

HALO-(AC)³ – 2022/03/22 – POLAR 5 research flight 03

Objectives:

- Sampling the Cold Air Outbreak (CAO) west of Svalbard
- Sampling the evolution of clouds from sea ice towards open water
- Performing some collocated measurements with the POLAR 6 in a similar area

Mission PI POLAR 5:

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POLAR 5 Crew	
Mission PI	Marcus Klingebiel
AWI	Cristina Sans Coll
AWI	Maximilian Stöhr
SMART/EAGLE/HAWK	Hanno Müller
MiRAC/AMALi	Maximilian Maahn
Drosondes	Pavel Krobot
Pilots	James Steward Noah Hladiak
Ground PI	Imke Schirmacher

Flight times:

POLAR 5	
Take off	11:45 UTC
Touch down	16:00 UTC

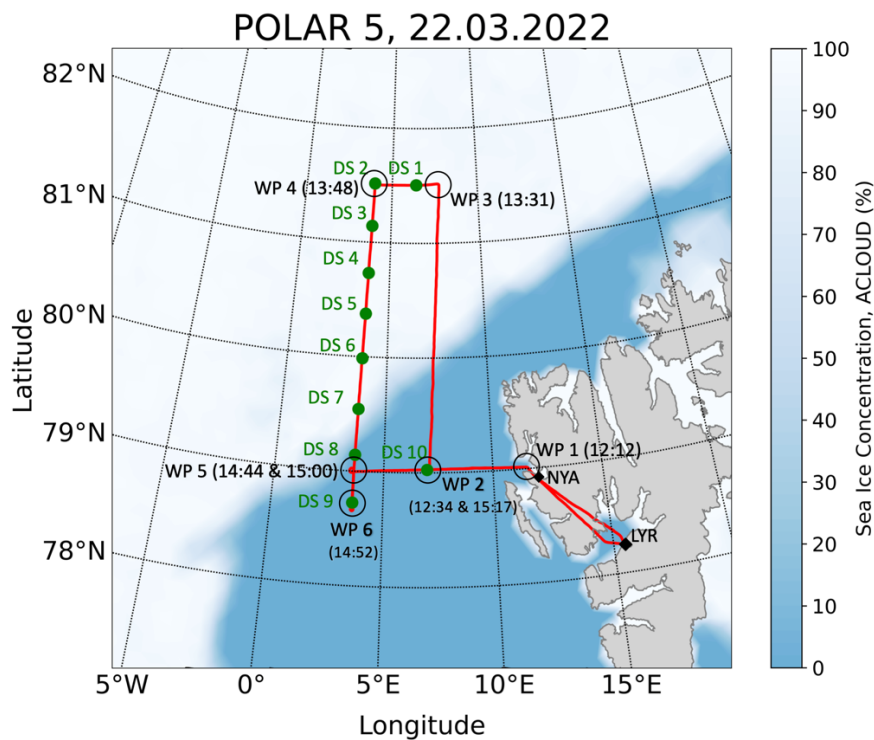


Fig. 1: Flight track with AMSR sea ice concentration and location of the launched drosondes (DS) and waypoints (WP), including the passing times of the waypoints in UTC.

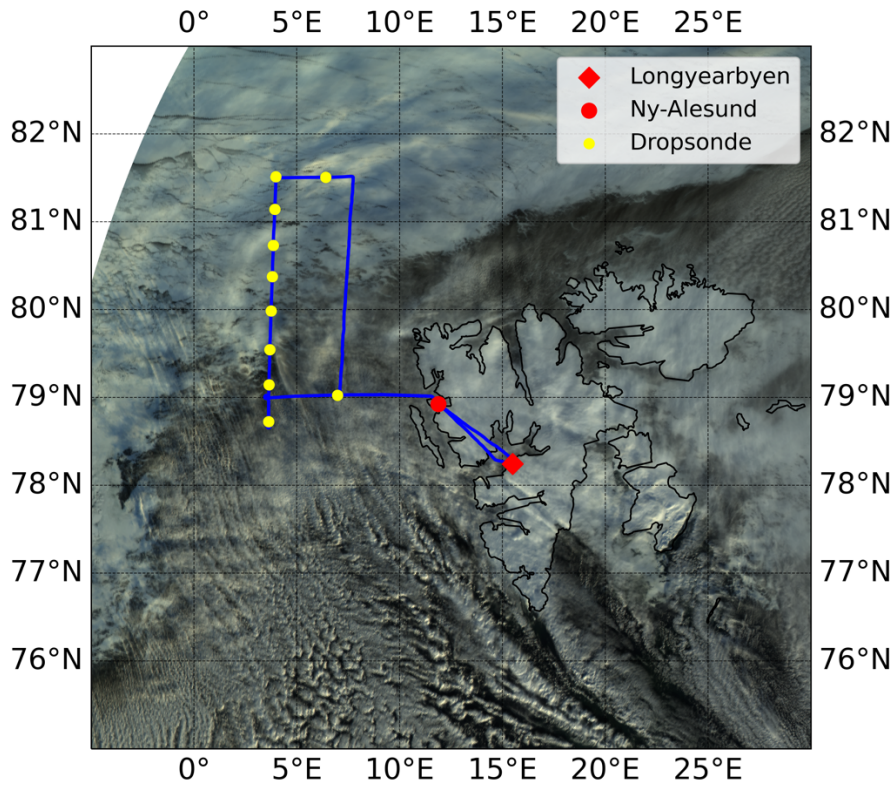


Fig. 2: Flight track with MODIS satellite image (from 22.03.2022, 08:40 UTC) and location of the launched dropsondes.

Weather situation as observed during the flight:

During the whole research flight we were surprised that the weather forecast didn't match the observed weather very well. Especially between waypoint (WP) 2 and WP 3, the cloud top was much higher than predicted. In the following, the forecast and the observed weather will be described and the differences will be pointed out in the end.

Weather forecast:

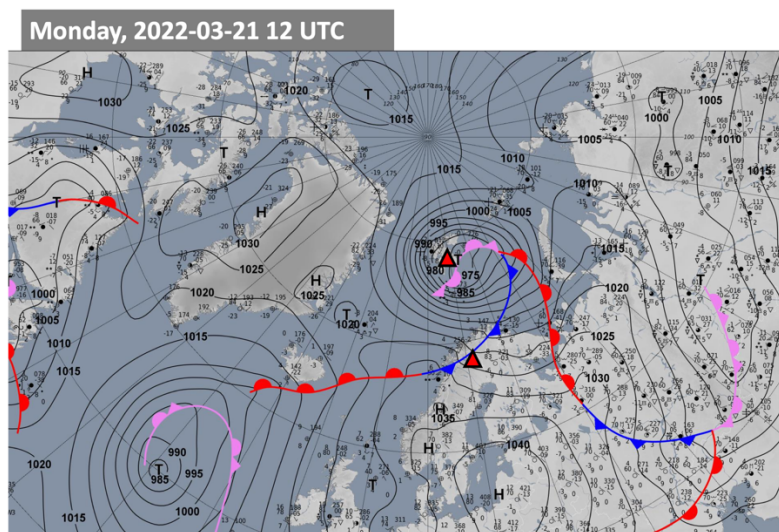


Fig. 3: Weather situation on Monday, 21.03.2022 at 12 UTC, one day before the research flight.

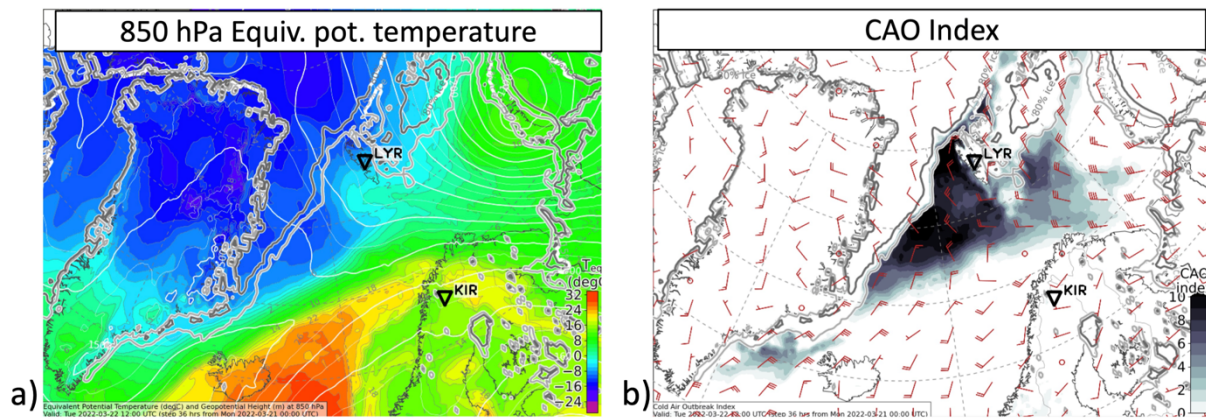


Fig. 4: a) ECMWF forecast of the temperature at 850 hPa valid for 22.03.2022, 12 UTC (from 21.03.2022, 00:00 UTC). b) CAO index for the same times.

The overall weather situation in the vicinity of Svalbard was governed by a low pressure system with its center close to Svalbard (see Fig. 3). This low pressure system lead to a Cold Air Outbreak (CAO) west of Svalbard, moving cold air masses from the Arctic sea ice towards the open ocean. Figure 4a and 4b show the massive CAO west of Svalbard, which was also persistent for the following days. Related to this CAO, low and mid-level clouds were expected on the west side of Svalbard (see Fig. 5). The goal was to sample these low level clouds, like it is indicated by the side view of the planned flight track in Fig. 5b.

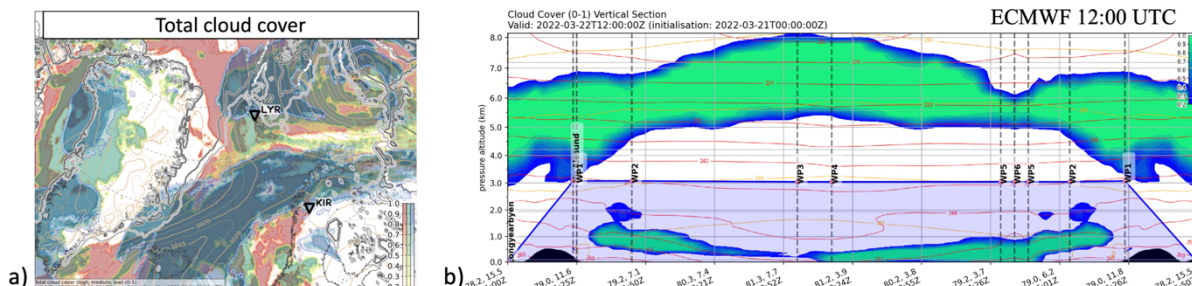


Fig. 5: a) ECMWF forecast of the total cloud cover (ref = low, green = mid-level, blue = high clouds) valid for 22.03.2022, 12 UTC (from 21.03.2022, 00:00 UTC). b) Side view of the cloud cover for the same forecasting times, including the planned flight track.

Observed Weather:

After takeoff we climbed to FL 100 (10000 ft) and were inside clouds until WP 2 (see Fig. 1). Between WP 2 and WP 3 the POLAR 5 climbed up 11000 ft to reach the cloud top and get out of the haze. Figure 6a shows the cloud situation before the climb, where no cloud top was visible because of the hazy conditions. After the climb the POLAR 5 was above the cloud layer and moving towards the north it cleared up and the cloud top was clearly visible (Fig. 6b). At the northernmost waypoint (WP 4), it was possible to see the ice below the thin cloud layer. Above the POLAR 5, only a few cirrus clouds were visible. Between WP 4 and WP 5, the cloud layer got thicker towards the ocean, but it was still possible to see the ice on the ground (see Fig. 6d and 6e). Towards the end of the flight, heading east, the cloud top increased again and different cloud layers were visible (see Fig. 6f).

Differences between Forecast and Observations:

The major differences between the model forecast and the observed situation occurred in

the beginning of the flight, up until the center of the flight leg between WP 2 and WP 3. The forecast clearly underestimated the cloud top height, which was up to around 10500 ft. On the flight leg between WP 4 and WP 5, the model forecast was more accurate in predicting the low level clouds. However, we didn't see very many midlevel clouds above the research aircraft on this leg, which were more dominantly predicted in the forecast (see Fig. 5b).



Fig. 6: Pictures from the cloud situation during different times of the flight.

Overview:

The flight strategy worked out well and we were able to sample the outflow of the CAO on two flight legs, namely between WP 2 – WP 3 and WP 4 – WP 5. Only the high cloud top on the first flight leg (WP 2 – WP 3) was unexpected so that we adjusted the altitude of the aircraft from 10000 ft to 11000 ft.

Even it was not planned, on the flight leg between WP 4 – WP 5, the POLAR 5 and POLAR 6 flew parallel to each other. This correlated flight pattern might be useful to combine remote sensing and in-situ measurements, although the flight tracks were slightly apart (see Fig. 7).

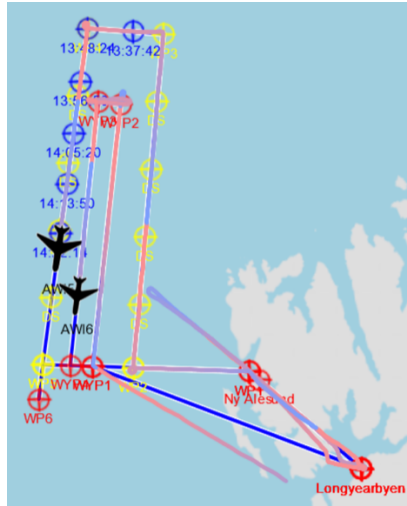


Fig. 7: Correlated flight leg with POLAR 6.

Instrument Status:

POLAR 5	
SMART	
EAGLE	Crashed many times, roughly 1 hour of data
HAWK	No dark current measured
MIRAC	
AMALI	Started late: 12:45 UTC
Noseboom	
HATPRO radiometer	
Broadband radiation	
Sunphotometer	
Nikon Camera	
Dropsondes	Dropsondes only launched in the seconds half

Table 1: Instrument status as reported after the flight for all instruments on POLAR 5.

Detailed Flight Logs:

- 11:45 Take off
- 12:04 Inside clouds on the way to Ny-Ålesund
- 12:11 Ny-Ålesund passed
- 12:15 Reached coast of Svalbard, Clouds are getting thinner
- 12:20 AMALI on, but doesn't work properly, clear sky above us
- 12:21 DROPSONDES not working
- 12:24 Clouds getting thinner
- 12:48 AMALI seems to work now
- 12:55 Climbing to 10500ft, still inside the clouds
- 13:05 Climbing now to 11000 ft and try to get out of the cloud. We can see the blue sky above, but it is still very hazy. We will stay here for the rest of the flight. Different from the forecast.
- 13:14 We are leaving now slowly the hazy stuff and can see the cloud top layer at the horizon.
- 13:28 It clears up more and more now
- 13:31 Reaching waypoint 3
- 13:37 1. Dropsonde launched

- 13:48 2. Dropsonde launched
- 13:56 3. Dropsonde launched
- 14:05 4. Dropsonde launched
- 14:13 5. Dropsonde launched
- 14:22 6. Dropsonde launched
- 14:23 On the way back, to WP 5 and WP 6, we are getting into clouds again
- 14:32 7. Dropsonde launched
- 14:41 8. Dropsonde launched
- 14:54 9. Dropsonde launched
- 15:17 10. Dropsonde launched
- 15:35 Passing Ny-Ålesund
- 16:00 Touch down

Quicklooks:

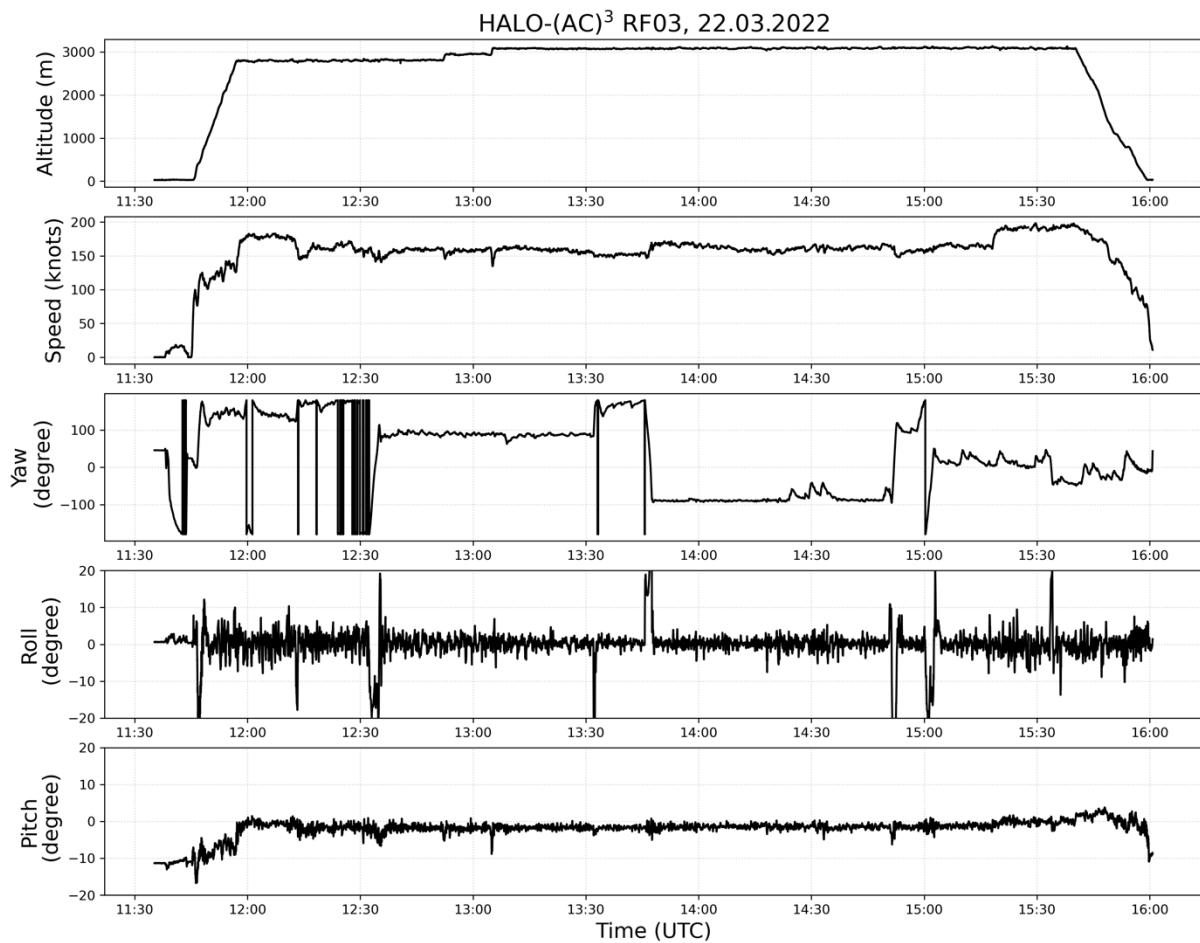


Fig. 8: Altitude, speed and attitude measurements.

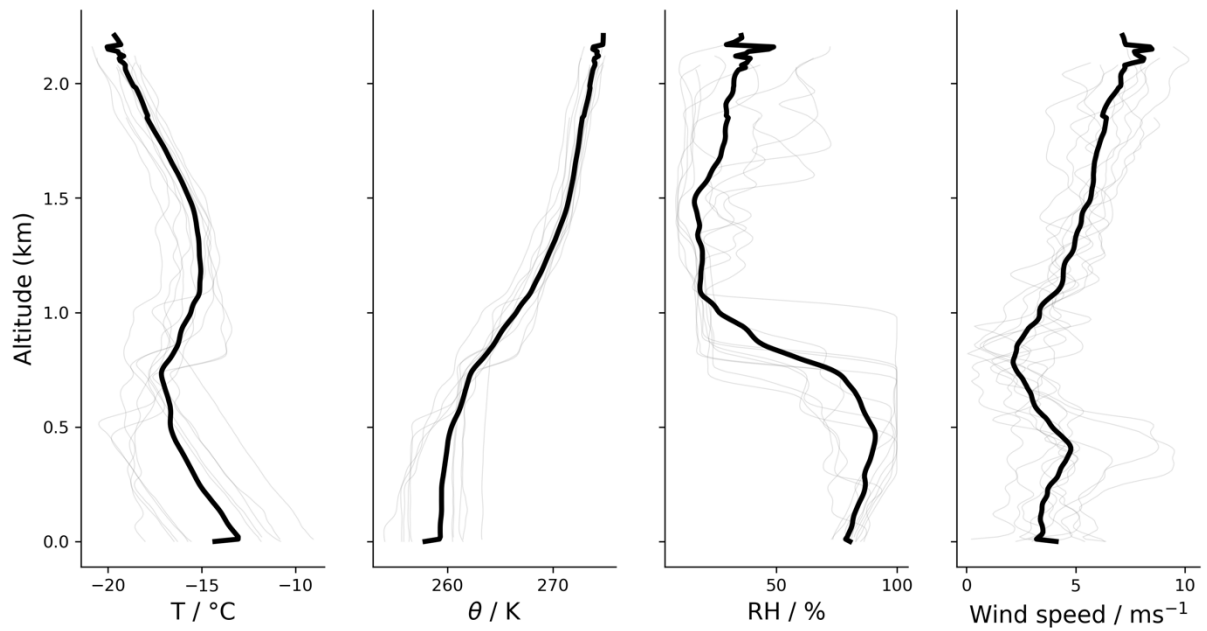


Fig. 9: Profiles of all launched dropsondes. Mean values are indicated by the black line.

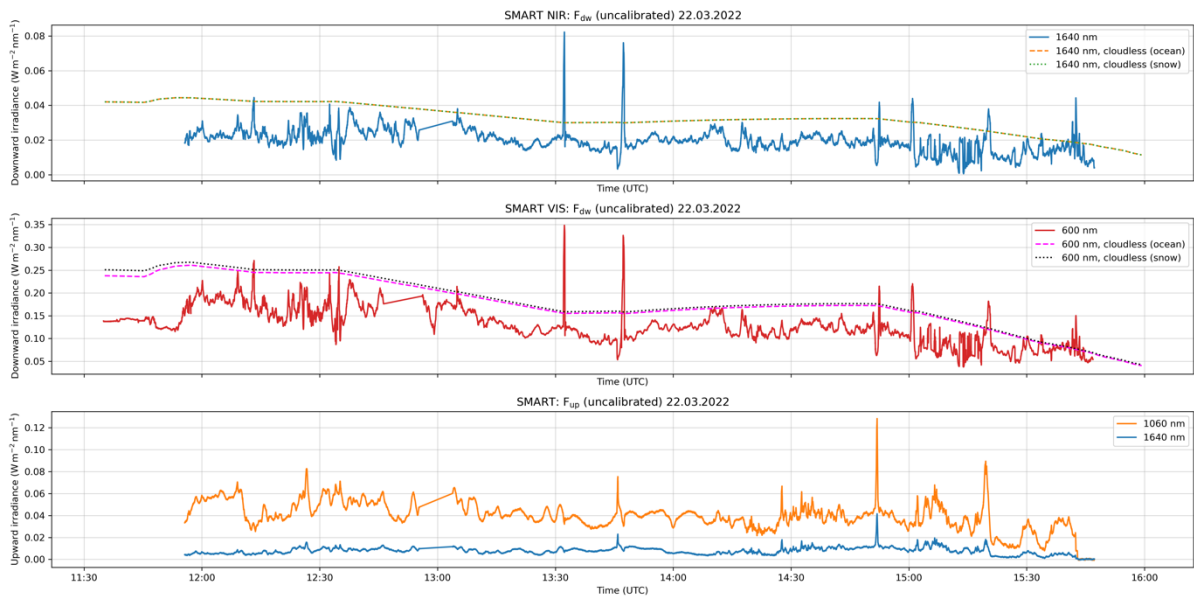


Fig. 10: SMART measurements along the flight.

HATPRO, 2022-03-22, 11:45-15:59 UTC

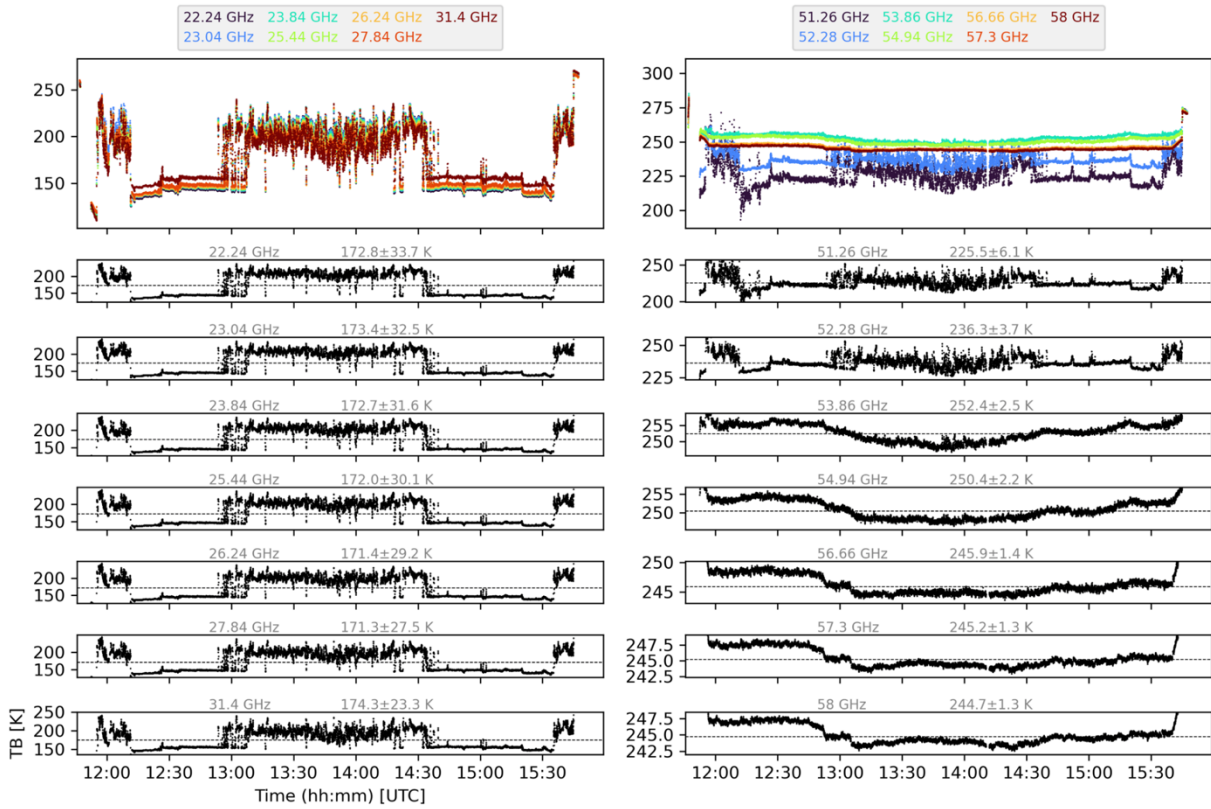


Fig. 11: HATPRO Radiometer measurements along the flight.

MiRAC-A, 2022-03-22, 11:45-15:59 UTC

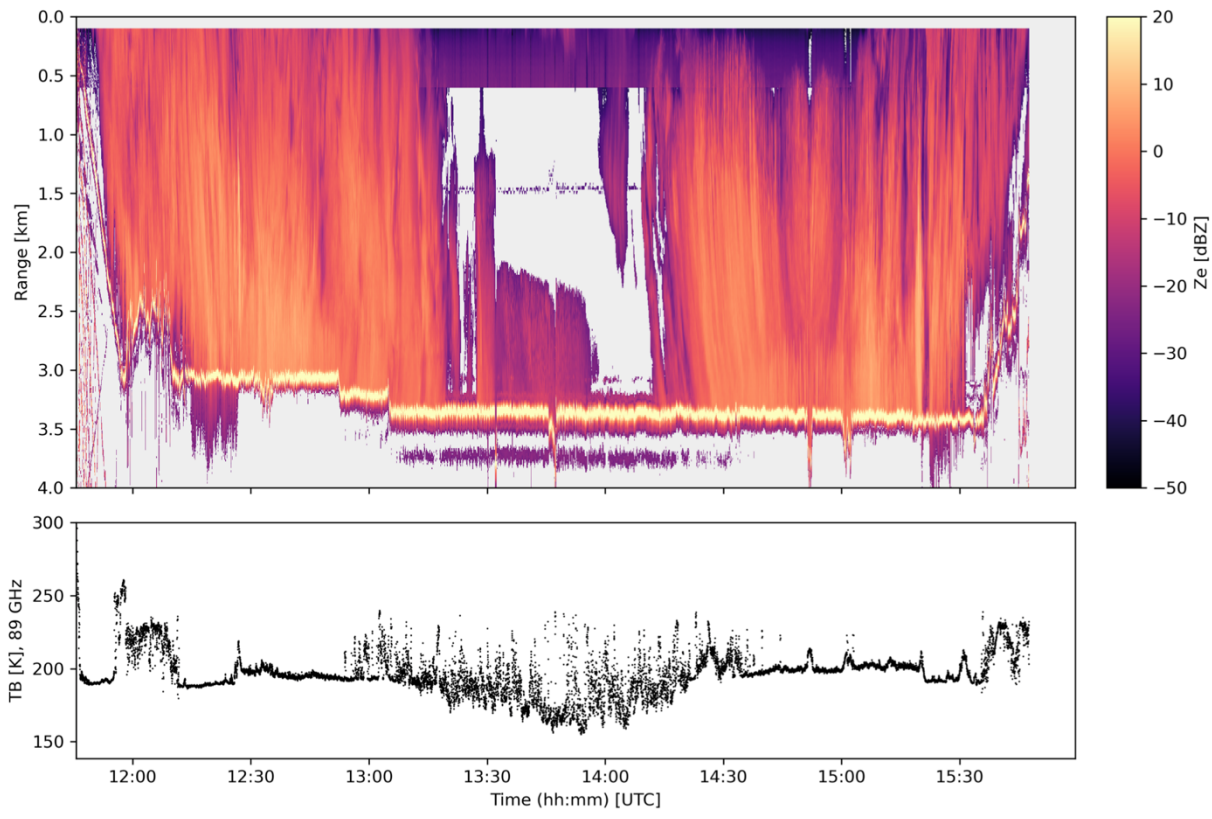


Fig. 12: MiRAC radar measurements. Not altitude corrected.

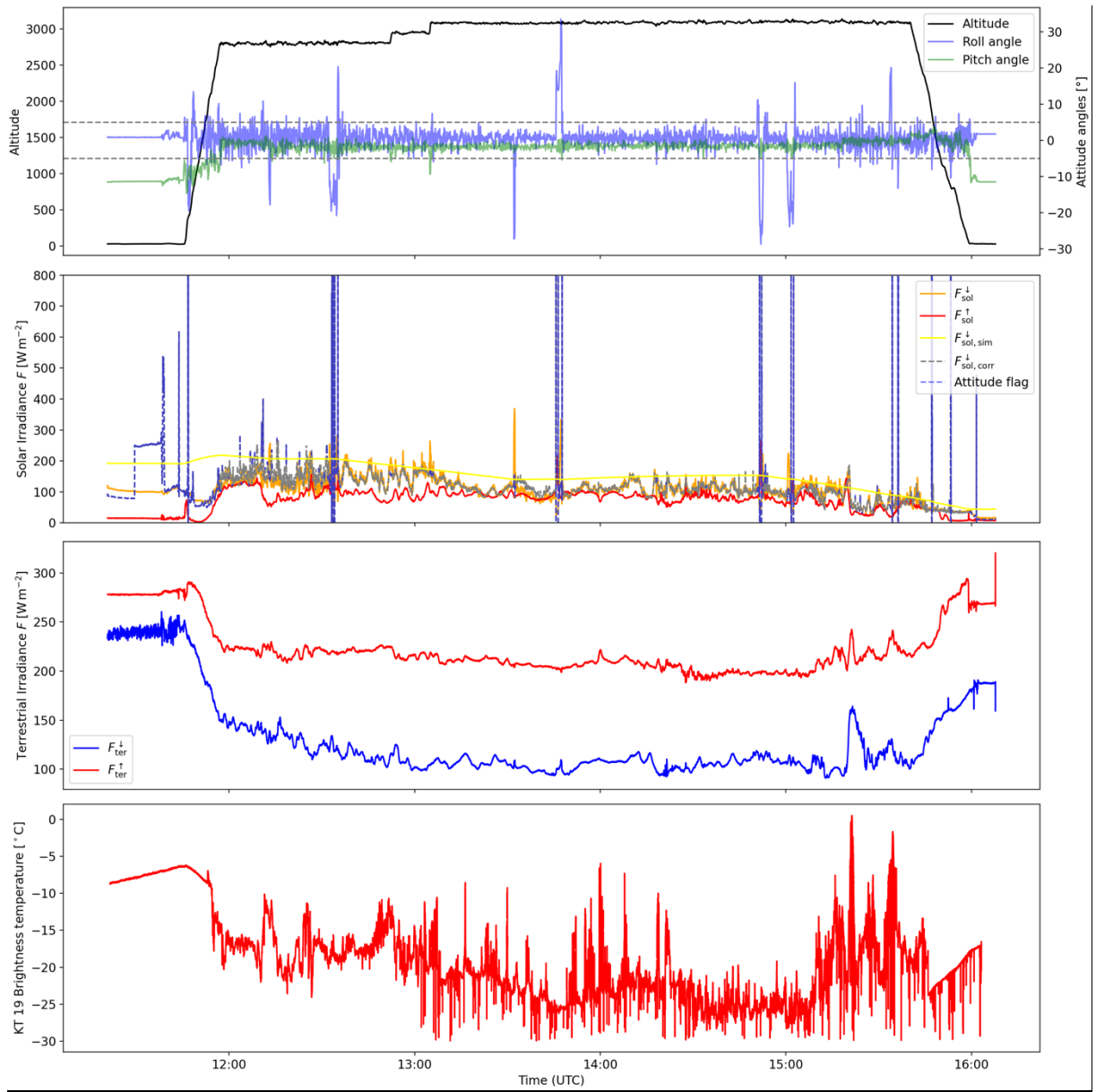


Fig. 13: Broadband radiation measurements along the flight.

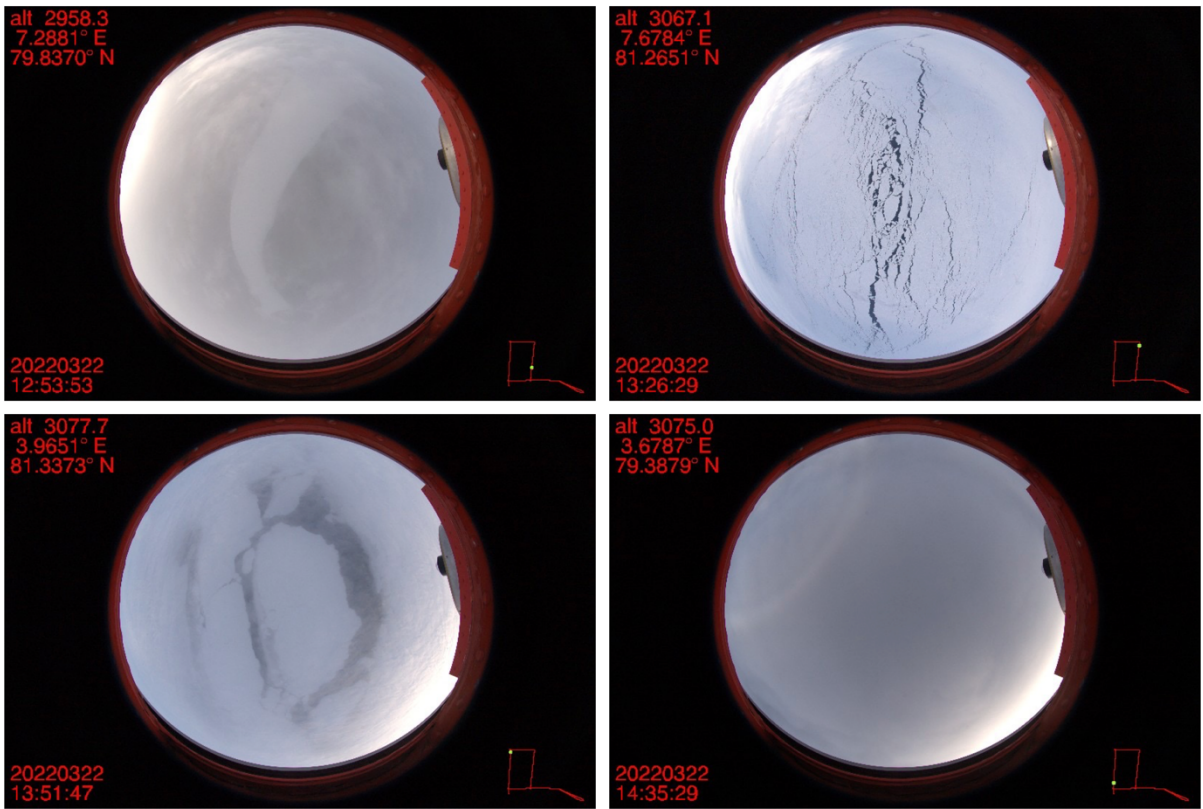


Fig. 14: Nikon camera pictures from different locations.