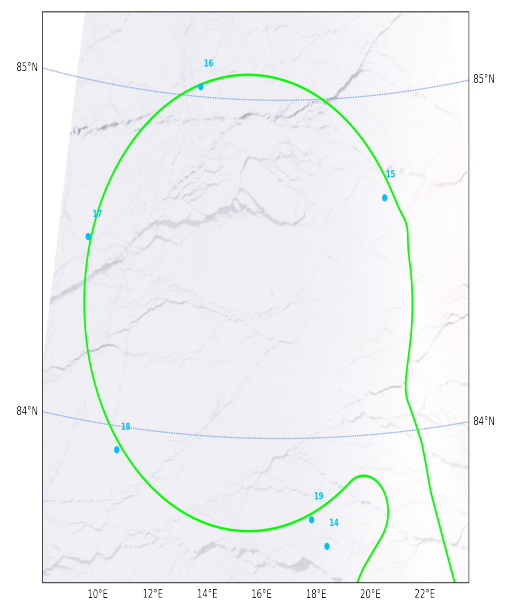
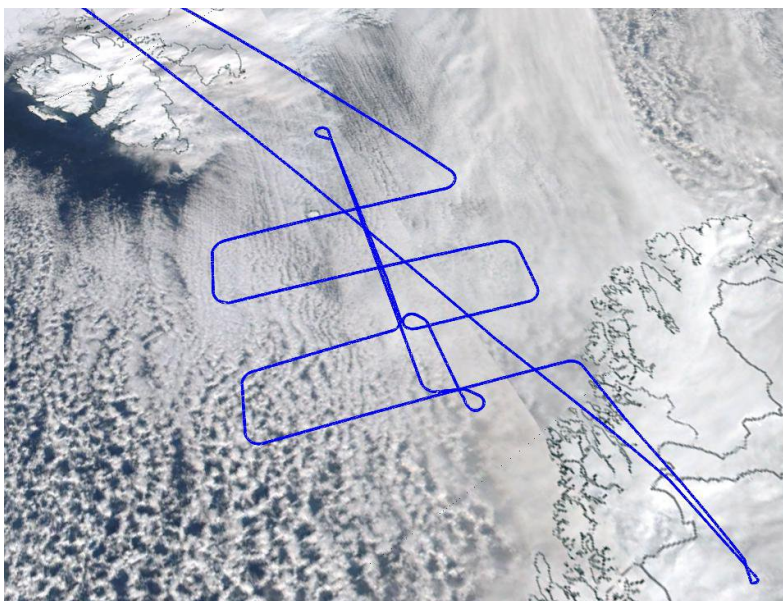


HALO-(AC)³ - 2022/03/29 - HALO research flight RF10

Cold Air Outbreak (the East side) and the hunt for a polar airmass

Objectives:

- Steady northerly flow from the Arctic causing two CAO areas East and West of Svalbard
- Analyzing the cloud evolution on the stronger side of CAO East of Svalbard in coordination with FAAM and SAFIRE aircrafts
- Perform a circular pattern with dropsonde release in the Arctic, capturing the properties of an airmass that is predicted to be transported Southward in the target area of RF11, allowing the analysis of the airmass transformations as it moves on a long (24 hours) time span.



<https://worldview.earthdata.nasa.gov/>

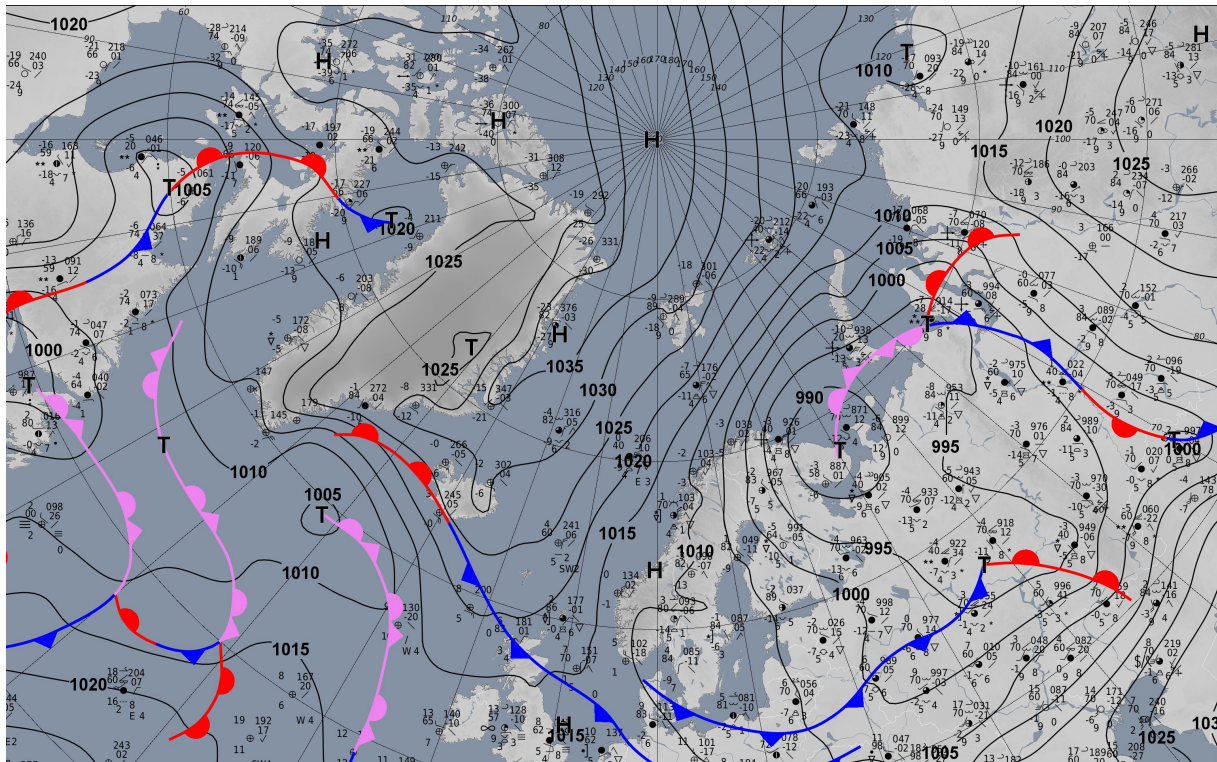
Mission PI HALO:

HALO Crew	
Mission PI	Davide Ori
HAMP	Lutz Hirsch
WALES	Georgios Dekoutsidis
SMART/VELOX	Michal Schäfer
specMACS	Veronika Pörtge
Dropsondes	Sebastian Schmidt
Media/Press	Björn Duseler
Pilots	Roland Welser Thomas Kalfas
Engineer	Thomas Leder

Flight times:

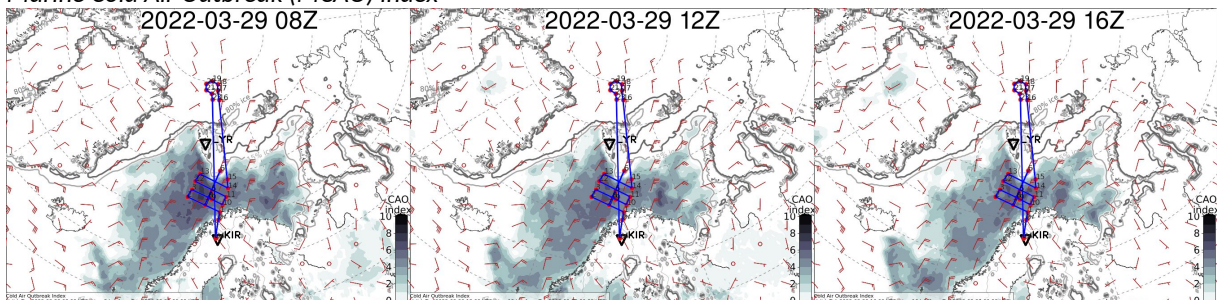
HALO	
Take off	07:50 UTC
Touch down	16:30 UTC

Weather situation as observed during the flight:

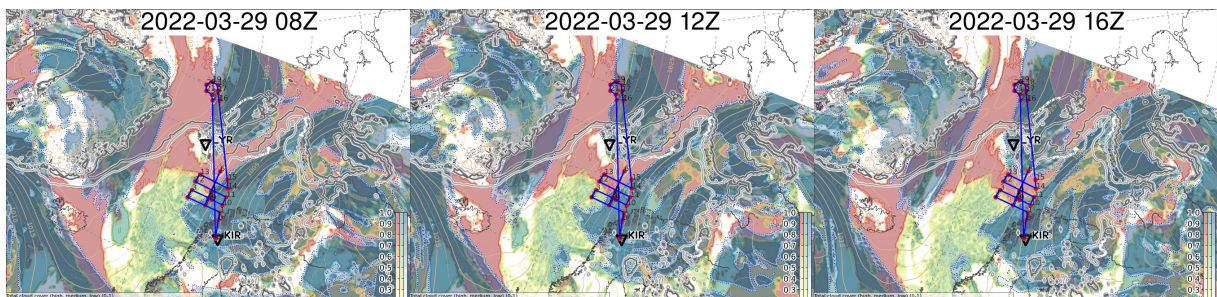


The synoptic situation was dominated by the presence of a low pressure system over the Kola peninsula and a ridge East of Greenland that were driving a steady North-Easterly flow over the Barents Sea and the Fram Strait. This situation developed two areas of Cold Air Outbreak (CAO) East and West of Svalbard. The steeper pressure gradient over the Barents Sea caused much more intense surface winds and a larger CAO index East of Svalbard. The MCAO index remained rather stable during the flight. The cloud conditions were predicted to be mostly low to mid-level clouds with few high-level clouds.

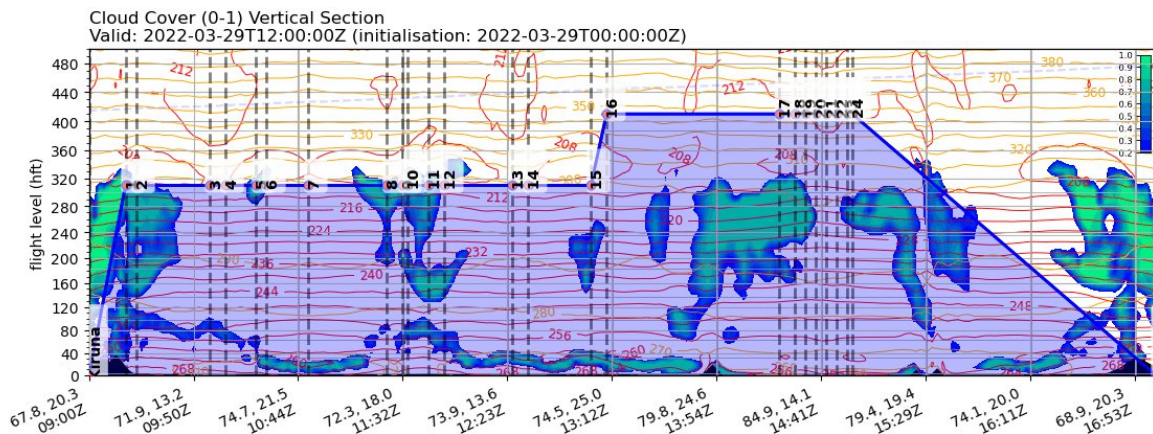
Marine Cold Air Outbreak (MCAO) index



Total Cloud Cover



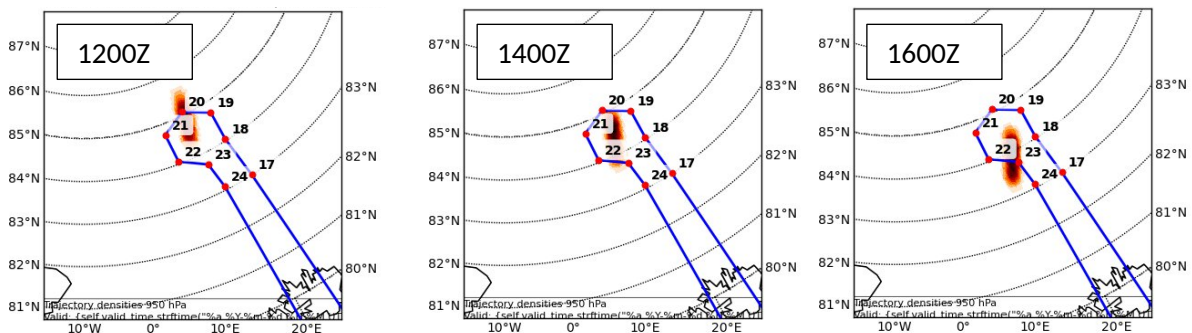
Predicted Cloudiness along the track



Compared to the predicted situation, a substantial amount of higher level clouds were encountered, especially in the CAO operation area (see also radar and lidar quicklooks), while the Arctic operation area was covered only by a thin, transparent cloud layer.

Overview:

The weather situation offered a steady northerly wind transport of air masses that allowed to plan a study on the transformation of airmass properties over a long time span, coordinating the release of dropsondes in circular pattern with the subsequent flight RF11.



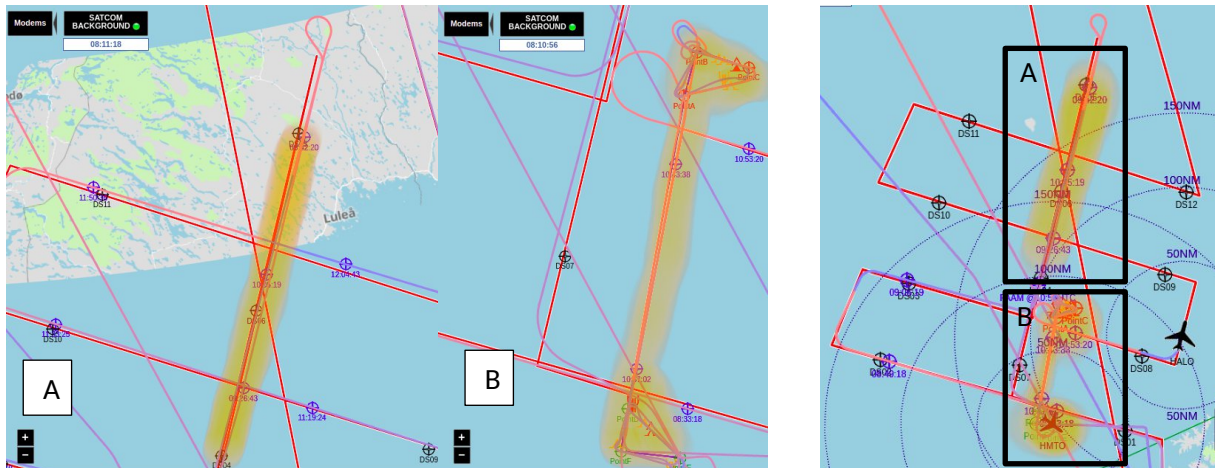
The strategic planning of the flight started with the calculation of the predicted location of the airmass that 24h later will be in a favorable location for the RF11 operations. This defined a circle of 75km radius around the (84.4N, 17.43E) center-point to be performed around 1400Z. This constrain defined the second half of the flight plan.

For the first part of the flight HALO operated in the stronger CAO area South-East of Svalbard leveraging on the opportunities of co-location with the FAAM and SAFIRE operation areas.

The plan was to statistically sample the CAO area with closely separated cross-flow transects that will be interrupted after the first leg to perform one (doubled, going back and forth) along-flow scan operated above the other two research aircrafts.

In the next image you can see the target area of the FAAM and SAFIRE aircrafts highlighted in yellow. FAAM was expecting to operate in the Northern leg between 0740Z and 0900Z while SAFIRE planned

to make measurements in the two triangular areas and the path connecting them starting around 0900Z for around 2 hours in total.



In order to match these two patterns in space and time the second cross-flow leg was interrupted at half of the path. From there it was expected to fly over FAAM two times, one northbound and the other on the way back. Unfortunately, the FAAM aircraft took off with a substantial delay with respect to the plan. The discussion with the FAAM pilots before the flight and the constant updates on the FAAM position on Planet were essential for managing the procedure turns in air in order to make the coordinated stretch as planned.

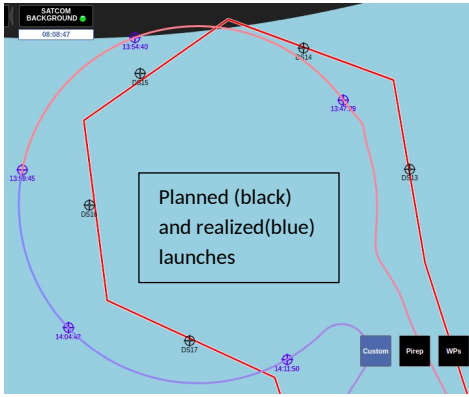
After this leg the flight proceeded southbound towards the target area of SAFIRE. SAFIRE decided last minute to shift their operation area 50 km East, off of the continuation of the FAAM measurement line. For this reason the HALO flightplan was changed: the southbound path aligned with FAAM route was kept unmodified while the returning leg was shifted to meet the new operation area of SAFIRE. The SAFIRE leg was performed only once northward between their two triangular area of operations.

On both coordinated routes the dropsonde launches were optimized to better cover the common measurement areas.

Despite the few adjustments the coordinated routes were performed effectively and the HALO plan continued as planned with two additional cross-flow tracks that were completed in time for the ferry route to meet catch the northern airmass.

Despite the forecasts of mostly low-level clouds the upper cloud deck extended considerably in the CAO area and HALO climbed up to FL410 to improve the measurements of WALES. At the same time the precipitation on the sea was more intense than predicted and the HAMP radar package has not been affected too much in terms of sensitivity.

The circle in the North was initiated at 1350Z. Due to limitations imposed by the ATC in terms of separation with respect to the Russian airspace border, the center location had to be shifted slightly to the West to (84° 24'N ; 15° 25'E). This new location still allowed to fully encircle all the predicted origin location of the airmass and did not affect the mission goals. Unfortunately, during the circle, the Planet system did not show the route: in order to space the dropsondes evenly we separated them by time according to pilot's estimates of circle duration, however this estimate resulted to be overestimated and we adjusted the time separation of the subsequent launches. For the future it is definitely better to use measured aircraft heading to separate the launches. Another limitation



potential obstacle was determined by the limitation imposed by Danish ATC to drop at most 5 dropsondes, with the possibility to extend this allowance in case one dropsonde fails. For this reason the operator was instructed to prepare additional dropsondes and, in case one of the first fails to launch an additional one without waiting for permission. This allows to maintain a more robust spacing and timing of the operations, without skipping launches at the optimal position and postponing the request to launch additional ones to later time.

Nonetheless, all launches were successful and the mission goal was accomplished.

On the ferry back to Kiruna, HALO climbed to FL450 to allow for bonus measurements in the stratosphere as requested by the WALES team.

Instrument Status:

HALO	
BAHAMAS	
BACARDI	
HAMP Radar	
HAMP Radiometer	
WALES	
SMART	
VELOX	
specMACS	
Dropsondes	

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

Comments:

HAMP radiometers KV and 119/90 were giving connection and data flow problems. Both instruments lost approximately 50 minutes of measurements from 0900Z to 0950Z. There were also reports of the 120.15 GHz channel providing some questionable measurements (to be verified).

Detailed Flight Logs:

0745Z Taxi
 0752Z Take off
 0800Z Ferry to the first waypoint. Reached FL310. Flying in the clouds
 0820Z First turn, initiate first cross-flow leg
 0833Z Dropsonde 01, Higher level clouds are getting thinner. A lower stratocumulus cloud deck is appearing underneath
 0857Z Discontinuous liquid clouds with pools of ice clouds in between (picture)



0849Z Dropsonde 02

0902Z Beginning the half-leg eastward

0906Z Dropsonde 03, we are below the tropopause, very dense layer of clouds under us. FAAM has begun operation in the target area

0910Z Alternating stripes of liquid and ice cloud tops (picture)

0915Z We are flying again in a thin, high-level cloud

0915Z Georgios requests higher altitude to increase WALES performances. Relatively intense snow precipitation at the sea-level, HAMP radar has a good SNR. We wait until after the turn to climb.

0920Z Started operation above FAAM. Coordination with the lower aircraft on dedicated HF channel for updated position

0925Z Climbing up to FL350 first, then FL370 and finally even FL390 to improve WALES.

0926Z Dropsonde 04 Moved North with respect to plan to cover better the operation area of FAAM

0942Z Dropsonde 05

0947Z Northernmost point common with FAAM. More organized cloud streets (picture). Drifting sea ice visible underneath

0950Z 180° turn and going back on the FAAM common operation area

0952Z Clouds are organizing rapidly into a dense deck over open ocean (picture)

1005Z Dropsonde 06

1012Z High clouds are getting thicker

1032Z Beginning common operation area with SAFIRE

1037Z Dropsonde 07, moved to the new common leg with SAFIRE

1043Z Dropsonde 08, SAFIRE exits the upper triangle area and flies towards HALO, kept radio contact to double check on separation

1053Z Dropsonde 09

1100Z Completed second half-leg. Returning to HALO-only operations

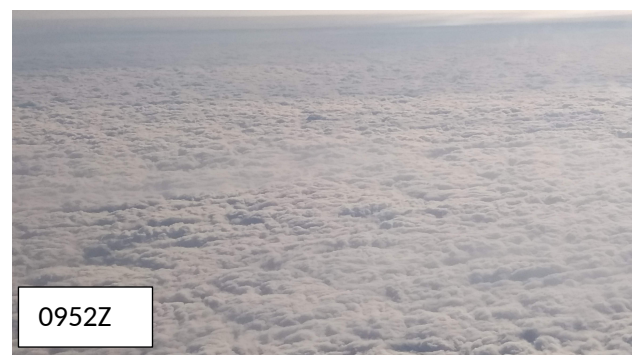
1105Z Climbing up to FL410 to improve WALES

1110Z Beginning full cross-flow leg westward

1119Z Dropsonde 10

1133Z Dropsonde 11

1137Z Small scale convective, liquid clouds covered with thin ice clouds



1145Z Beginning last cross-flow leg eastward

1150Z Dropsonde 12

1204Z Dropsonde 13

1215Z Beginning ferry to Arctic circle, Climbing up to FL430. New pilots' estimate for the rendezvous at the Arctic circle 1340Z, info communicated to ground. Our coordinates remained the same.

1320Z Approaching the Arctic operation area. We do not have clearance for the circle in the planned location, moving West by some degrees. Communicating the new center to the ground. The trajectories are still within the circle

1325Z Planet does not display the neither the track, nor the dropsonde-points, we attempt to drop evenly using time and pilots's prediction of a full circle in 35 minutes.

1347Z Dropsonde 14

1354Z Dropsonde 15, seems too much spaced from the first one, attempting to recover

1358Z Ice surface clearly visible (picture)

1400Z Dropsonde 16, better spacing

1405Z Dropsonde 17, a little short

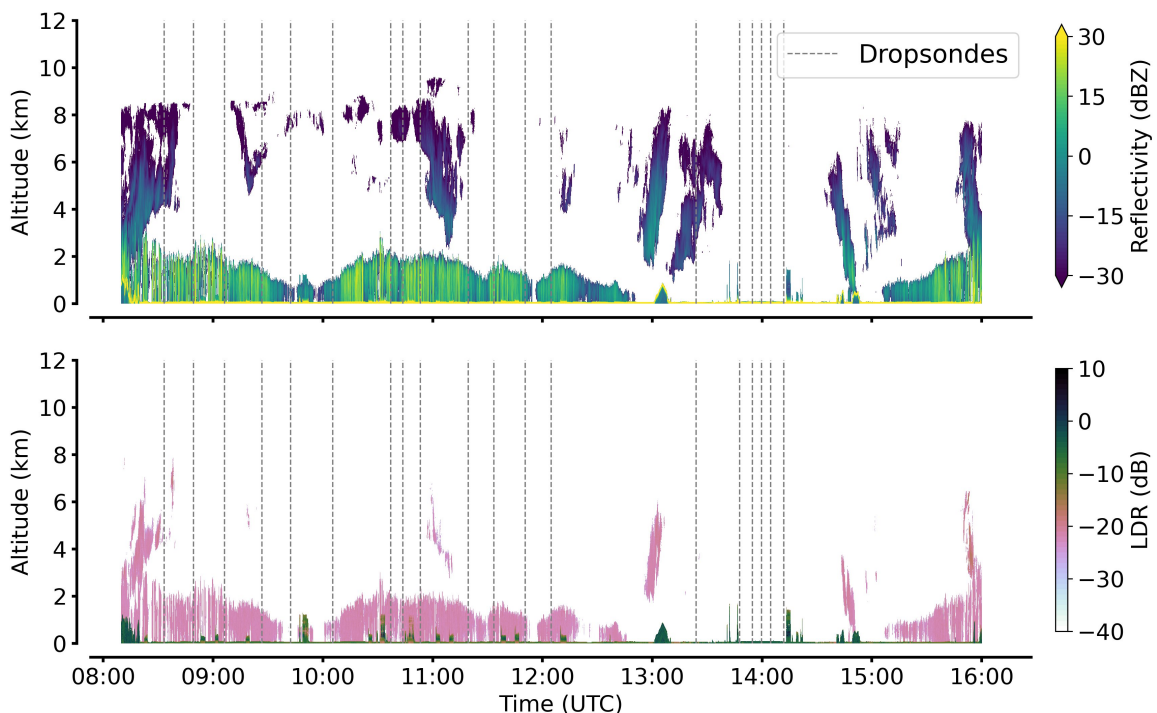
1412Z Dropsonde 18, good

1420Z Completed circle. Heading home. Climbed to FL450 for WALES stratospheric measurements

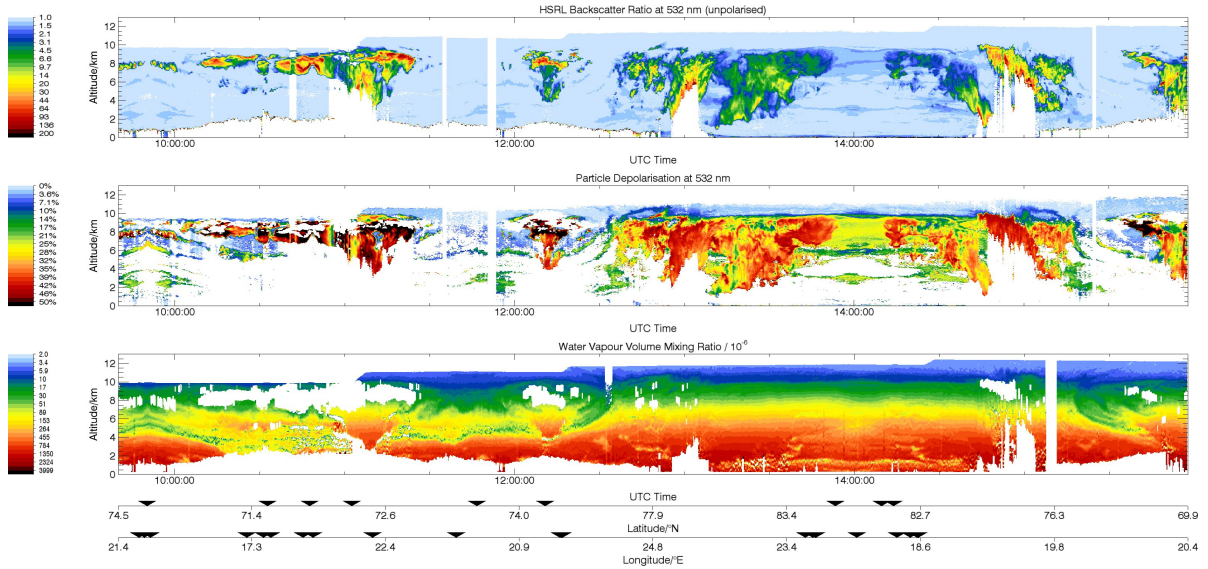
1630Z Landing



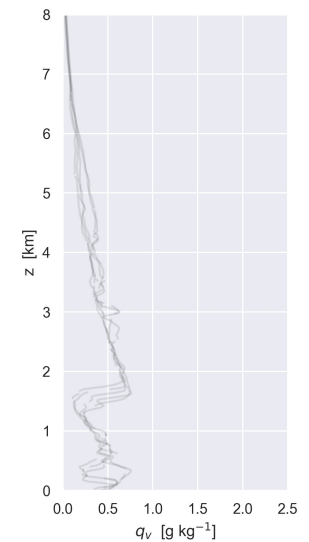
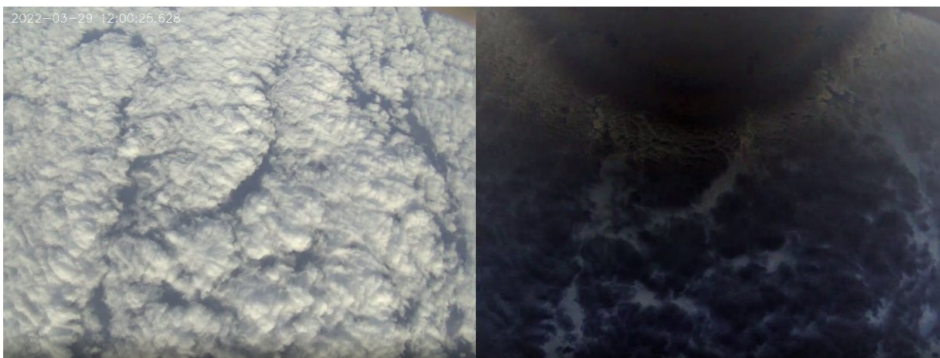
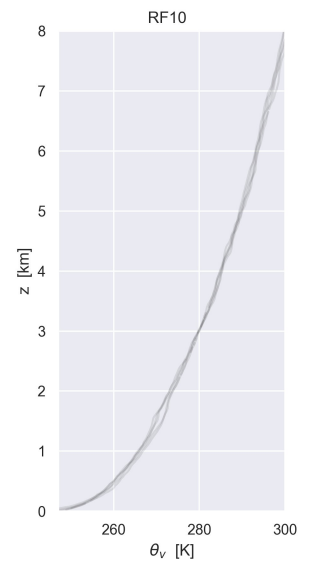
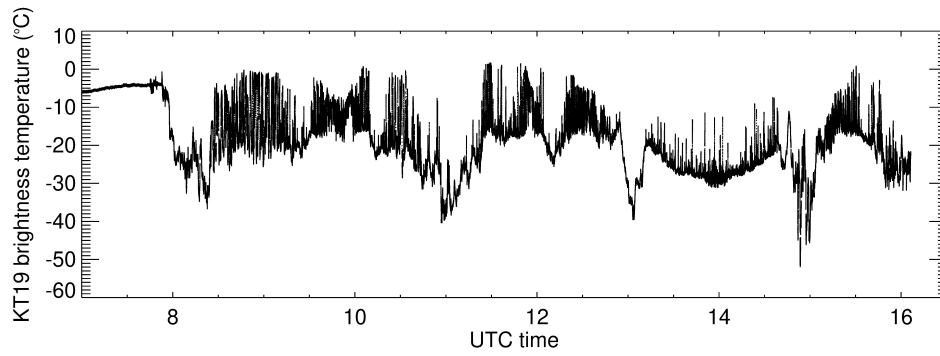
Quicklooks:



Quicklooks from HAMP-MIRA



Data Version 1 Processed on 30-03-2022 Contact: DLR Institute of Atmospheric Physics Martin.Wirth@dlr.de



Quicklooks from WALES, SMART and impressions of the mixed-phase clouds from specMACS. On the right: results from the first circular pattern with dro sondes in the Arctic

Due to a bad planning we did not manage to take a group picture... But the team was fantastic and deserve a lot of recognition

