AFLUX Flight #11 – Polar 5 – 190404

Mission PI: André Ehrlich

Objectives:

Characterize clouds and surface fluxes below clouds that are pushed ahead of a warm front northward on the sea ice where sea ice fraction continuously increased.

Crew:

Pilots	Jim Haffey, Marc-Andre Verner
PI	André Ehrlich
Basis Data Acq.	Cristina Sans Coll
SMART/ Eagle/Hawk	Johannes Stapf
MiRAC / AMALi	Birte Kulla
Microphysics I	Régis Dupuy
Microphysics II	Guillaume Mioche

Flight times:

Polar 5	
Take off	08:38 UTC
Touch down	12:26 UTC

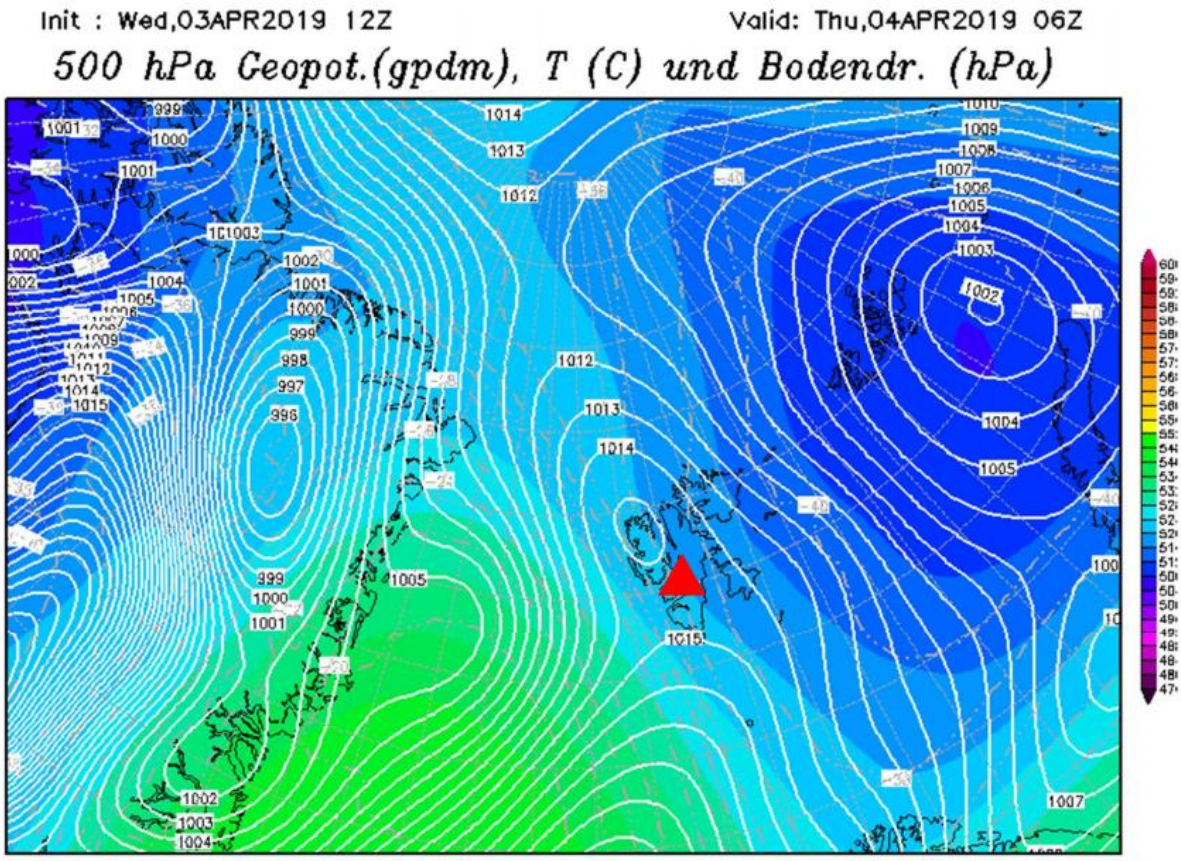
Overview:

The flight objective was to characterize a constellation where an approaching warm front pushed the low level clouds over marginal ice zone. Planned flight pattern was in north/south direction perpendicular to the sea ice edge. However, reaching the first waypoint, in direction north, the cloud field ended quite soon. Therefore, we decided take a more easterly heading into a larger and more compact cloud field. Over the sea ice the clouds already showed a different character to the convective condition in the cold air outbreak of the days before. Cloud tops where more smooth and sometimes driven by the southerly winds. The clouds were first observed by remote sensing along a leg of 60 NM. About 10 NM before the end of the leg, the clouds field gradually ended, while the sea ice concentration reached almost 100%. In distance, another cloud field was visible east of the WP2.

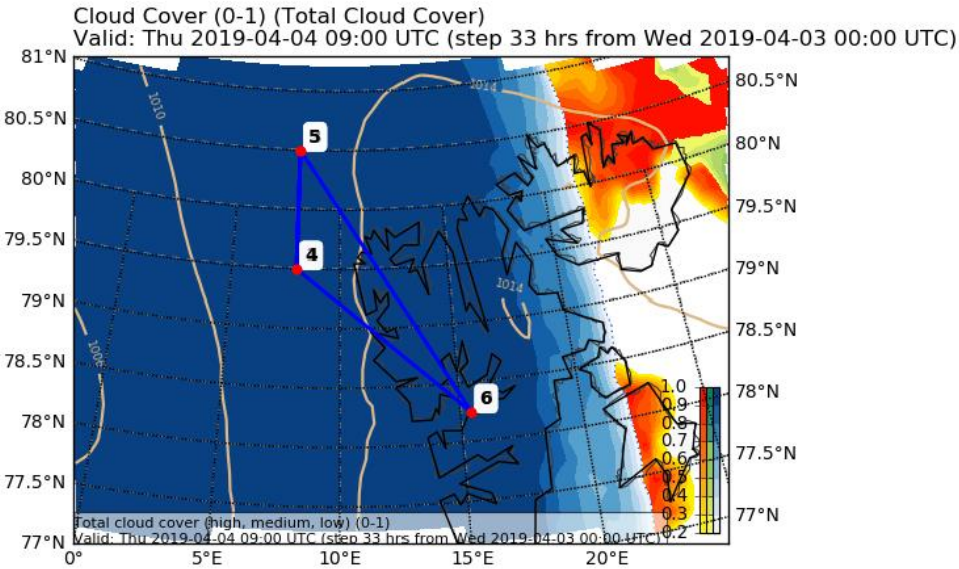
After descending, the entire leg was repeated back in 200 ft altitude to study the surface fluxes. The cloud base was elevated and the cloud structure quite homogeneous with only occasionally little precipitation. Along the track we visually saw the sea ice concentration to decrease, from closed ice, to broken ice flows to loose ice flows and finally only branches of floes reaching into the open ocean. At the same time, cloud geometry changed gradually, which was confirmed during the third leg flying 3 complete saw tooth (3x down + 3x up). As time allowed, we decided to go back to LYR following the same way we came out WP2-WP-NyA-LYR in 10.000 ft. Close to WP1 mid-level clouds have been detected by radar and in situ probes. Ny Alesund was passed in the center of the fjord. Over the island clouds in many different layers have been observed.

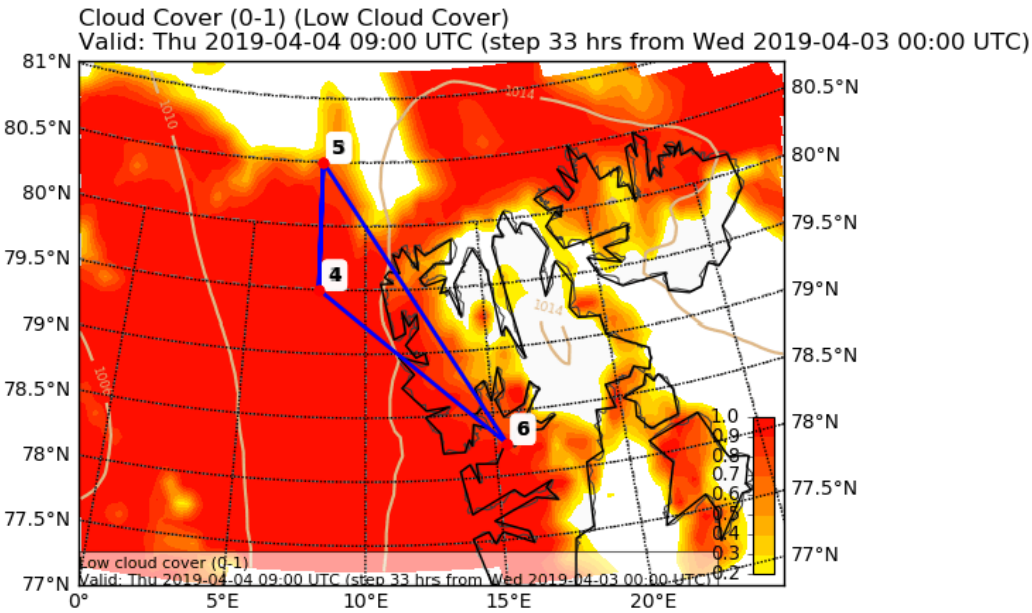
Weather situation as observed during the flight (compare to forecast)

The persistent low east of Svalbard moved more to the east and was replaced by a small intermediate high pressure system. This high pressured turned the winds toward southerly direction for about a day. East of Greenland a low pressure system was developing and moving quickly towards Svalbard. A text-book warm front was predicted to pass the area of observations and the island in the evening of 4 April. The warm front cirrus has been visible all the flight with the forecasted tendency of thinner/higher cirrus in north-east direction. This was also observed during the flight. Most time, the Sun was not shining through the cirrus but at WP2 the cirrus was sufficiently thin to observe the Sun.
The low-level clouds were present over the sea ice but only in an area east of the planned flight track. On the original track the clouds soon finished. Along the new flight track we could observe the decreasing cloud top altitude (3500-2000ft). Cloud base was almost constant at 1500 ft well lifted from the surface. Further behind the end of the leg (northeast), another low-level cloud field was visible which was also predicted in the forecast. Winds increased over time and had been higher in the southern end of the flight leg. So did surface turbulence and waves.
Remarkable for the flight have been the sea ice conditions which now show a very diverse and spread MIZ.

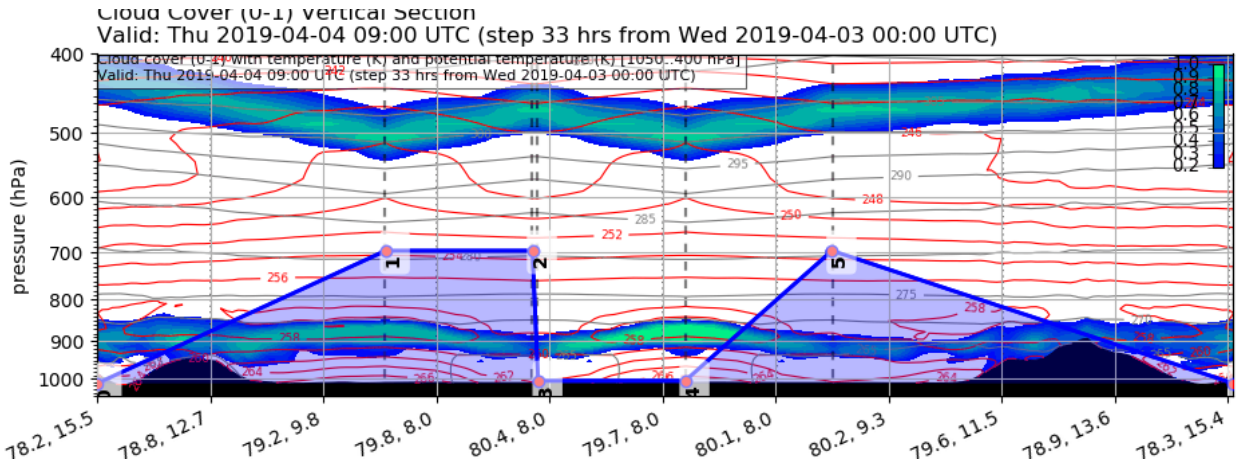


ECMW prediction of clouds—horizontal

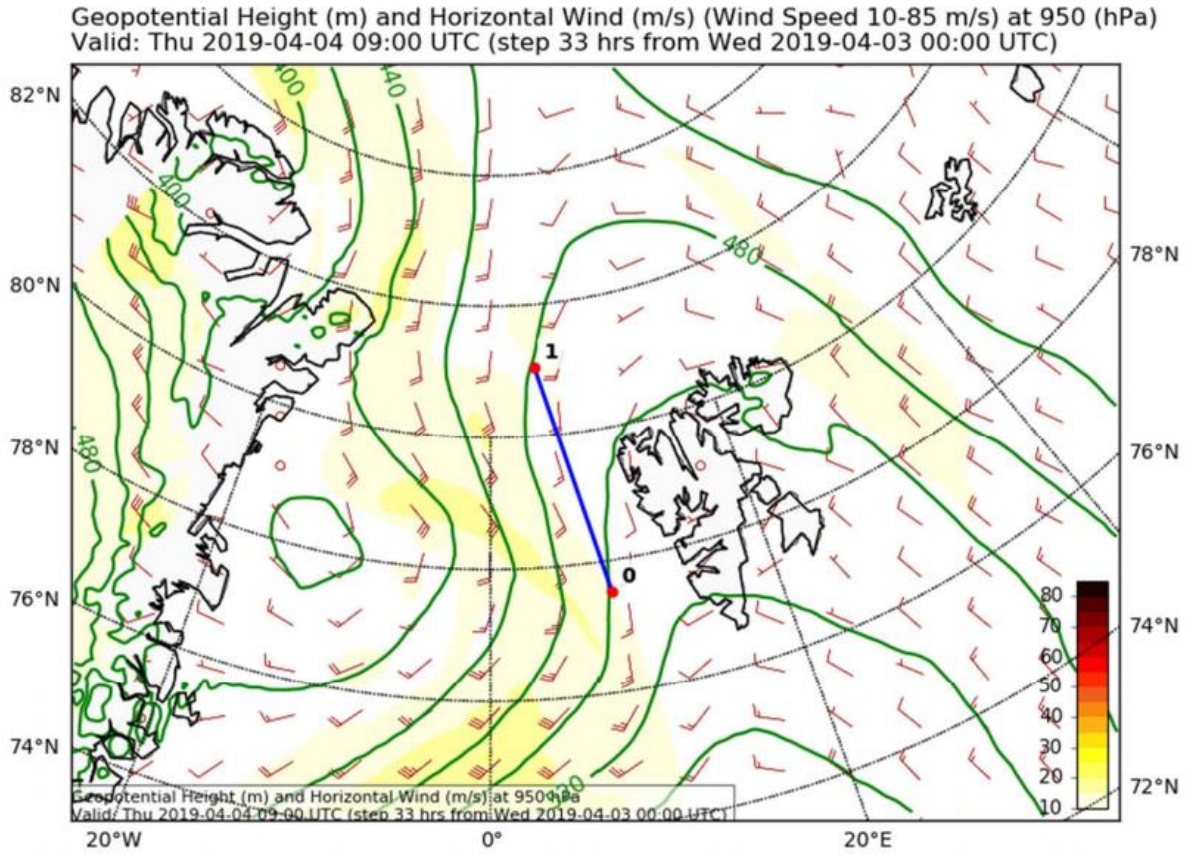




ECMW prediction of clouds—vertical



ECMW prediction of wind 950 hPa

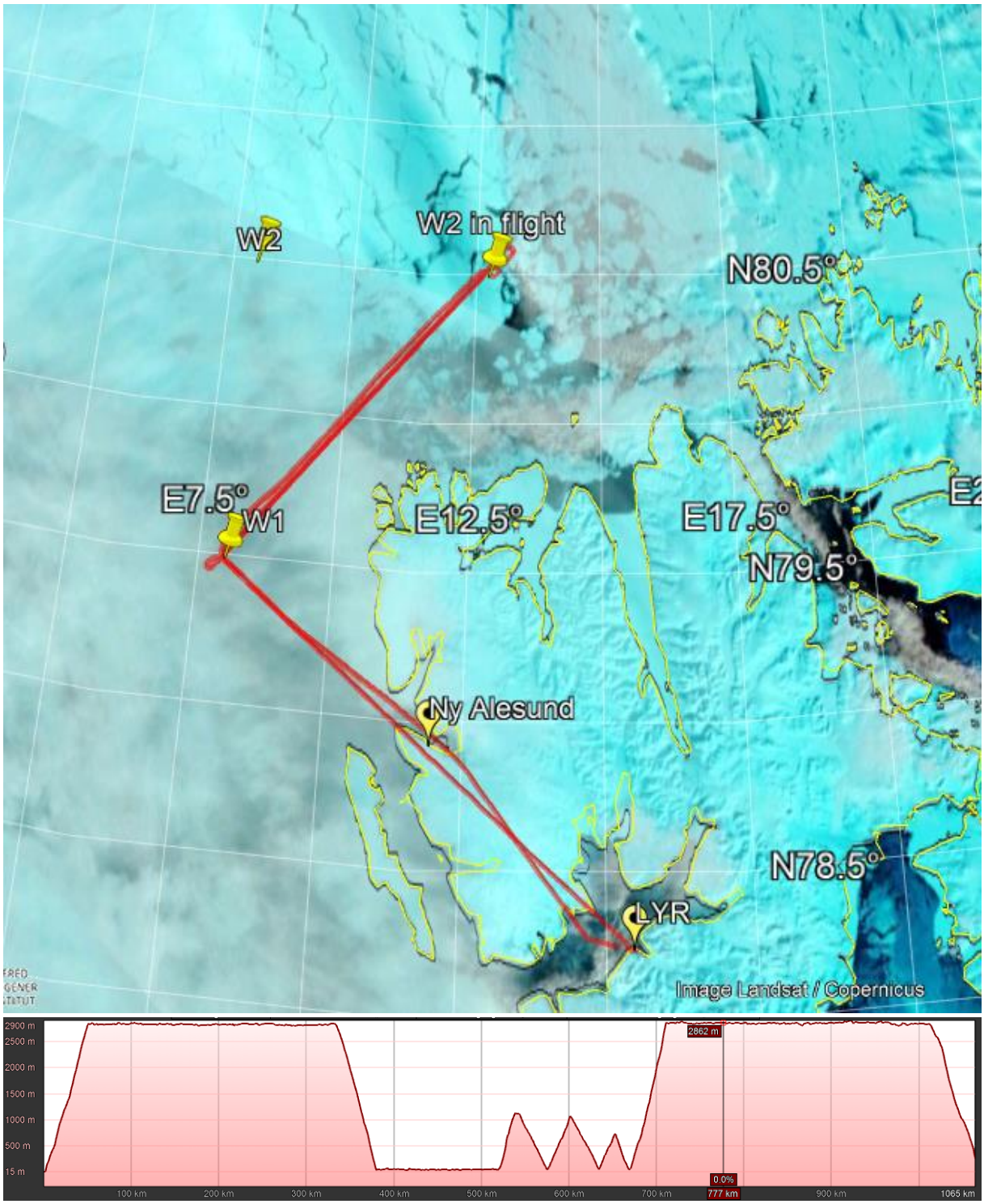


Flight pattern

WP1: 79° 30’ N 8° 0’ E
WP2: 80° 30’ N 12° 45’ E

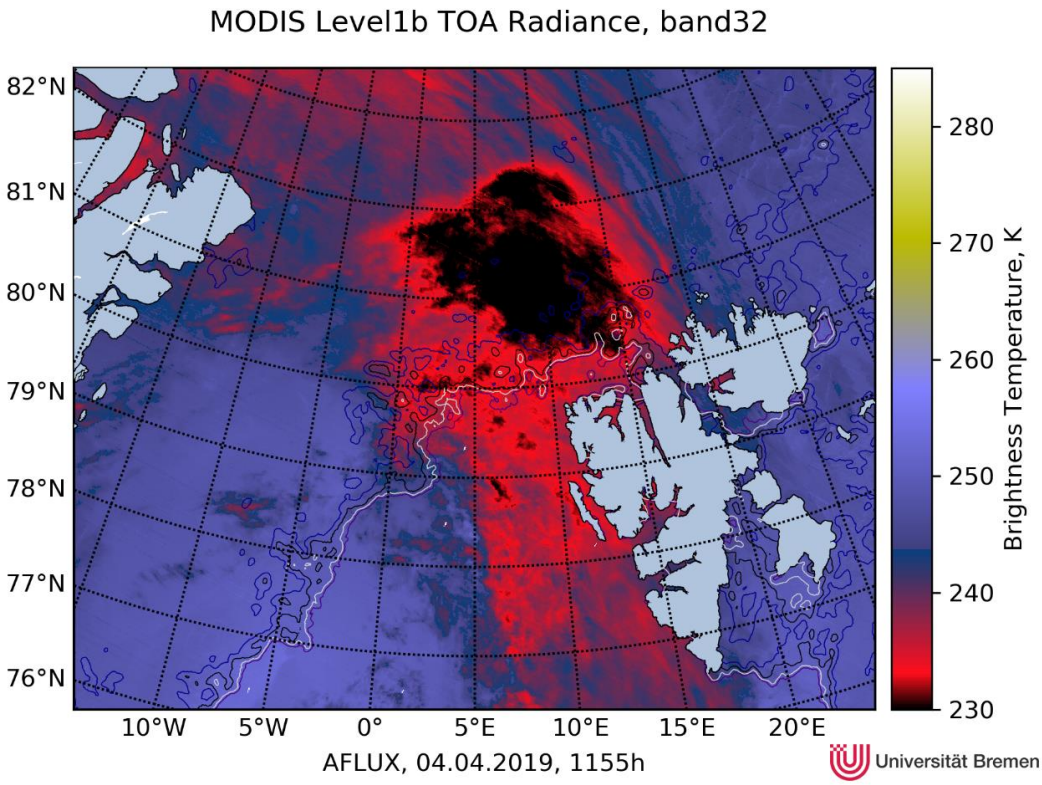
L-shaped flight pattern with WP1, WP2 defining the north-south leg. WP2 was adjusted to a north-east heading during the flight.

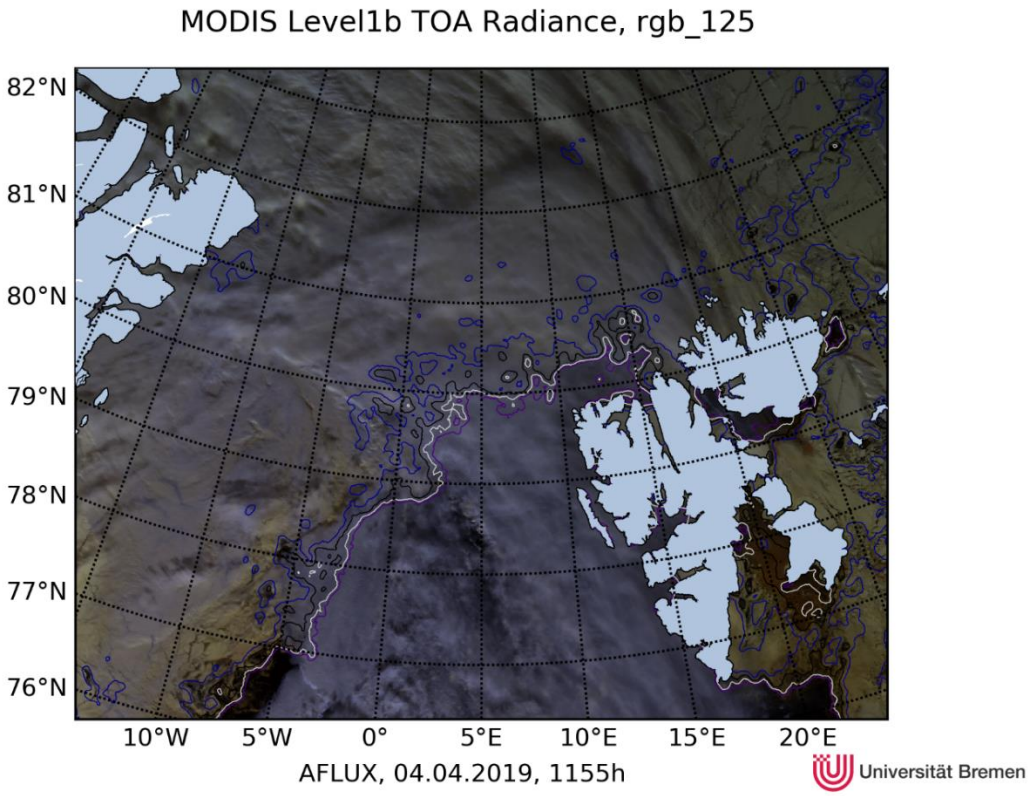
From LYR to WP1 remote sensing at 10.000 ft was performed over a field of low-level clouds. This is continued towards WP2 on leg 1 until the end of the cloud field. Descend to WP2 and leg 2 between WP2-WP1 at 200 ft (120kn). The leg 3 between WP1-WP2 was flown with three saw tooth pattern adjusted to the decreasing cloud top. For leg 4 we climbed to 10.000ft and returned the same way. Close to Ny Alesund, the track was slightly adjusted to follow the center of the Kongsfjord.


W2
W2 in flight
N80.5°
E7.5°
W1
E12.5°
E17.5°
N79.5°
Ny Alesund
N78.5°
LYR
Image Landsat / Copernicus
2900 m
2500 m
2000 m
1500 m
1000 m
500 m
15 m
2862 m
0.0%
100 km
200 km
300 km
400 km
500 km
600 km
700 km
777 km
900 km
1065 km

More Satellite images

The satellite images illustrate the cirrus band of the warm front with highest clout top at WP2.





Instrument Status

Polar 5	
Basis data acquisition	INS not aligned
Nose Boom	
MiRAC-A	
MiRAC-P	
AMALi	
SMART	
Eagle/Hawk	
Sun Photometer	
Polar Nephelometer	
2D-S	
CAPS	
PIP	
Drop Sondes	None launched

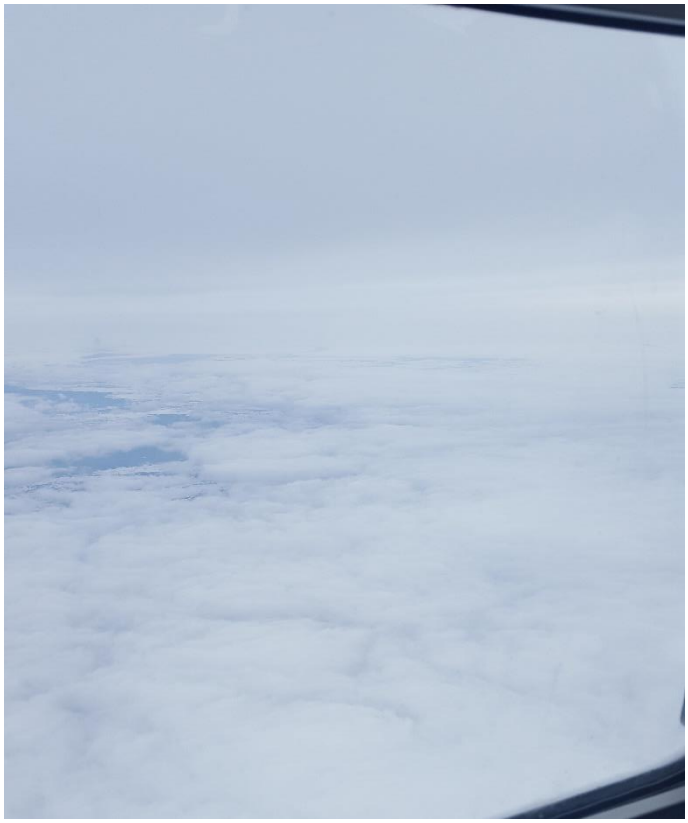
Detailed Flight Log (all times in UTC)

LYR-WP1: 10.000 ft 160kn

- 08:55 UTC: no low clouds above the island
- 09:00 UTC: Thick cirrus (west direction) very homogeneous
  Ahead clouds over water: look less convective
- 09:05 UTC: low level cloud field starts: CT 900-1000m
- 09:11 UTC: also larger cloud gaps
- 09:14 UTC: cloud tops look like influences by southerly winds
- 09:16 UTC: some streets of ice flows stretching over the place
- 09:20 UTC: CT 900m from ALAMLi

WP1-WP2: 10.000 ft 160kn

- 09:25 UTC: longer and denser cloud field in north-easterly direction → decided to go there
- 09:32 UTC: sea ice very scattered today
- 09:34 UTC: cirrus gets thinner→ as predicted
- 09:38 UTC: no low clouds anymore, sea ice becomes denser
- 09:41 UTC: start descent but stay on track
  → reaching end of a larger ice flow
- 09:44 UTC: low clouds start far ahead → as forecasted
- 09:45 UTC: large leads: fresh frozen
- 09:47 UTC: 1st Inversion at 3500ft
  2nd Inversion at 2300ft



WP2-WP1: 200 ft 120kn

- 09:50 UTC: very smooth flight conditions
- 09:52 UTC: Sun visible through cirrus, closed ice flow
- 09:56 UTC: now scattered ice flow close to each other
- 09:58 UTC: ice fraction decreases, partly fresh frozen
- 09:59 UTC: low-level clouds ahead
- 10:01 UTC: clouds now above: elevated cloud top, little bumpy
- 10:03 UTC: still sea ice
- 10:04 UTC: clouds above quite dense
- 10:06 UTC: no precipitation
- 10:07 UTC: still 30% sea ice

- 10:14 UTC: more sea ice, gust/wind increases
- 10:15 UTC: little snow/precipitation?
  Wind southish→ getting stronger
- 10:23 UTC: ice fraction down to <10%
- 10:28 UTC: almost sea ice free
  Cloud base looks rather high

WP1-WP2: saw tooth pattern 140kn

- 10:34 UTC:	start saw tooth pattern: always little icing at cloud top			
- 10:34 UTC	#1 up:	CB 1400 ft	CT 3700 ft	
- 10:40 UTC	#2 down:	CB 1800 ft	CT 3500 ft	
- 10:46 UTC	#3 up:	CB 1500 ft	CT 3300 ft	
- 10:53 UTC	#4 down:	CB 1700 ft	CT 2800 ft	sea ice fraction 40%
- 11:00 UTC	#5 up:	CB 1400 ft	CT 1900 ft	
- 11:04 UTC	#6 down:	very thin cloud only		

WP2-WP1: 10.000 ft 160kn

- 11:15 UTC: frontal cirrus all over us
- 11:38 UTC: flying through mid-level clouds (radar+in situ)
- 11:41 UTC: 2nd cloud layer in radar
- 11:46 UTC: at WP1

WP1-LYR: 10.000 ft 160kn passing Ny Alesund

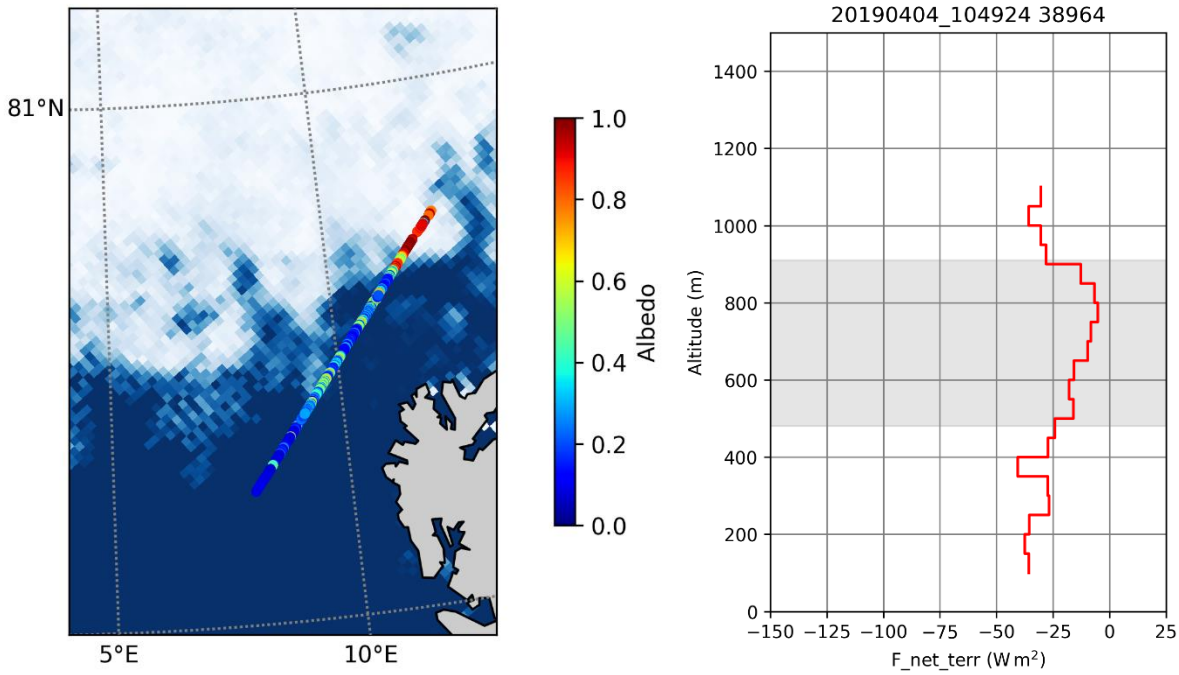
- 11:55 UTC: wave structure visible in low-level clouds
- 12:02 UTC: messy cloud situation over the island

Comments

Quicklooks

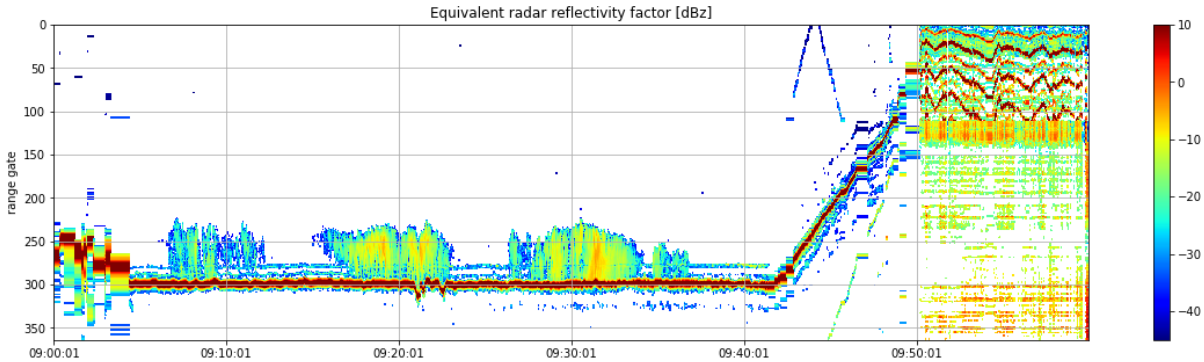
Broadband Albedo and net terrestrial flux profile

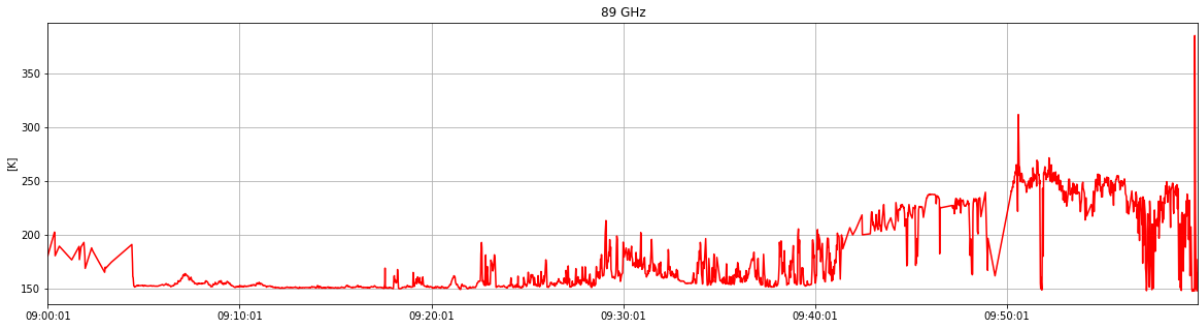
The broadband albedo shows the increase along the flight track and corresponds well with the sea ice fraction. The terrestrial net flux profile shows a weak gradient on cloud top (weak cloud top cooling) which is caused by the thick cirrus above.



MIRAC

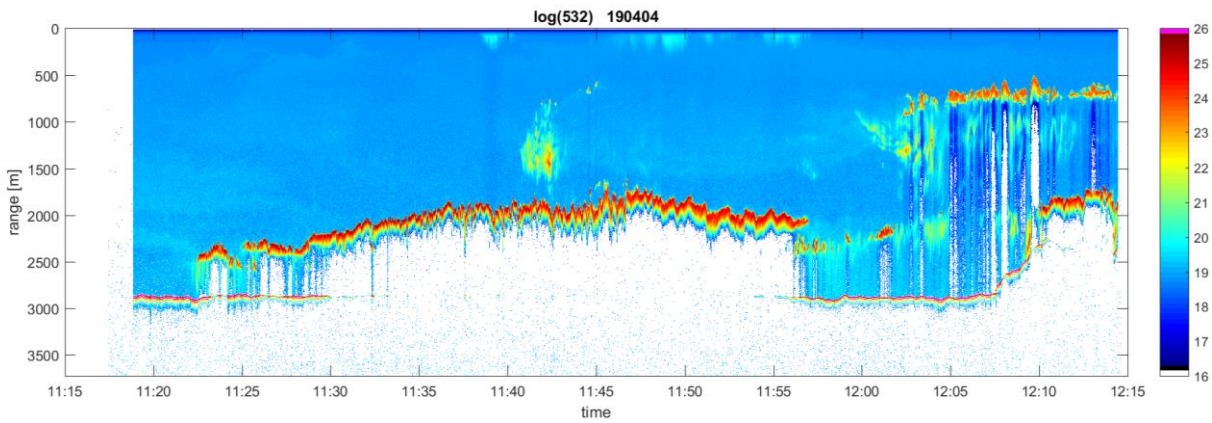
Radar and microwave radiometer data of the first remote sensing flight leg LYR-WP1-WP2. Although the clouds looked visually like one continuous cloud field, the radar reflectivity is enhanced in two to three parts.





AMALI

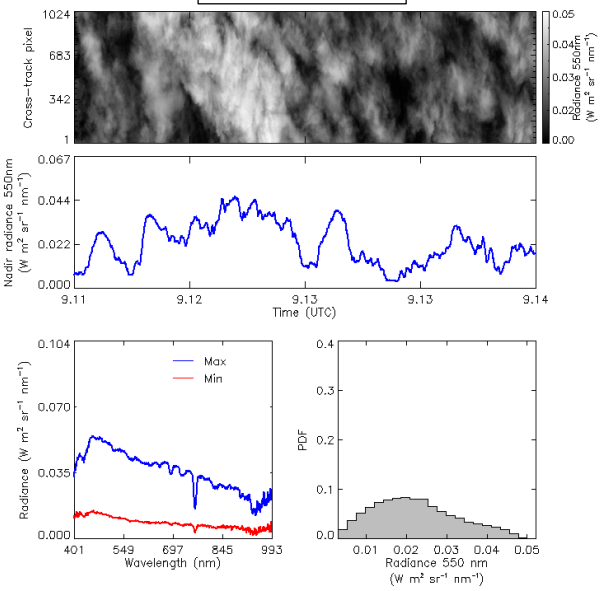
The lidar backscatter signal along the second remote sensing leg way back to LYR, WP2-WP1-LYR. Cloud altitude increased with decreasing sea ice cover. From the middle of the leg and close to Svalbard, additional cloud layers were present.



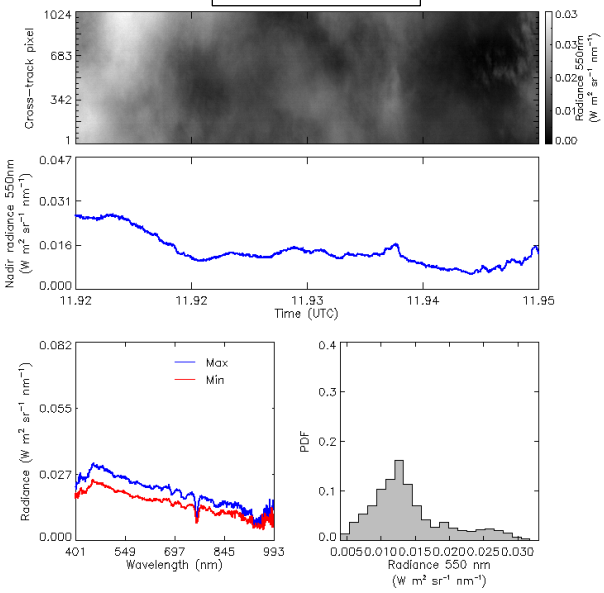
EAGLE/HAWK

Two Eagle/Hawk sequences are shown, both over open ocean, one at the first leg in the begin of the flight, the second almost three hours later at the end of the light. The cloud structure had obviously changed. While at the first leg, cloud structures are more small scaled, later the cloud top became more smooth. This might have been caused by the southerly winds, less cloud top cooling due to the approaching cirrus or other dynamic effects. Phase index increased over the time indicating more cloud ice in the later measurement

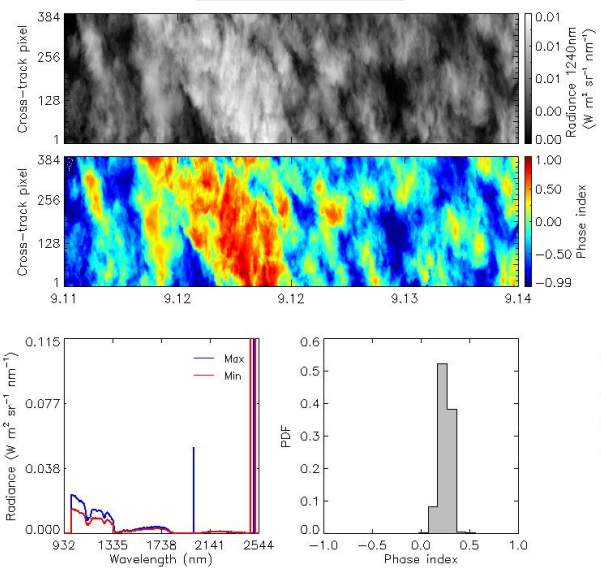
09:06 UTC



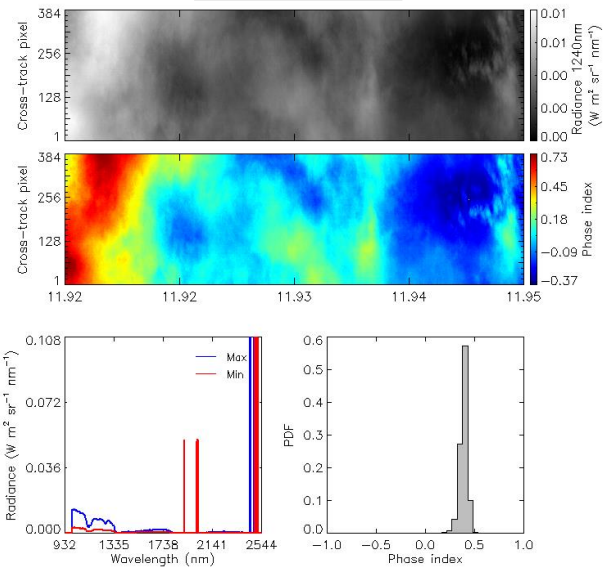
11:54 UTC



09:06 UTC

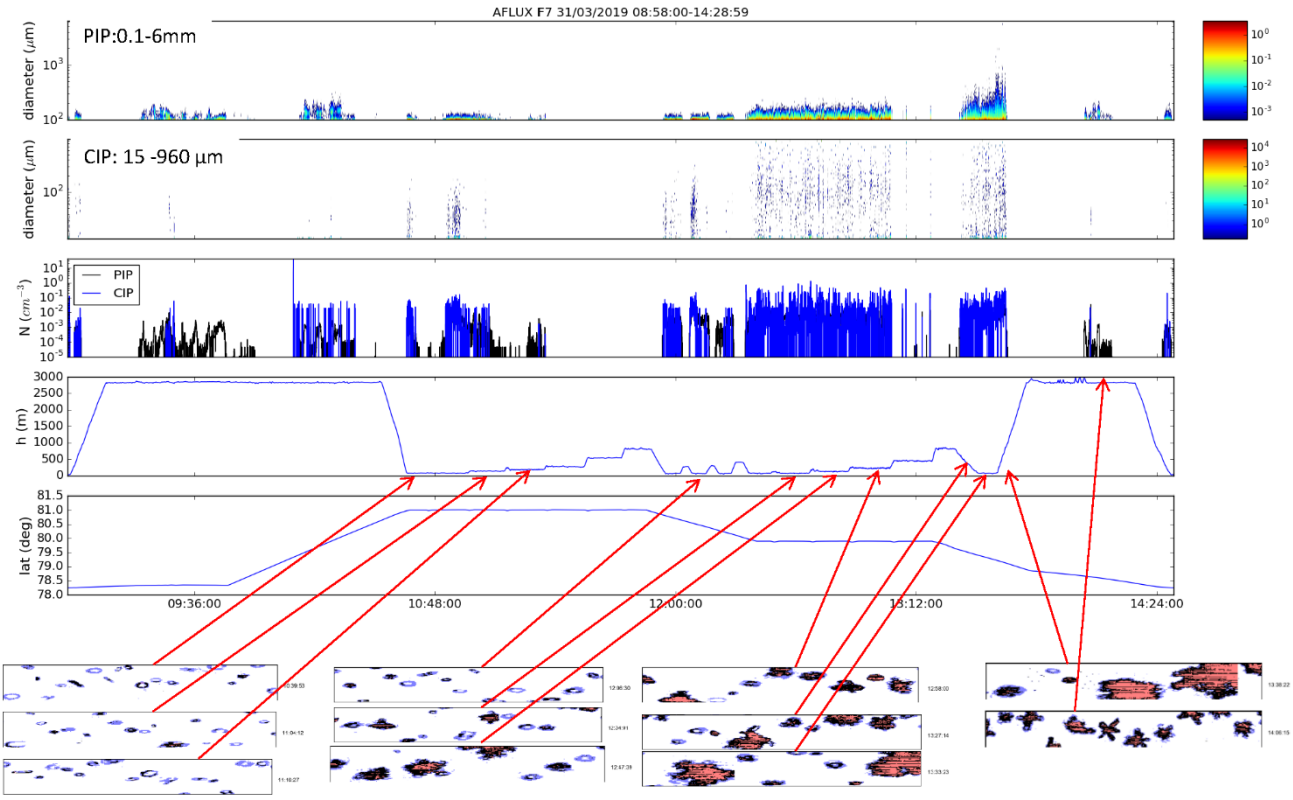


11:54 UTC



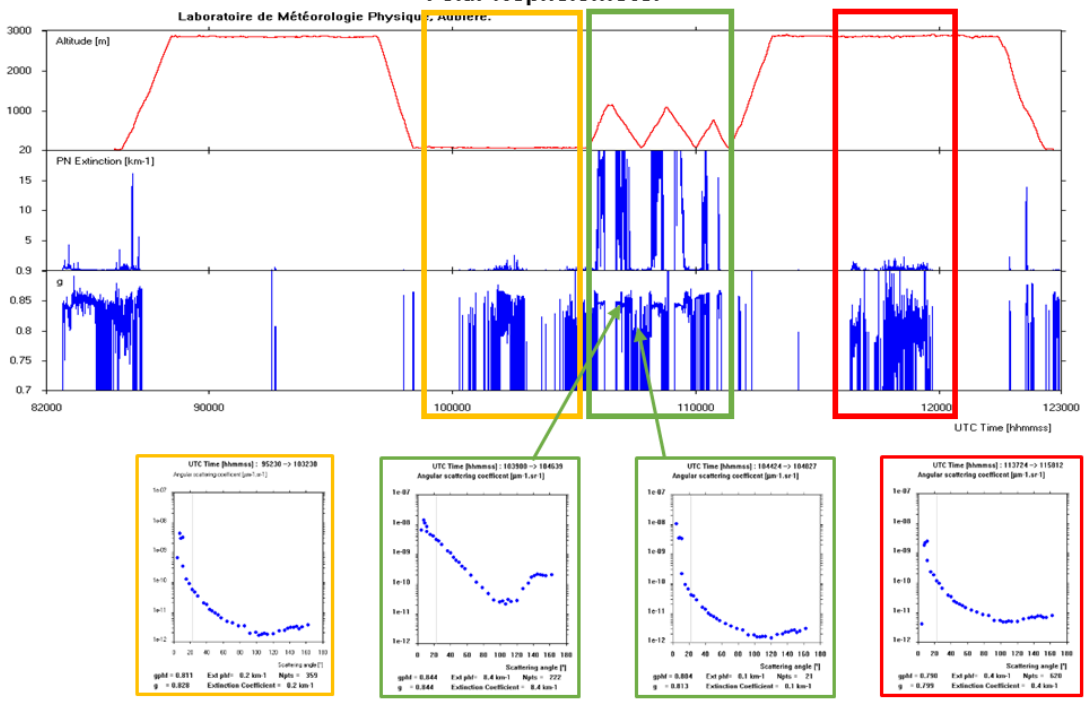
Microphysics

The probes showed some precipitation on the long 200 ft leg and the typical distribution of ice and liquid particles in the profiles. In the end some ice crystals in the mid-level cloud were observed.



Flight #10 - 190404 – Quicklook Microphysics LaMP (Preliminary data)

Polar Nephelometer



2DS probe