

## MOSAiC-ACA Flight #07 – Polar 5 – 2020/09/07

### Objectives:

The aim was to concentrate on remote sensing of clouds in different regimes (single layer, multi-layer clouds, over sea ice, over open ocean). Dropsondes were released in regular distances to characterize the thermodynamic structure of the atmosphere and the wind field.

### Mission PI P5:

André Ehrlich

Polar 5 Crew	
Mission PI	André Ehrlich
Basis Data Acq.	Clemens Gollin
SMART/ Eagle/Hawk	Michael Schäfer
MiRAC / AMALi	Mario Mech
PMS	Manuel Moser
Optional seat	Martin Gehrman

### Flight times:

Polar 5	
Take off	08:22 UTC
Touch down	14:03 UTC

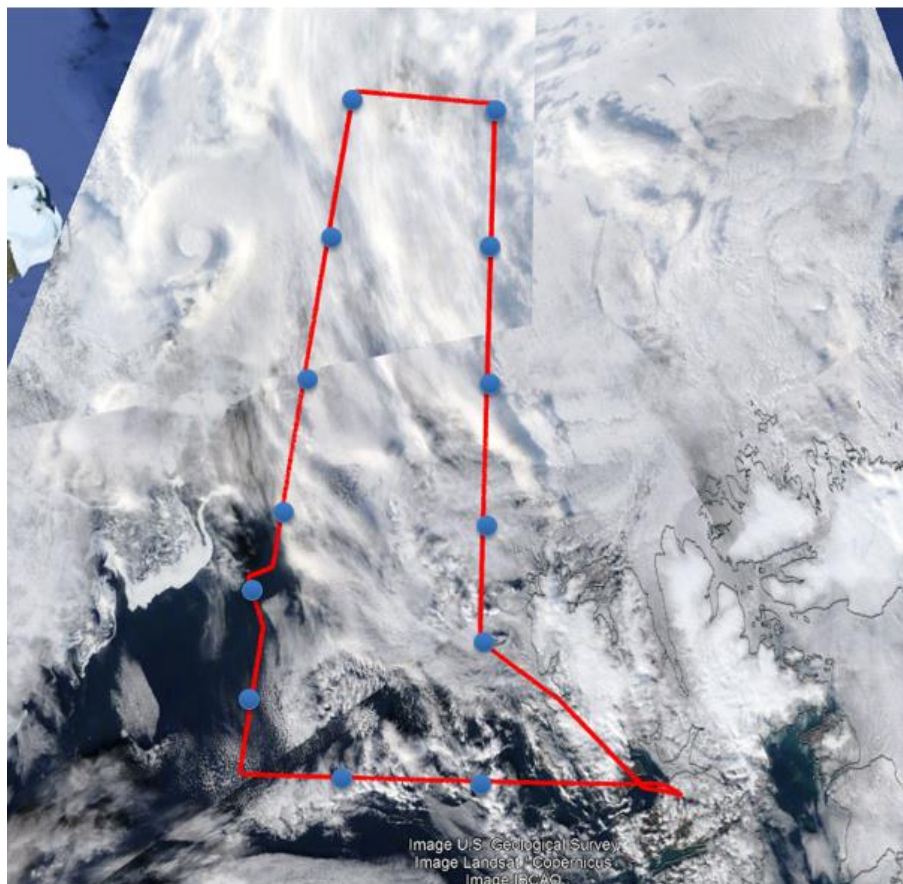
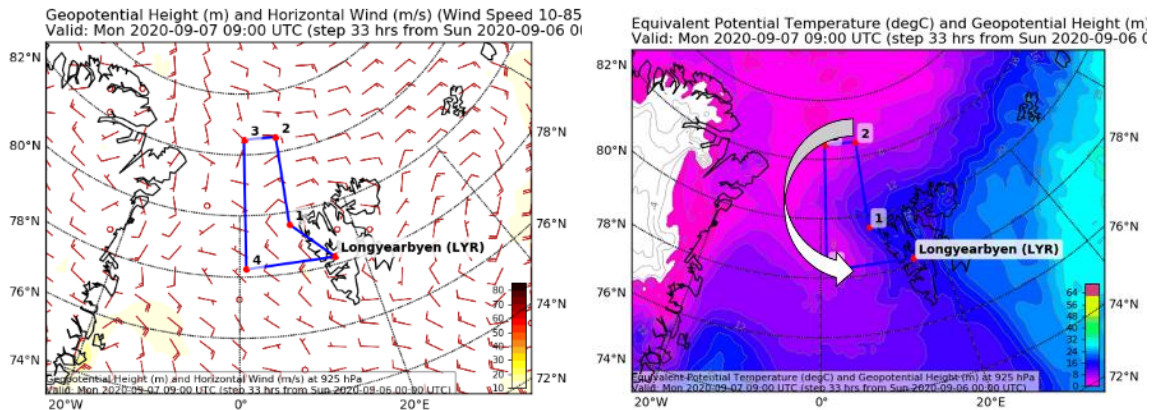


Fig. S5.1: MODIS (Terra) satellite composite and Flight Track of Polar 5. Blue dots indicate the location of dropsonde releases.

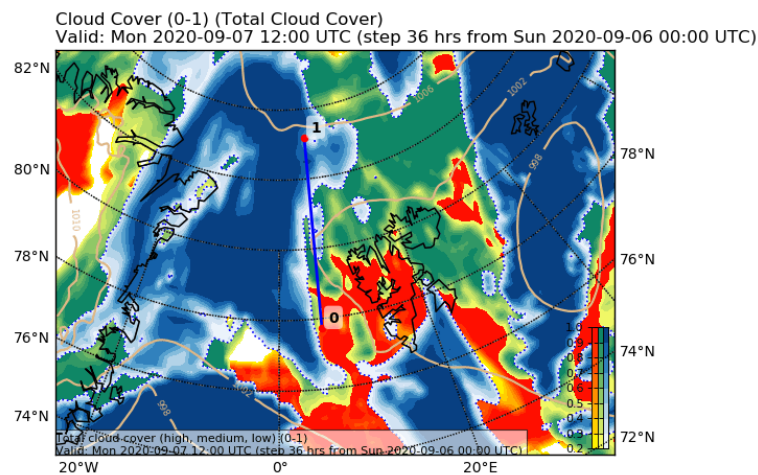
**Weather situation as observed during the flight (compare to forecast):**

After the weak cold air outbreak on Sunday, the northerly flow became weaker. A low pressure system was located far east of Svalbard. Still it caused a cyclonal flow around the island. This is reflected in the temperature map showing a cold air mass moving south-east west of Svalbard.

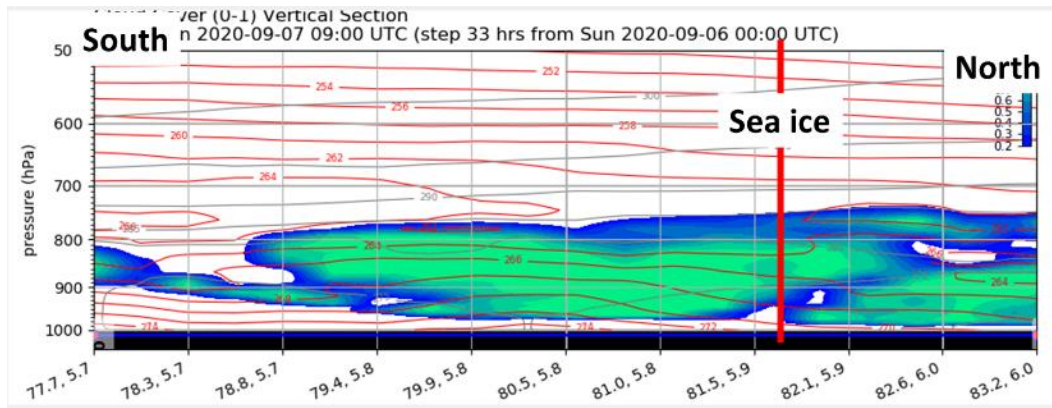


ECMWF Wind field and equivalent potential temperature in 925 hPa.

Due to the low winds and different wind directions, the forecasted cloud field was very heterogeneous. The vertical extend of the clouds west of Svalbard were predicted to be rather thick indicating that different cloud layers should be present. This was confirmed by the observations. Also the predicted increase of cloud top altitude was observed. Further west, where the colder air mass moved eastward, less low-level cloud cover was forecasted. In the flight, we saw the reduced cloud cover with partly only scattered cumulus fields and cloud free sections. The ECMWF showed a thick field of cirrus reaching to 5°E at 12 UTC. This field was also present during the research flight significantly reducing the solar radiation and shadowing the lower clouds.



Total cloud cover as forecasted by ECMWF.



Cloud cover cross section along the north-south line shown above.

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### Overview:

The flight started with a 15-min delay due to a failure of the aircraft inverter, which could be solved temporary. Climbing above the clouds in the Isfjord was not a problem and we could climb to 10 000 ft way before overpassing Ny Alesund. At Ny Alesund the clouds were rather thick and could not be penetrated by the Lidar. Afterwards, we followed the track in survey altitude releasing dropsonds about every 60 NM.

On the way north, the clouds showed different layers. Sometimes the upper layer showed precipitation into the lower layer. Cloud top altitude increased continuously, so that we ascent to 11000 ft for save operation of AMALi.

The marginal sea ice zone was reached at about 82° 20' N indicated by the microwave radiometer. Visually, the sea ice was not visible as the clouds were optically thick. On the western leg south, the sea ice last until about 81° 30' N. The western leg showed different cloud characteristics. Low cloud layer became thinner and later broken and scattered. For a long time, a thick cirrus was located over the flight patch dimming the Sun very significantly. Later a mid-level cloud appeared in about flight altitude. The particle probes sampled some ice crystals at cloud base or precipitating particles below cloud base. To ensure a good operation of AMALi and MiRAC, we decided to descent back to 10000ft.

At the southern end of the leg, about 80°N, a cloud free area was close by the flight track. We did a short detour to release a dropsond into this cloud free spot for calibration of the microwave radiometer. A second cloud free spot was observed short before W4.

The flight eastward back to Svalbard was characterized by a change in cloud cover. Closer to the island, more convective cumulus with heavy precipitation was observed. The island itself was partly cloud-free due to orographic effects.

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**Instrument Status:**

Polar 5	
Basis data acquisition	
Nose Boom	
MiRAC-A	
MiRAC-P	
AMALi	
SMART	
Eagle/Hawk	
Sun Photometer	
Polar Nephelometer	
2D-S	
CAPS	
PIP	
Drop Sondes	14 launched

Table S5.1: Instrument status as reported after the flight for all instruments on Polar 5.

Comments: The Hawk camera still suffered from condensation of moisture on the window. All dropsonds were successful, except #10 which did not get GPS signal and therefore no wind measurements.

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**Detailed Flight Logs:****LYR – NA – WP1:**

07:53 overcast at the airport  
08:02 Inverter problem → delay by 15min  
08:22 Take-off  
08:24 at cloud base  
08:25 above first cloud layer, was quite thin  
08:28 at cloud top of second layer, little icing  
08:35 at 10 000ft  
No cirrus, low clouds all over the place  
08:42 some high clouds North West  
08:48 crossing Ny Alesund  
08:50 over the open ocean clouds look more convective  
Westwards: thick high clouds – cast shadow and seem to affect the low cloud layer  
08:58 ahead: mixture of convective and thin layers of clouds

### **WP1 – WP2**

09:05 WP1 – turn and dropsond – DS#1  
09:06 low clouds with homogeneous cloud top  
09:12 intermediate change of low clouds: looks like a cloud gap but was likely a second thin layer  
09:19 DS#2 - before low clouds did change  
09:30 very homogeneous low clouds  
Some cirrus ahead (thin stripes which also are visible as a shadow on the lower cloud layer)  
09:40 cirrus causes shadows on low cloud layer  
09:42 DS#3  
09:43 cirrus became more frequently  
09:47 climb to 11 000 ft due to increasing cloud top altitude  
09:51 more cirrus and more shadows  
09:55 cloud top still climbing  
10:00 still large areas with shadows but will end soon  
10:04 DS#4  
10:10 cirrus less and only very thing → no shadows anymore  
10:10 over the sea ice??? Approx. 82° 20'N  
10:26 DS#5 - and turn at WP2

### **WP2 – WP3**

10:34 homogeneous low clouds everywhere  
Cirrus ahead to the west  
10:39 approaching cirrus – broad homogeneous field of cirrus  
10:47 Turn at WP3

### **WP3 – WP4**

10:52 DS#6  
Very thick cirrus → becoming thicker further south  
11:15 DS#7  
Getting almost dark due to the thick cirrus  
11:23 autopilot on → slight roll/yaw movements  
11:27 end of the marginal sea ice zone at about 81° 30'N  
11:39 DS#8  
11:40 still thick cirrus ahead  
Low clouds are in shadow  
Further ahead low clouds seem to get thinner (or it is a change of the shadow)  
11:50 low clouds with less structure of the cloud top  
May be: cirrus → less cloud top cooling → less turbulence → less structure  
11:55 no low clouds east of the flight track + thin sea ice visible in this area  
Ahead still low clouds and cirrus  
Far ahead less cirrus  
12:04 DS#9  
12:09 short cloud free area ahead  
12:18 detour to overpass the cloud free area for calibration of the microwave radiometer  
DS#10 in cloud free gap  
12:19 mid-level clouds in flight level – Polar 5 at cloud base – little precipitation

12:21 descent to 10 000ft to avoid the mid-level clouds  
12:26 back on track after detour  
12:32 DS#11  
Scattered low clouds  
No cirrus, just some further south  
12:40 cloud gap, only tiny thin cumuli  
12:43 DS#12 : almost clear sky below  
12:49 Scattered low clouds, further south cloud-free  
12:50 WP4 and turn

#### **WP4 – LYR**

12:51 ahead eastwards: first scattered low clouds → getting thicker soon  
13:05 low clouds became more complex, mixture of stratiform layers and cumuli  
13:08 DS#13  
13:26 DS#14: maybe into a cloud gap  
13:28 clouds up to the coast  
At the coast some parts are cloud-free  
13:41 start to descent  
14:03 touch down



08:31 UTC – homogeneous cloud field over Svalbard



08:47 UTC Some embedded convective clouds





09:11 UTC Darker cloud section, thinner cloud



09:28 + 09:50: Shadows by high cirrus.





10:47: Thick Cirrus darkening the sky.



11:30: End of the cirrus field.



11:46 + 12:12 UTC: Midlevel cloud with precipitating ice crystals.



11:57 UTC: scattered cumuli close to W4.

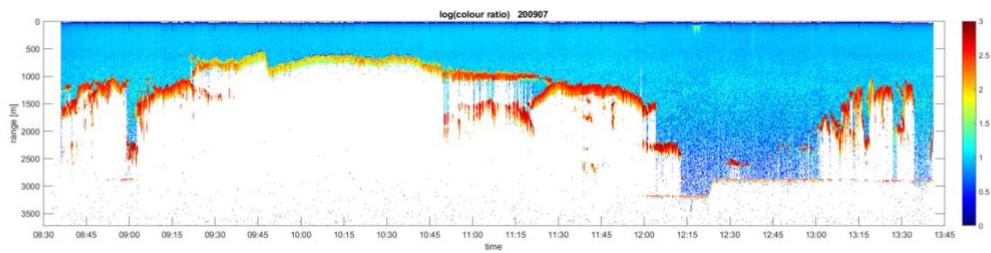
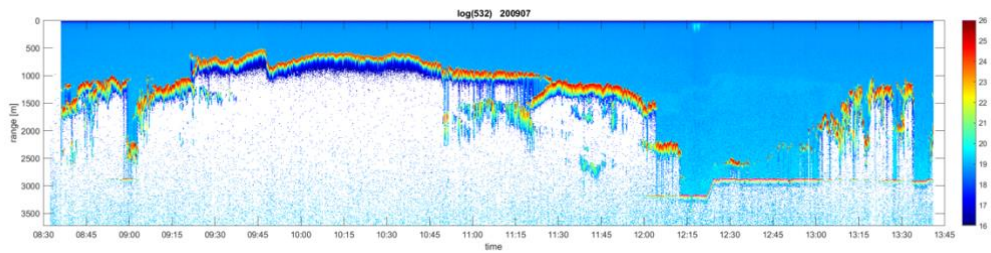
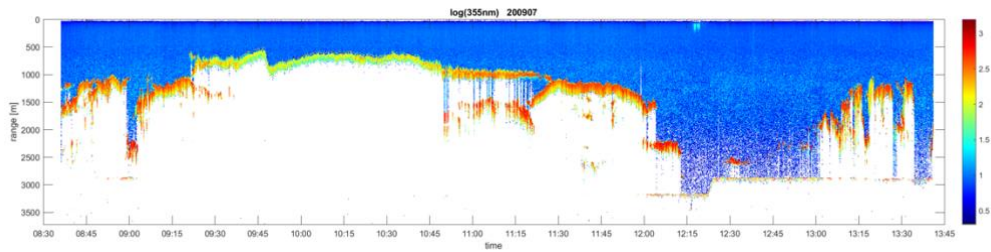
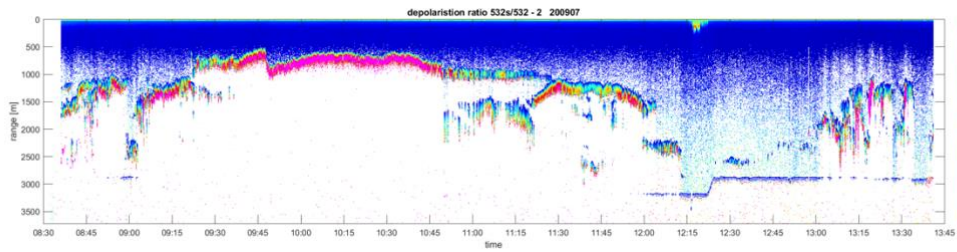
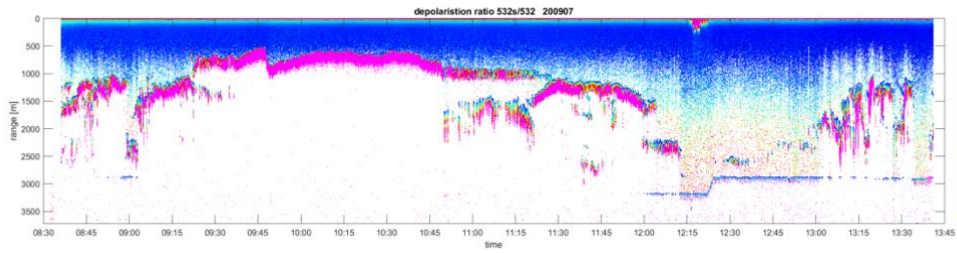
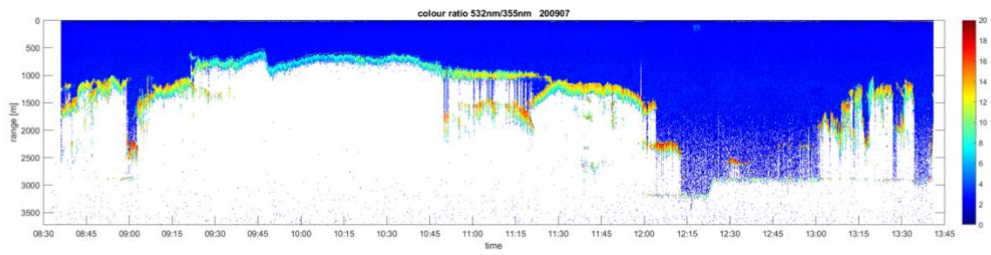


12:46 UTC: Embedded convection and showers on the southern leg.

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**Quicklooks:**

AMALI 20200907:





# Quicklook Flight 07, 07.09.2020

## EAGLE (Spectral imager)

