to 3800ft
- **14:56** UTC: cloud top rises – ascend to 4100ft

- **15:05** UTC: cloud top rises – ascend to 4600ft
- **15:06** UTC: until this point clouds were non broken, now we start seeing the ocean from time to time
- **15:09** UTC: start to descend to WP4; inversion at 1200m
- **15:10** UTC: now in cloud
- **15:13** UTC: trace icing
- **15:13** UTC: descending through a broken cloud
- **15:15** UTC: hard to determine cloud base; broken clouds with heavy precipitation

W4 ←→ W5: 'racetrack'

- **15:23** UTC: on the leg to W4; leg for INP measurements to W5 and back to W4 @200ft
- **15: XX** UTC: second leg @2300ft
- **15:49** UTC: turn at WP6; cloud base is estimated at 2200ft
- **15:50** UTC: climb and turn to next leg @3100ft
- **15:53** UTC: broken cloud
- **16:00** UTC: now leg @3900ft leg, right in cloud top
- **16:05** UTC: done with leg @3900ft, now turn and climb to 5200ft leg between W6 and W4 (above clouds – leg for aerosols)

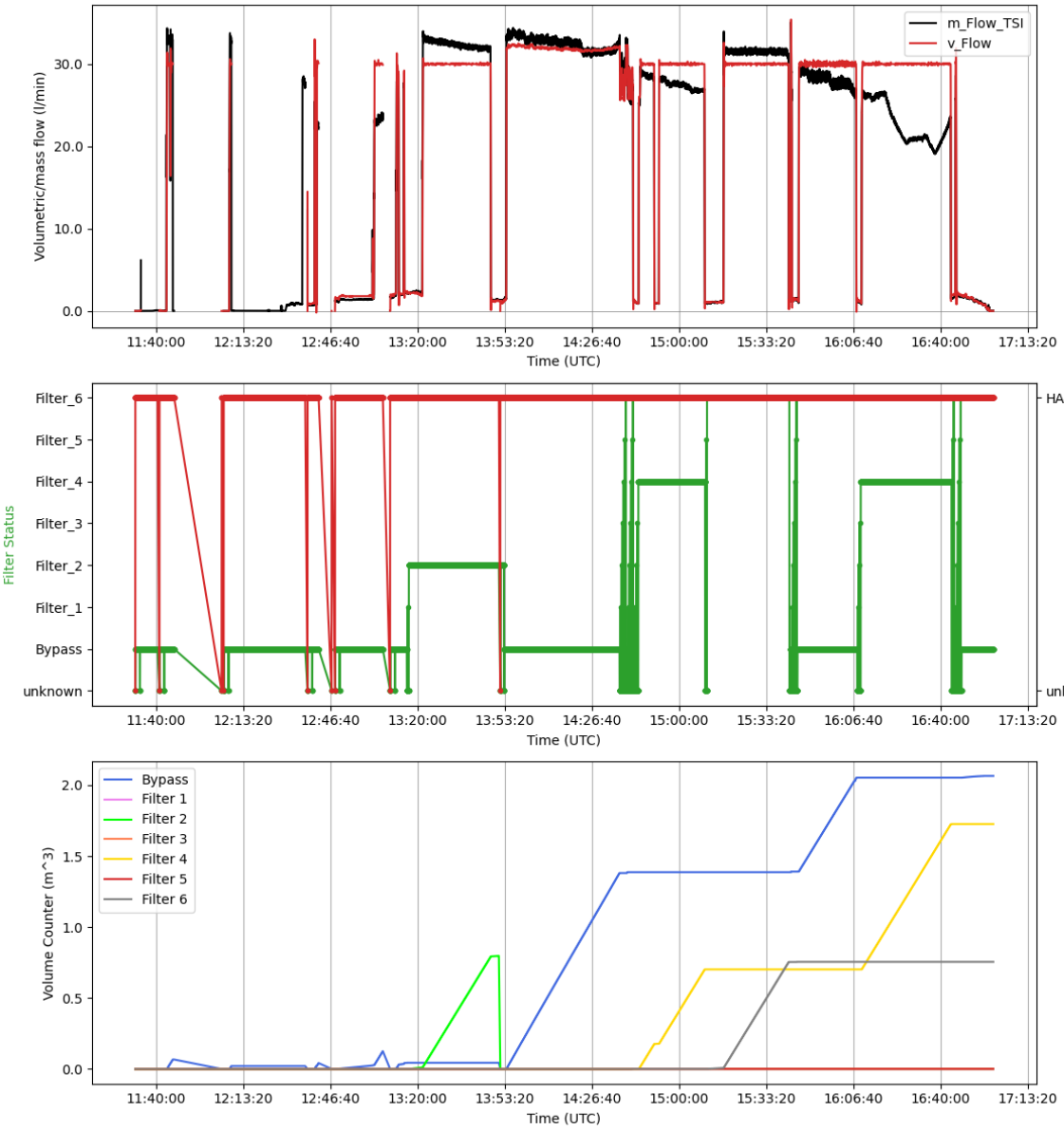
- **16:10** UTC: Inversion observed at 1100m and a second one at 1350m
- **16:11** UTC: 5200ft leg has to be adjusted to 5400ft to avoid clouds

W4 – LYR:

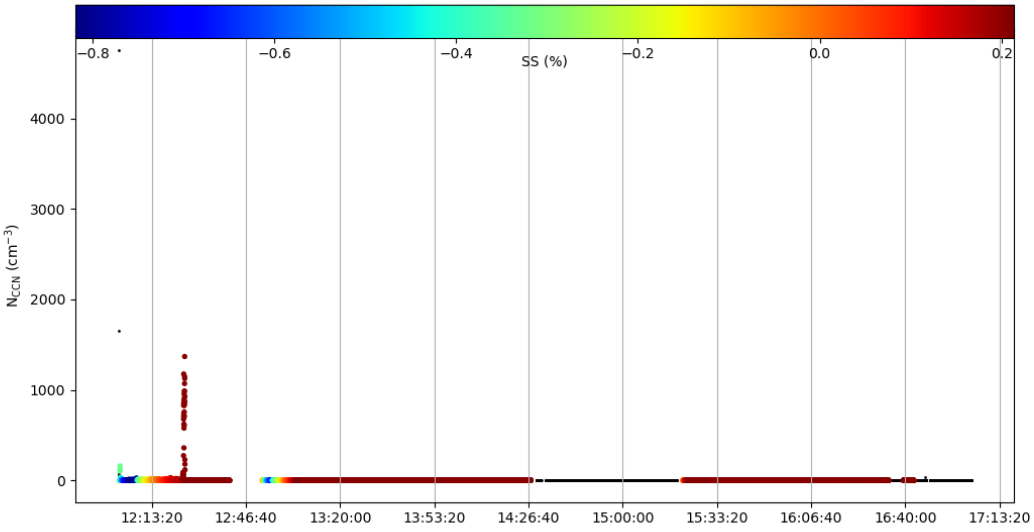
- **16:13** UTC: done with the second staircase, now going to 6000ft for trace gas calibration for 3min
- **16:19** UTC: done with the leg at 6000ft now climb to 12000ft
- **16:20** UTC: Another inversion layer observed @1650m
- **16:27** UTC: leg @12000ft for trace gas measurements
- **16:37** UTC: leg @14000ft for trace gas measurements
- **16:38** UTC: done with science – we head back to Longyearbyen

Quicklooks:

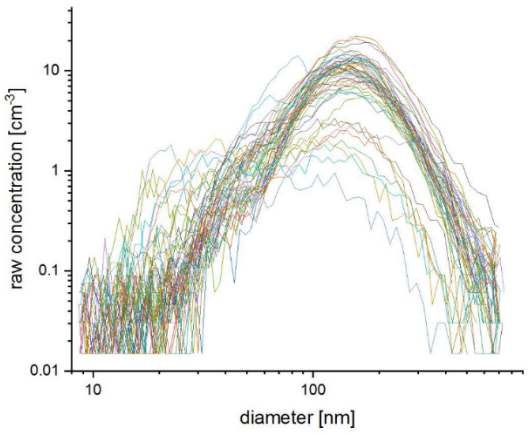
HERA

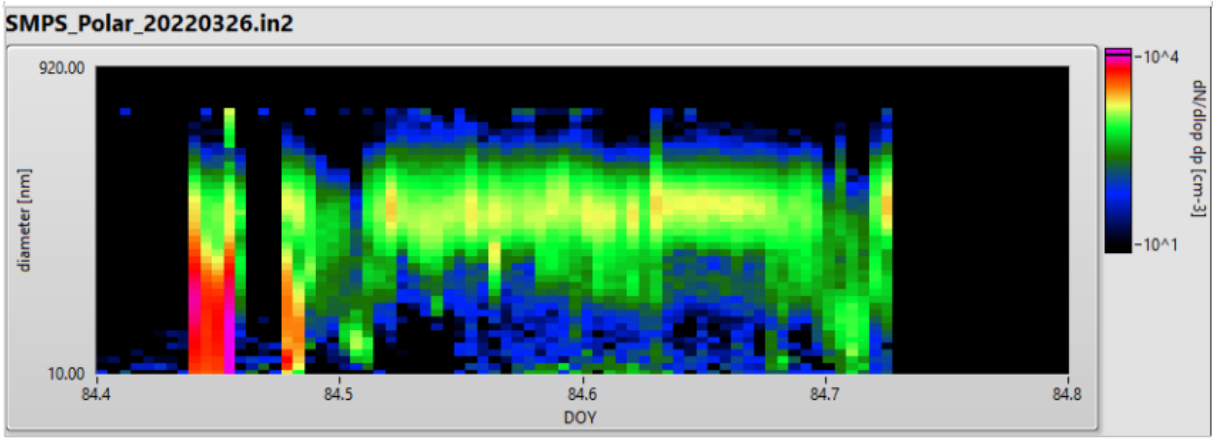


mCCNC

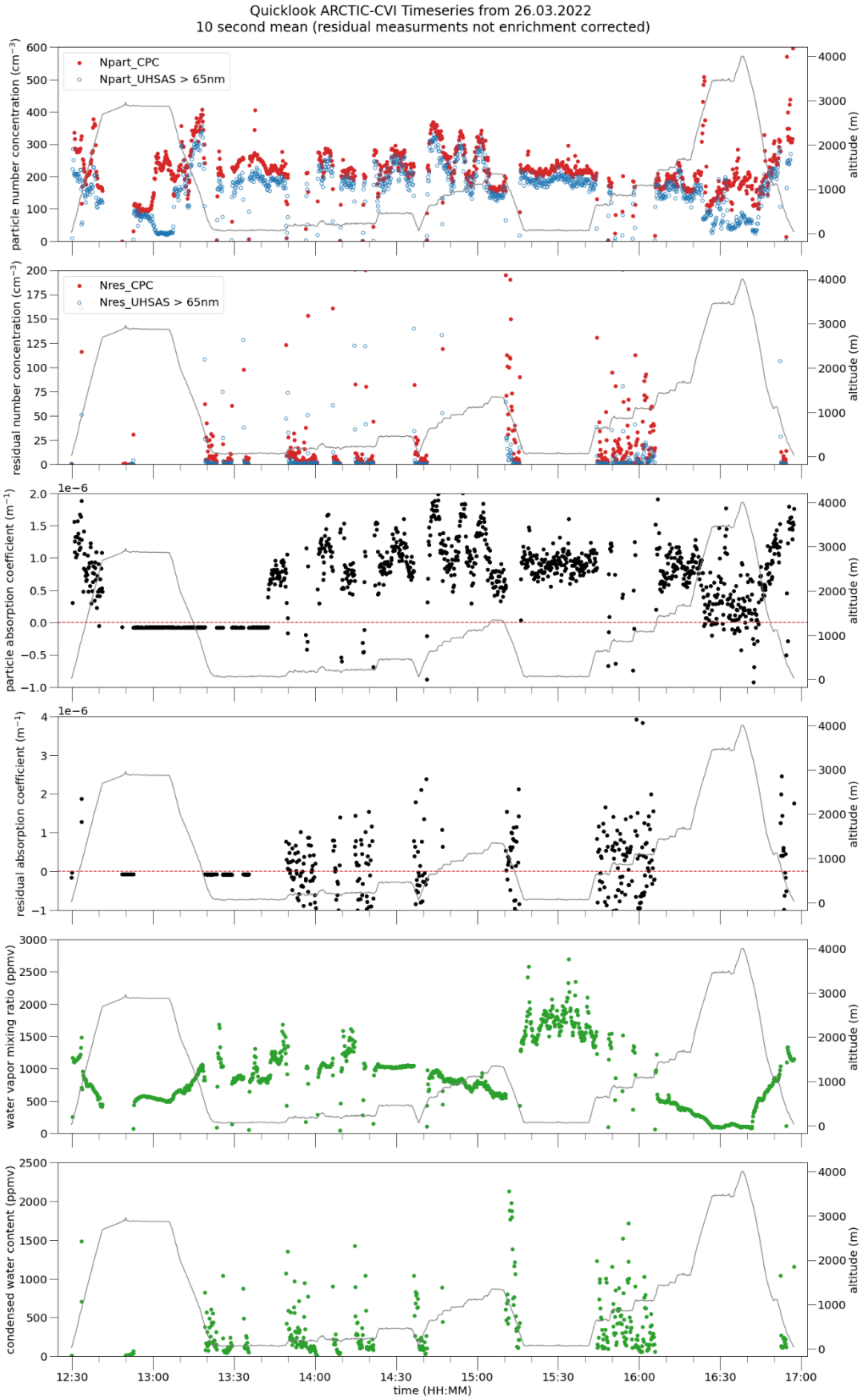

−0.8
−0.6
−0.4
SS (%)
−0.2
0.0
0.2
4000
3000
2000
1000
0
N_{CCN} (cm^{-3})
12:13:20
12:46:40
13:20:00
13:53:20
14:26:40
15:00:00
15:33:20
16:06:40
16:40:00
17:13:20

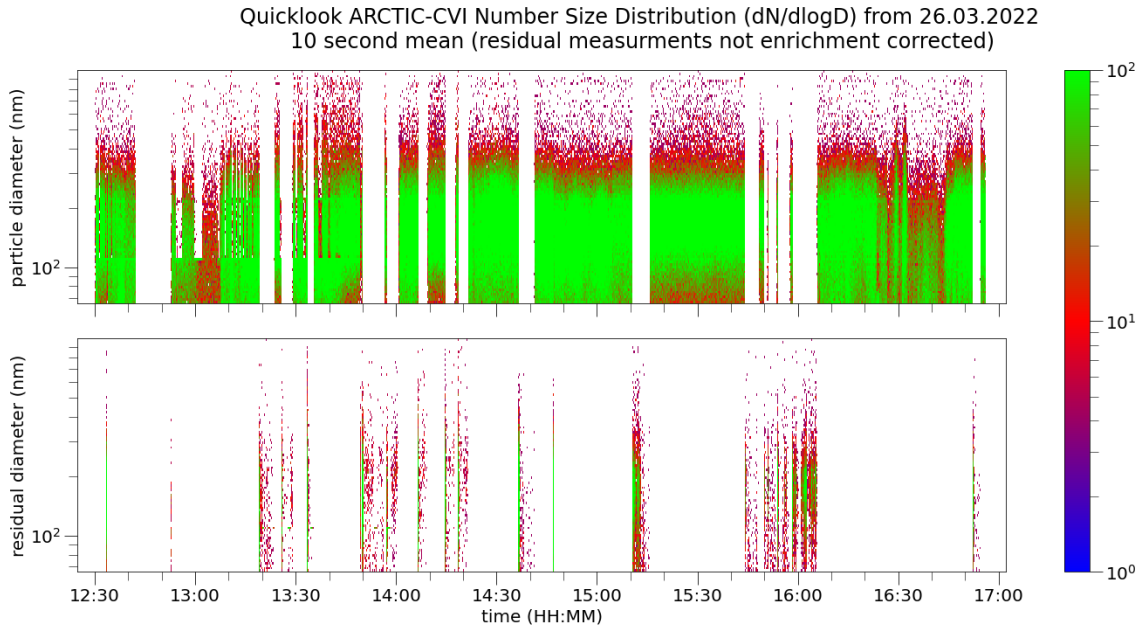
SMPS

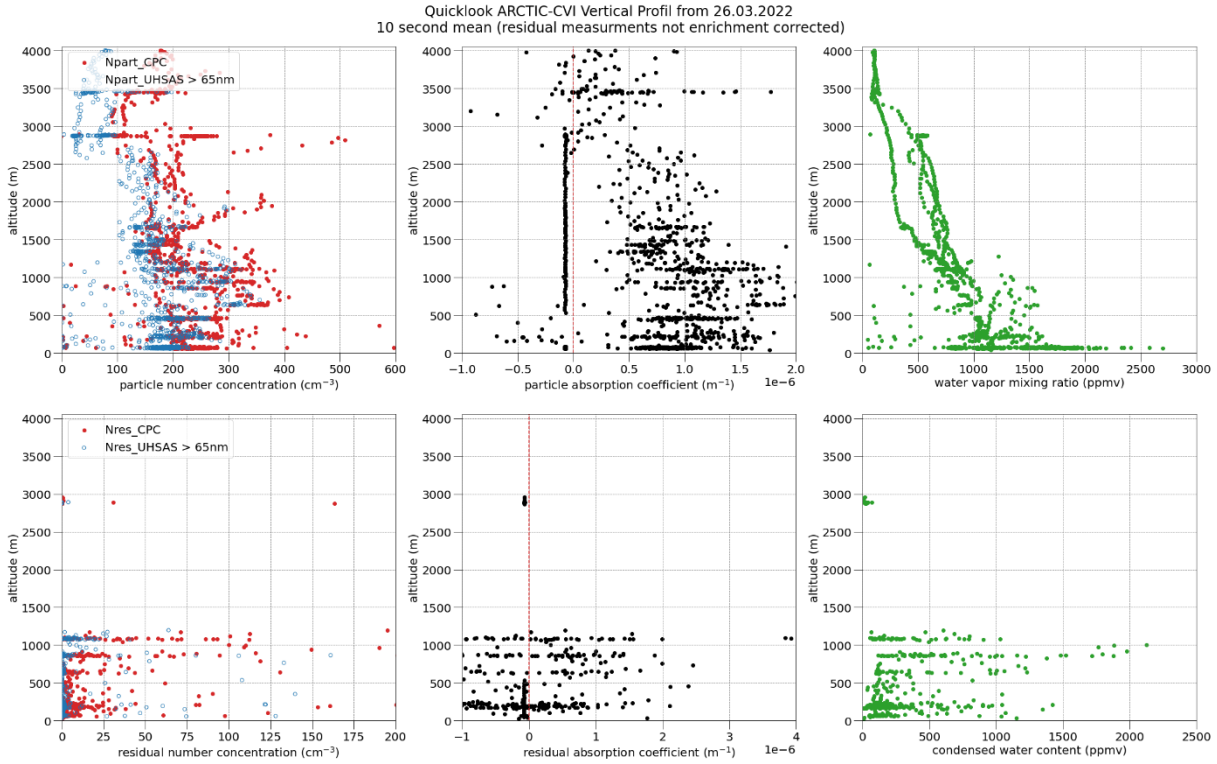

raw concentration [cm-3]
10
1
0.1
0.01
10
100
diameter [nm]


SMPS_Polar_20220326.in2
920.00
10.00
diameter [nm]
84.4
84.5
84.6
84.7
84.8
DOY
10^4
10^1
dN/dlog dp [cm-3]

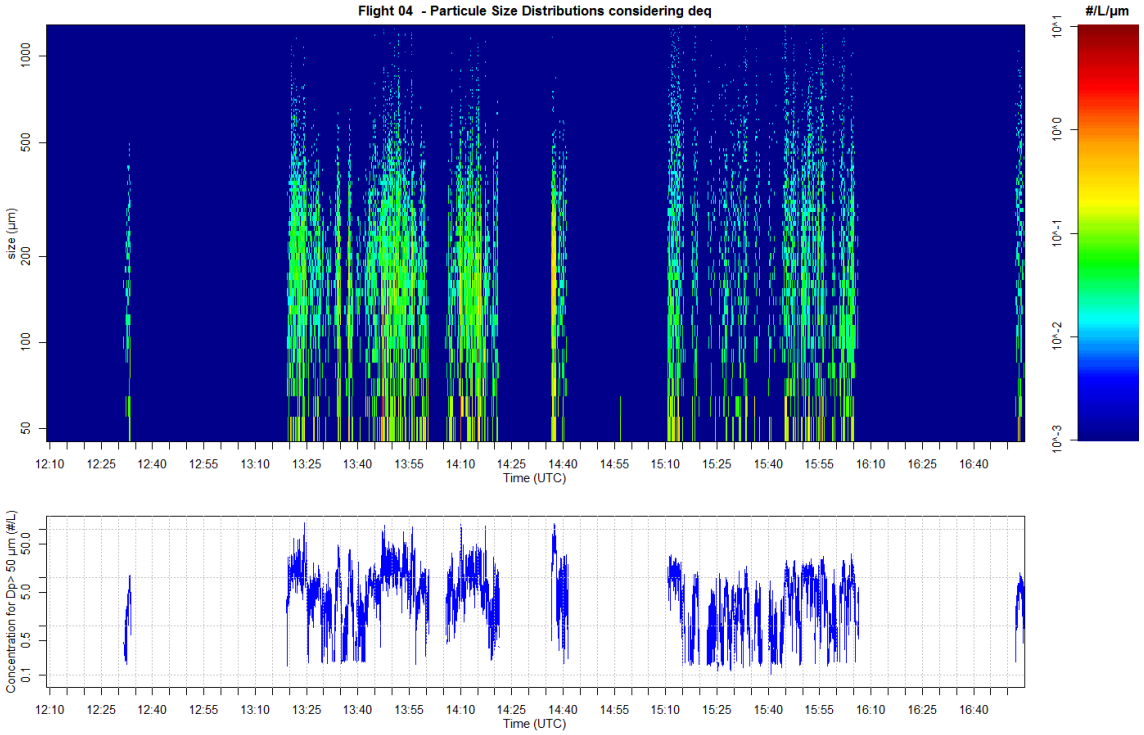
CVI

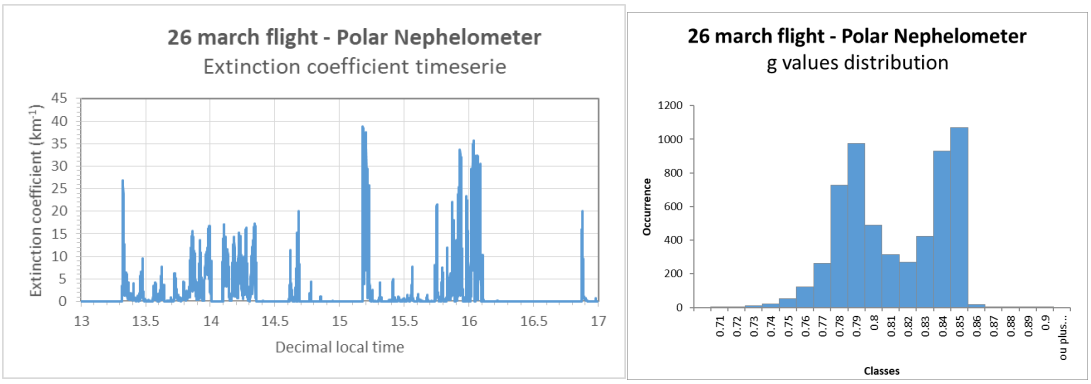

Quicklook ARCTIC-CVI Timeseries from 26.03.2022
10 second mean (residual measurments not enrichment corrected)
Npart_CPC
Npart_UHSAS > 65nm
particle number concentration (cm⁻³)
Nres_CPC
Nres_UHSAS > 65nm
residual number concentration (cm⁻³)
particle absorption coefficient (m⁻¹)
residual absorption coefficient (m⁻¹)
1e−6
water vapor mixing ratio (ppmv)
condensed water content (ppmv)
altitude (m)
12:30
13:00
13:30
14:00
14:30
15:00
15:30
16:00
16:30
17:00
time (HH:MM)

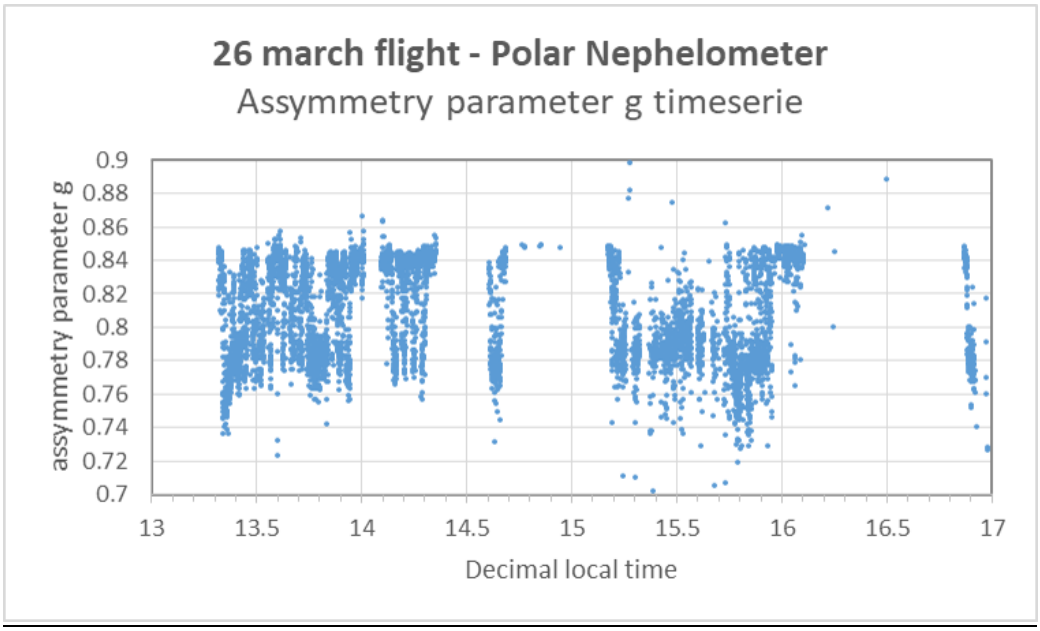

Quicklook ARCTIC-CVI Number Size Distribution (dN/dlogD) from 26.03.2022
10 second mean (residual measurments not enrichment corrected)
particle diameter (nm)
residual diameter (nm)
time (HH:MM)


Quicklook ARCTIC-CVI Vertical Profil from 26.03.2022
10 second mean (residual measurments not enrichment corrected)
Npart_CPC
Npart_UHSAS > 65nm
particle number concentration (cm⁻³)
particle absorption coefficient (m⁻¹)
water vapor mixing ratio (ppmv)
Nres_CPC
Nres_UHSAS > 65nm
residual number concentration (cm⁻³)
residual absorption coefficient (m⁻¹)
condensed water content (ppmv)
altitude (m)

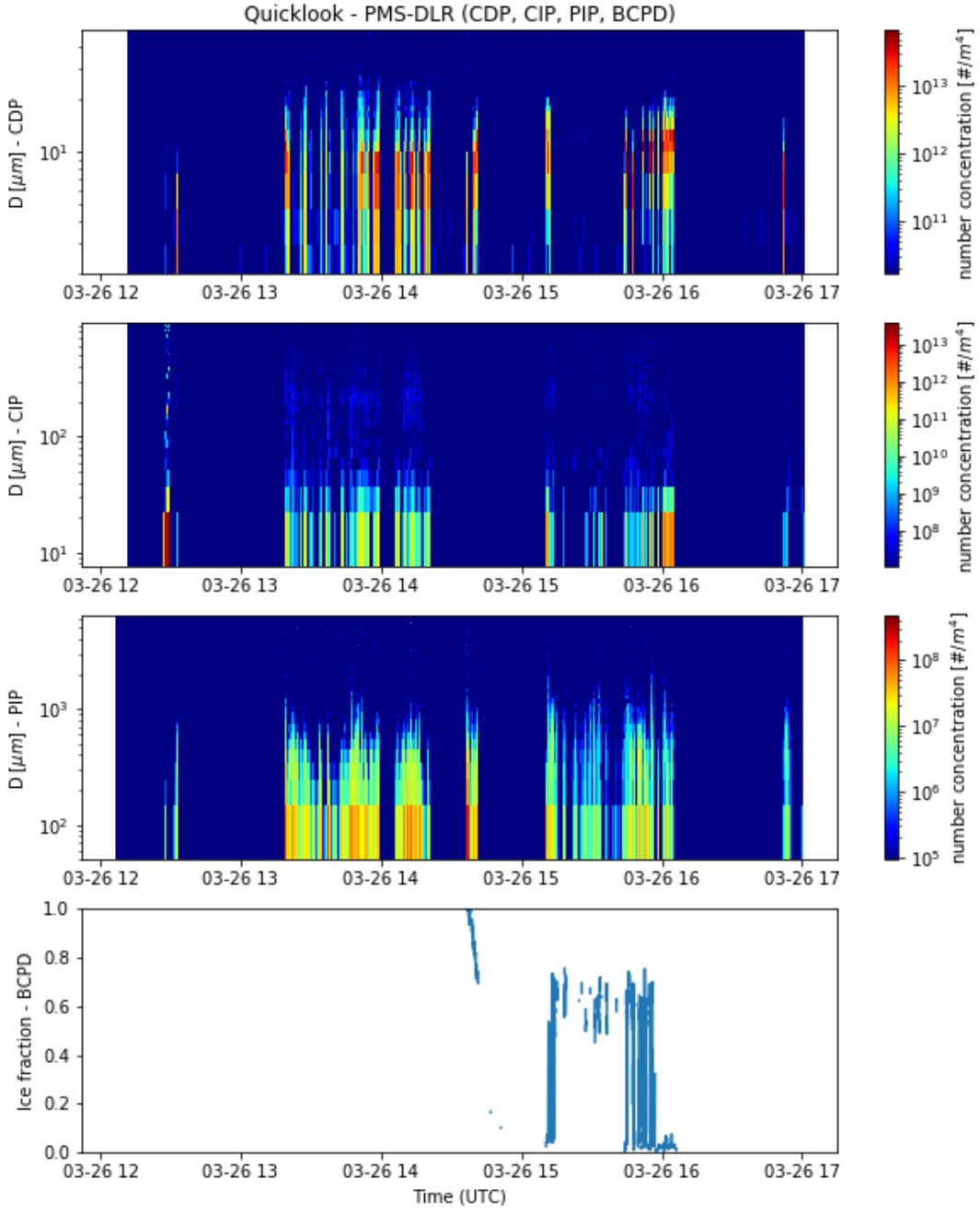
PMS-LaMP


Flight 04 - Particule Size Distributions considering deq
#/L/µm
size (µm)
Time (UTC)
Concentration for Dp> 50 µm (#/L)
Time (UTC)


26 march flight - Polar Nephelometer
Extinction coefficient timeserie
Extinction coefficient (km-1)
Decimal local time
26 march flight - Polar Nephelometer
g values distribution
Occurrence
Classes


26 march flight - Polar Nephelometer
Assymmetry parameter g timeserie
assymmetry parameter g
Decimal local time

PMS - DLR


Quicklook - PMS-DLR (CDP, CIP, PIP, BCPD)
D [μm] - CDP
D [μm] - CIP
D [μm] - PIP
Ice fraction - BCPD
number concentration [#/m^4]
03-26 12
03-26 13
03-26 14
03-26 15
03-26 16
03-26 17
Time (UTC)