AFLUX Flight #05 – Polar 5 – 24 March 2019

Mission PI:

Manfred Wendisch

Objectives:

Sample clouds during the initial stage of an evolving cold air outbreak. Flying against and with the wind above, below, and within the clouds over the sea ice and the open ocean. Measure turbulent and radiative energy fluxes and study differences caused by the surface conditions.

Crew:

Pilots:	Jim Haffey, Marc-Andre Verner
1. PI:	Manfred Wendisch
2. Microphysics:	Christophe Gourbeyre
3. AWI Data:	Cristina Sans Coll
4. Remote Sensing:	Leif Leonard Kliesch
5. Radiation:	Johannes Stapf
6. Lidar:	Birte Kulla

Instrument status:

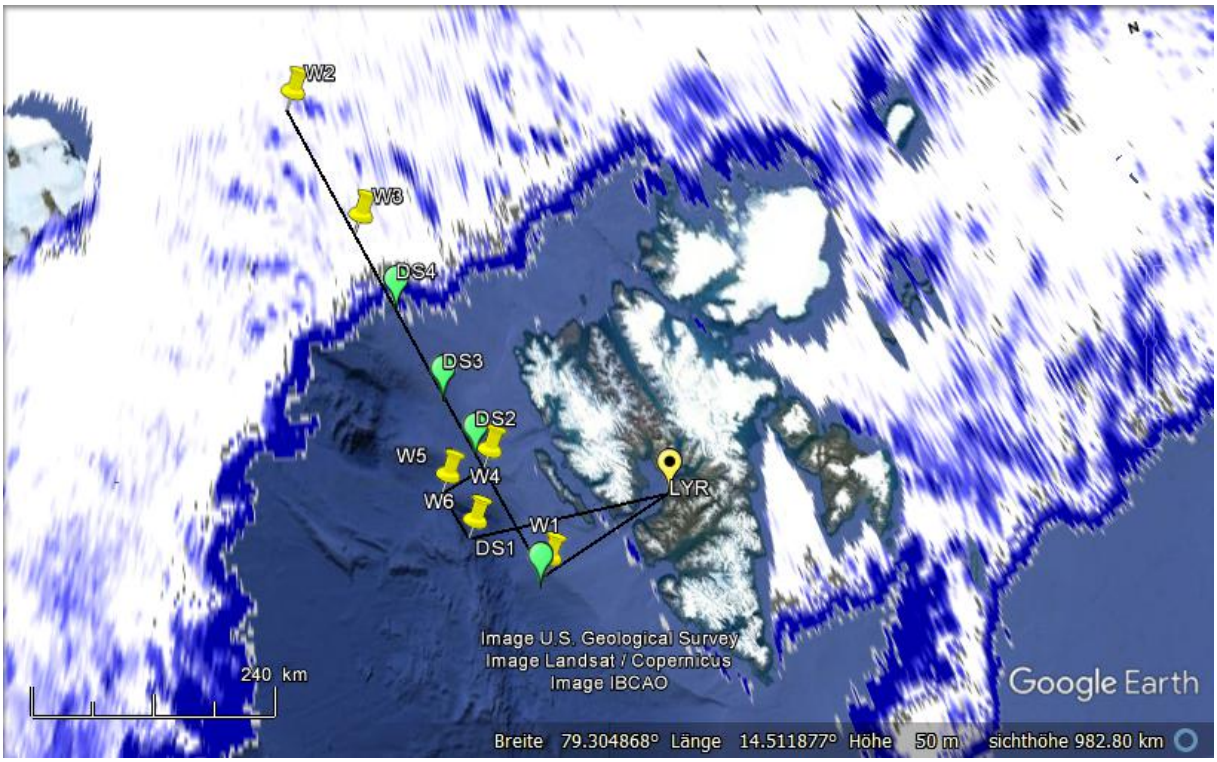
Polar 5	
Basic Data Acquisition	okay
Nose Boom	okay
Drop Sondes	okay
SMART Albedometer	Partly okay
Eagle/Hawk	okay
MiRAC Radar	okay
MiRAC Microwave	okay
AMALi	okay
Polar Nephelometer	okay
2D-S	okay
CAPS	okay
PIP	okay

Flight times:

Polar 5	
Take off	10:01 UTC
Touch down	14:51 UTC

Overview

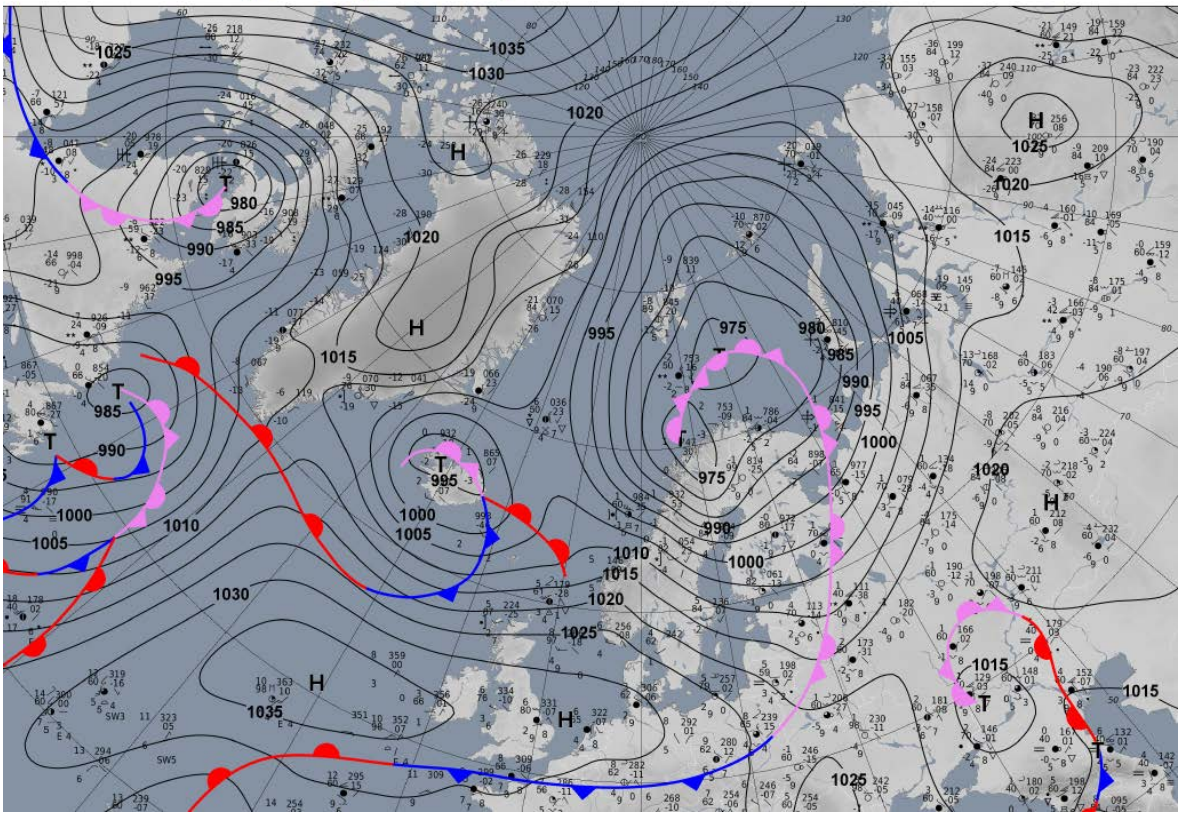
The strategy for this flight was to sample clouds along a developing cold air outbreak. In the first part of the flight (towards the north, between W1 and W2, see figure below) mostly remote sensing measurements of the cloud field at an altitude of 10.000 ft were performed. Four drop sondes were released. On the way back (W2→ W6) into southern direction, extended in situ measurements below, within, and above the cloud (close to the cloud top) were performed. The flight was more or less exactly done as planned. High winds were observed causing heavy turbulence and related air sickness by several members of the crew. As a consequence, flight patterns in high wind/turbulence conditions should be avoided in further flights during the campaign.



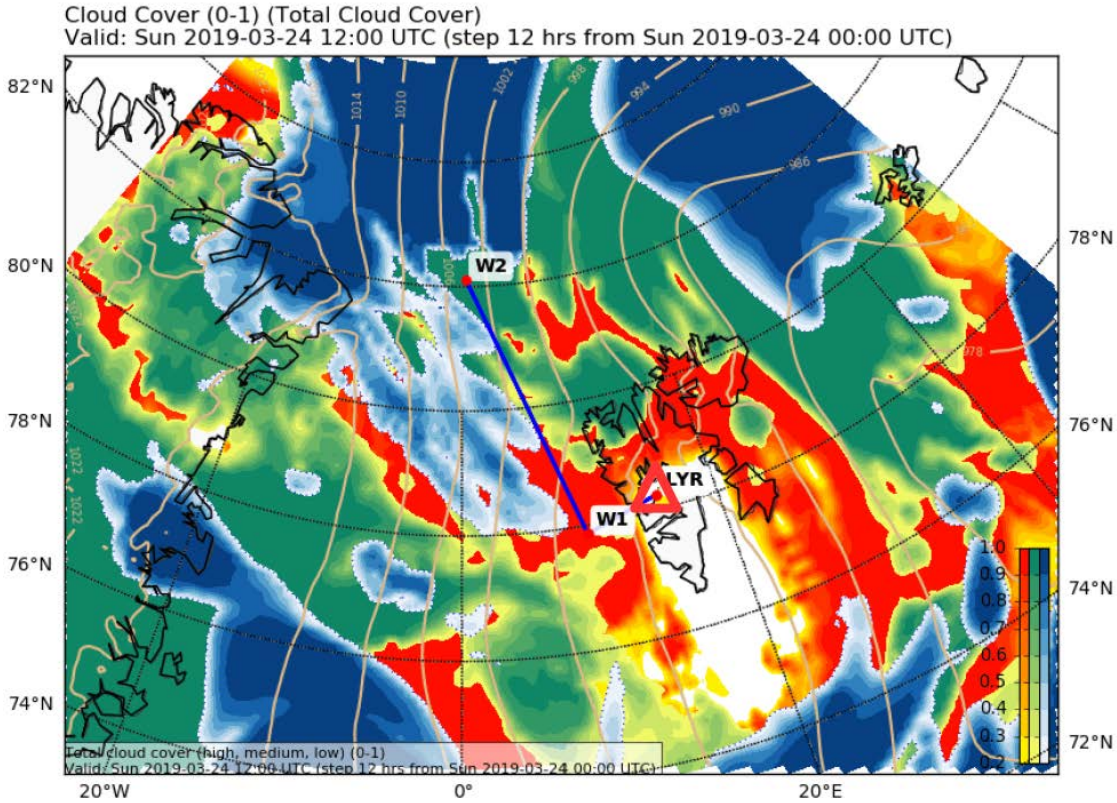
Weather (predicted and observed during the flight)

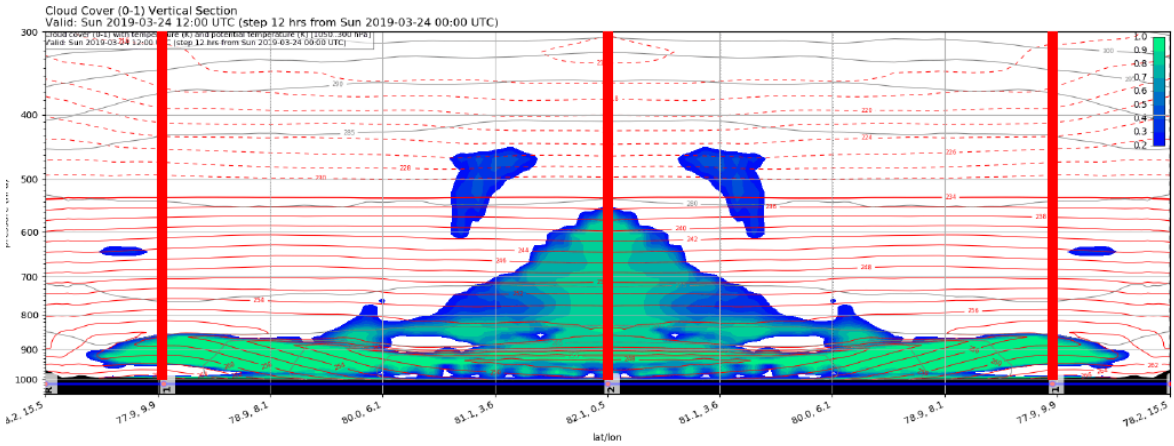
A low pressure system to the southeast of Svalbard caused a northerly flow west of the island. Cold air was transported from north to south. However, this cannot be considered a classical cold air outbreak, because the northerly flow also contained air transported within the low with southern origin, see the weather map below. This also caused mid-level clouds which are not part of a classical cold air outbreak, see the maps below.

Analysis (DWD) – 24.03.2019 / 0 UTC



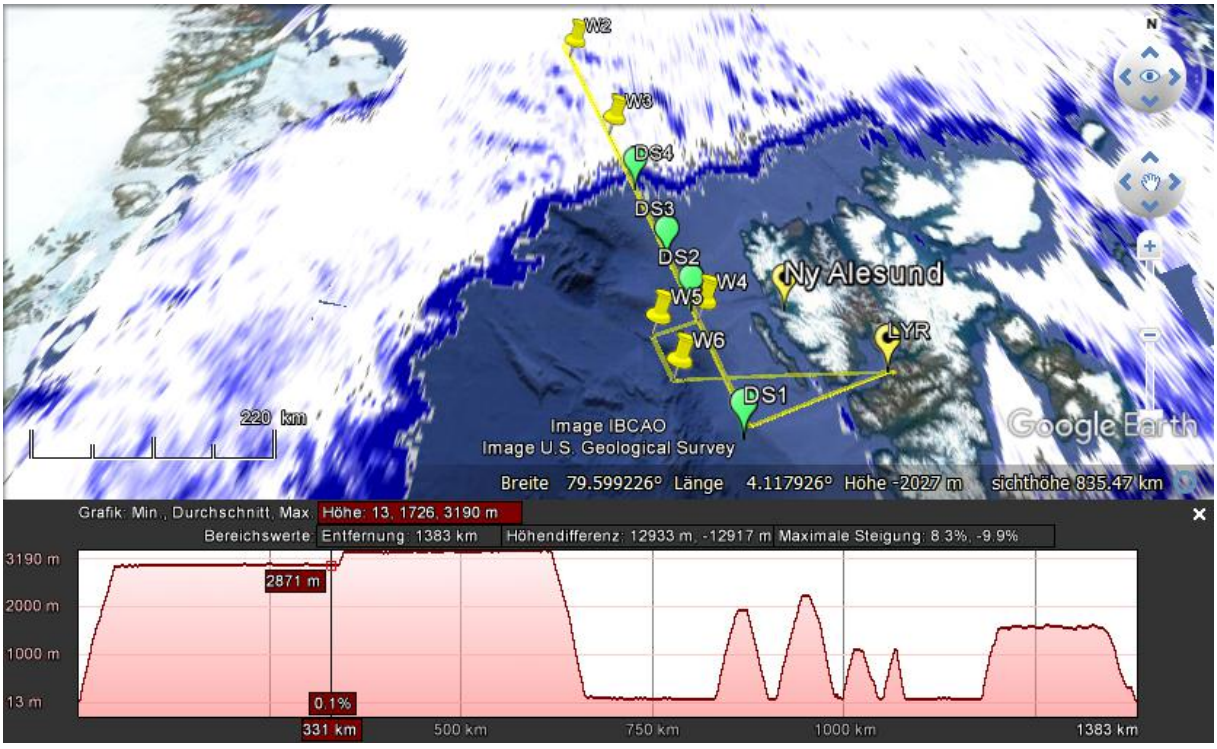
Cloud Cover (24.03 12 UTC, ECMWF)





Flight pattern

We flew out of LYR to W1 at an altitude of 10.000 ft and stayed at this altitude almost all the time until reaching W2. Four sondes were droped between W1 and W2. From there we returned into southern direction at lower altitude. Between W2 and W3 we stayed close to the surface below the clouds. From W3 to W4 we did fly 4 saw teeth flight patterns. Between W4 → W5 as well as W5 → W6 we stayed again below the clouds but flying in different directions. The cloud situation we observed during the flight was almost the same as predicted by the ECMWF model. The further north we flew the more midlevel clouds from the low pressure system we observed. However, we managed to stay above the clouds all the time on our way from W1 to W2. We had to climb slightly in the middle in between W1 and W2.



Detailed Flight Logs (all times in UTC)

LYR → W1	10000 ft	180 kn	77 nm	26 min

- Few clouds only at the airport
- 09:40 Motors on
- 09:51 Taxi
- 10:01 Take off
- Climb to 10.000 ft
- 10:11 Arrive at 10.000 ft
- Some shallow, low-level clouds

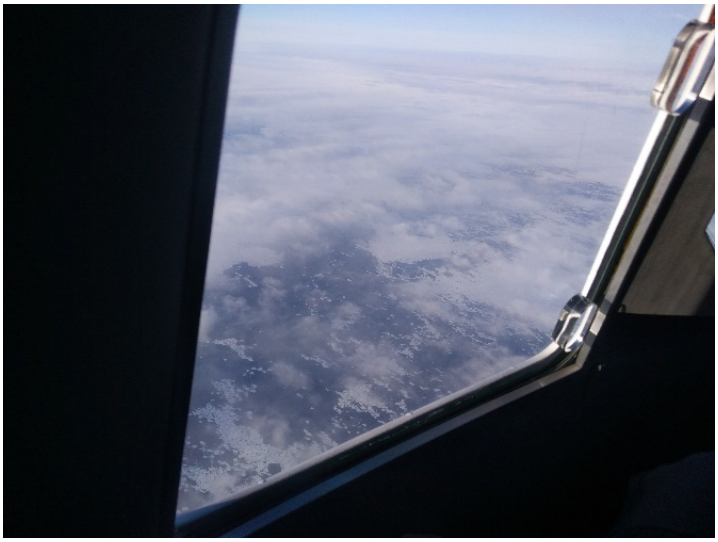
- 10:20 clouds getting thicker
- 10:31 Arrive at W1

W1 → W2	10000 ft	150 kn	276 nm	111 min

- 10:32 drop the first sonde
- 10:35 sonde seems to hit the surface
- 10:37-10:47 nice clouds below, nothing above, no cirrus

- 10:50 clouds below get more dense
- 10:54 2nd drop sonde
- 10:58 clouds get thinner, nevertheless still nice conditions, nothing above

- 10:59 2nd drop sonde seems to hit the surface
- 11:10 clouds getting thinner
- 11:14 climb higher (11.000 ft) to stay above the midlevel clouds which can be seen ahead of us
- 11:22 3rd drop sonde
- 11:27 Sea ice becomes visible



- 11:44 4th drop sonde
- 11:44 we reach W3, still almost no midlevel clouds, just low stuff
- 11:53 very nice low and mid-level clouds over sea ice, no cirrus

- 12:08 start descending to lowest possible level, from 11.000 ft
- 12:11 We reach cloud top, around 7000 ft, only very little icing
- 12:14 3000 ft in the middle of the cloud
- 12:16 we reach the cloud bottom, almost no icing, 20 Kelvin inversion
- Fog over ice

- 12:20 200 ft over ice
- 12:20 We reach W2

W2 → W3	**200 ft**	**120 kn**	**75 nm**	**38 min**

- We turn around, we see the sea ice surface, foggy, almost no icing
- One can hardly see the ground
- We stay at 200 ft between W2 and W3
- We see leads below
- It is quite bumpy, no icing at all, we cross leads
- 12:58 we reach W3

W3 → W4	Cloud top	120 kn	135 nm	68 min

- 12:58 we start to climb through the cloud upward
- 13:05 we are above cloud
- 13:07 we go down again
- 13:12 below the cloud again, better visibility below clouds this time

- 13:14 go upward again, now we have two cloud layers, second cloud layer with a base height of about 6800 ft, top height roughly 8000 ft
- 13:24 we go down again, several cloud layers
- 13:30 we arrive below cloud, open sea
- 13:31 we go upward again
- 13:35 we arrive at 4000 ft, above cloud
- 13:37 we go down again, reach open water below the cloud, sea fog

- 13:42 upward again
- 13:45 cloud top at 4000 ft
- 13:46 downward, go below the cloud at 200 ft
- 13:50 arrive at W4

W4 → W5	200 ft	120 kn	27 nm	14 min

- Flying at 200 ft
- Snow showers
- 14:00 arrive at W5

W5 → W6	Below clouds	120 kn	27 nm	14 min

- Flying at 200 ft
- Less bumpy, snow below the cloud
- 14:13 arrive at W6

W6 → LYR	10000 ft	180 kn	102 nm	34 min

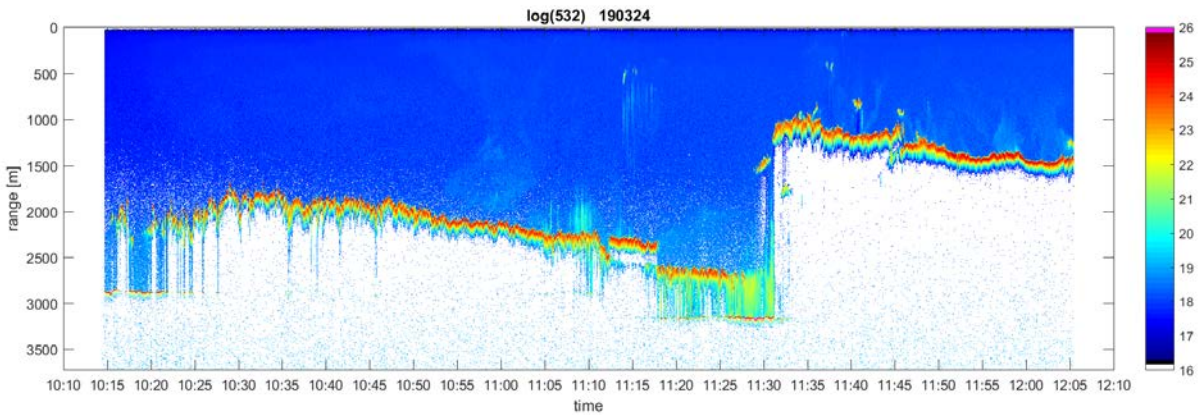
- Go upward above cloud
- 14:16 cloud top is reached
- No cirrus above

- Go home above clouds

- 14:51 landing
- Thanks a lot to the crew!!! And sorry for inconveniences during the flight, which was very challenging!

Quicklooks:

Lidar (Birte)



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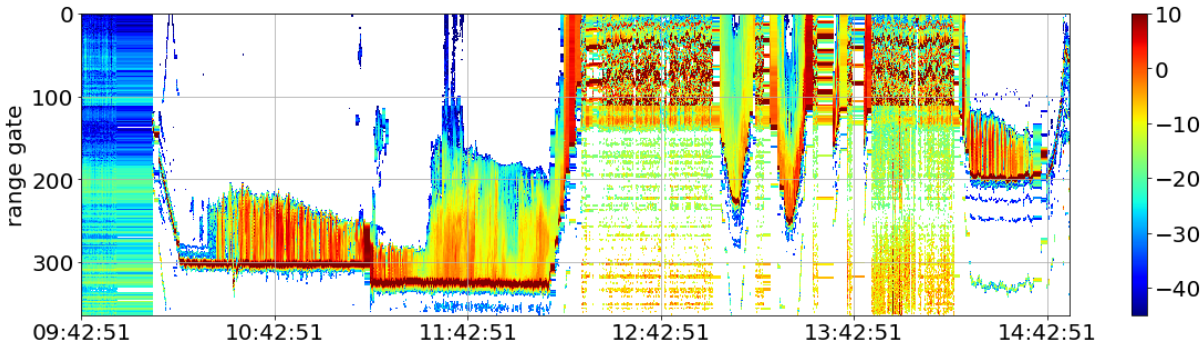
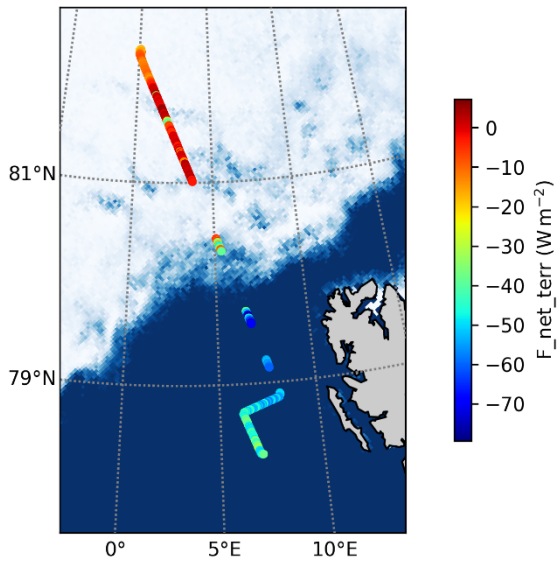
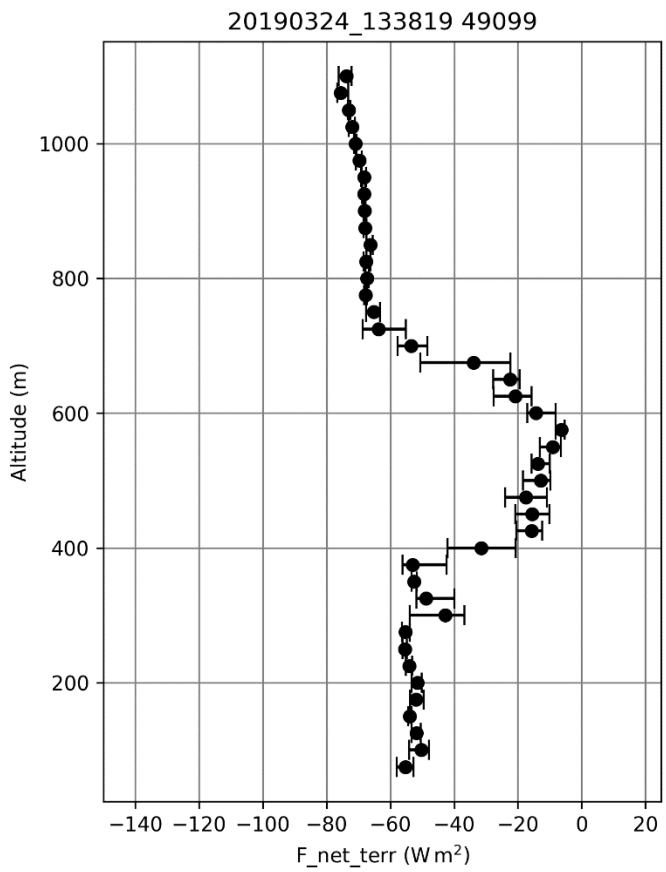
MiRAC (Leif)



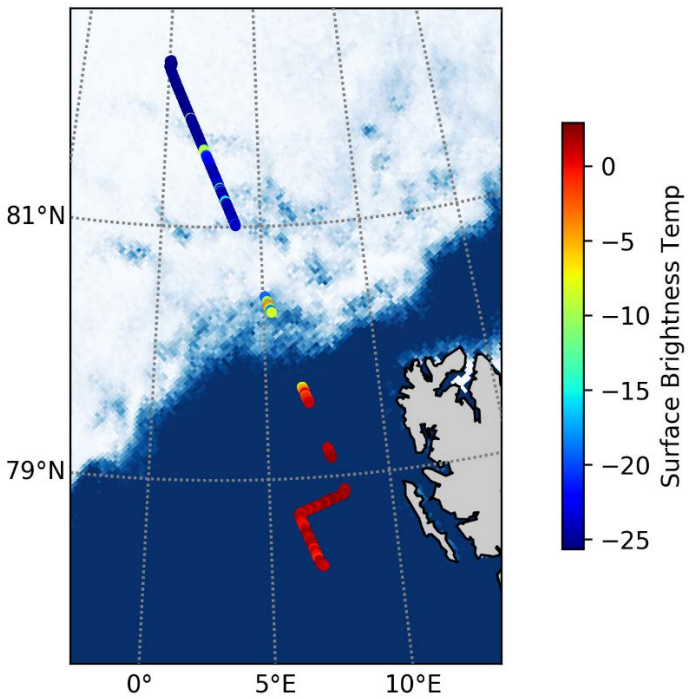
Radiation (Johannes)



F net terr low level map plot: Neutral, sometimes slightly positive F_net_terr over the ice. Strong negative (outgoing) F_net terr over the ocean in cloudy conditions. Towards the south F_net_terr becomes less negative. Atmosphere temperatures adapt to surface temperatures (slowly).

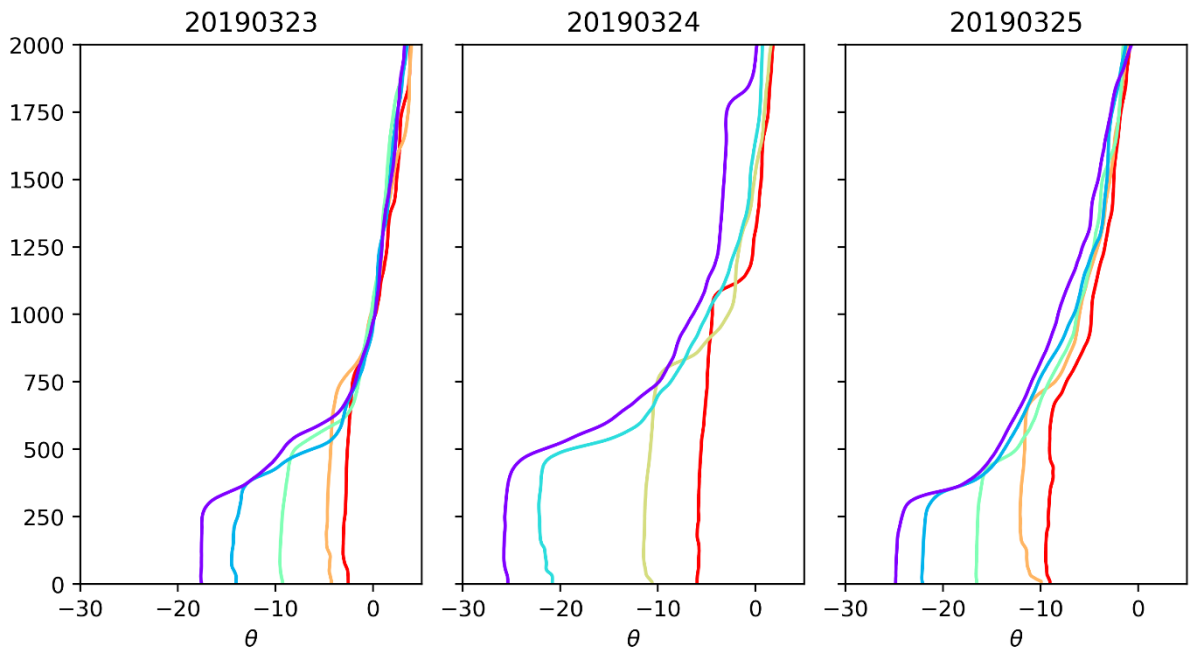


Profile F net terr: Single Layer cloud observed at 79.3 N . The flux convergence at the cloud base reaches similar values as the divergence (cloud top cooling) at the cloud top.

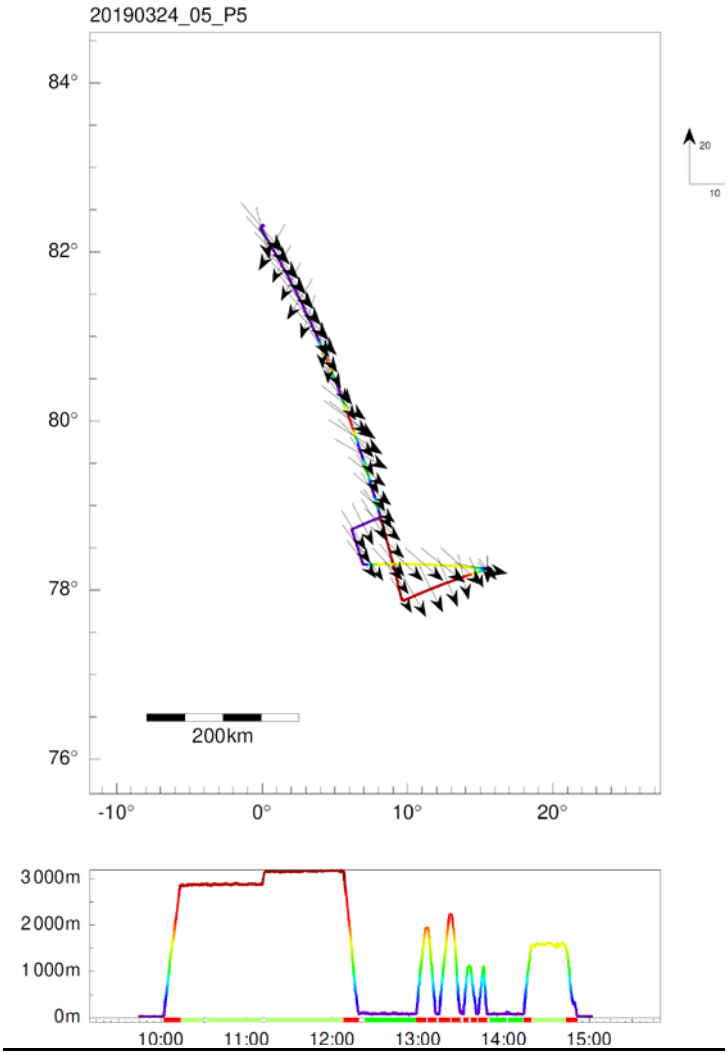


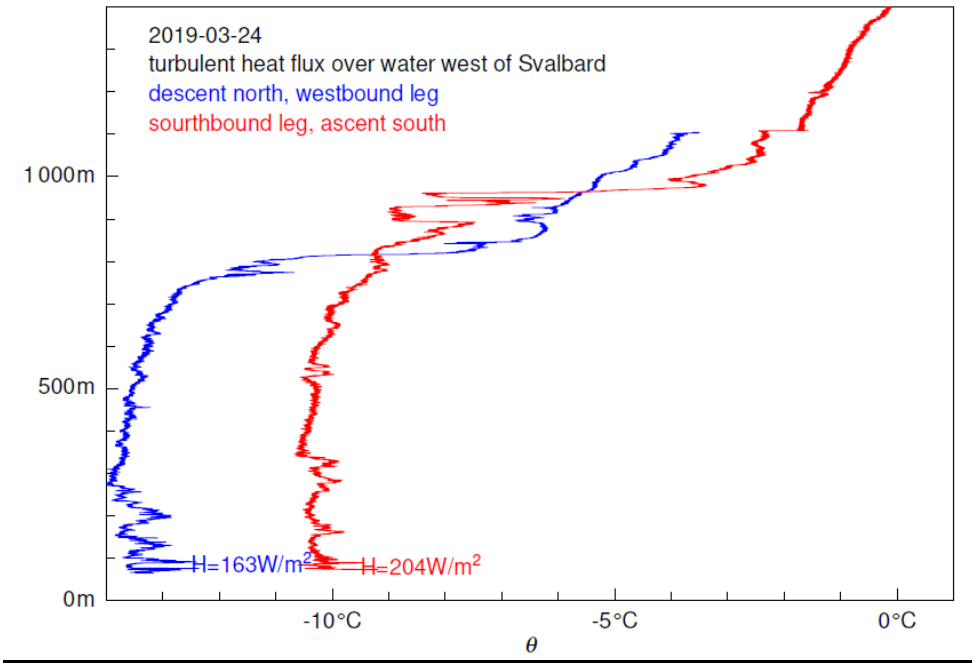
Surface Temp Map Plot: Surface temperature spread between sea ice and open ocean > 25 K

Dropsondes Profiles comparison between the 3 cold air outbreaks.



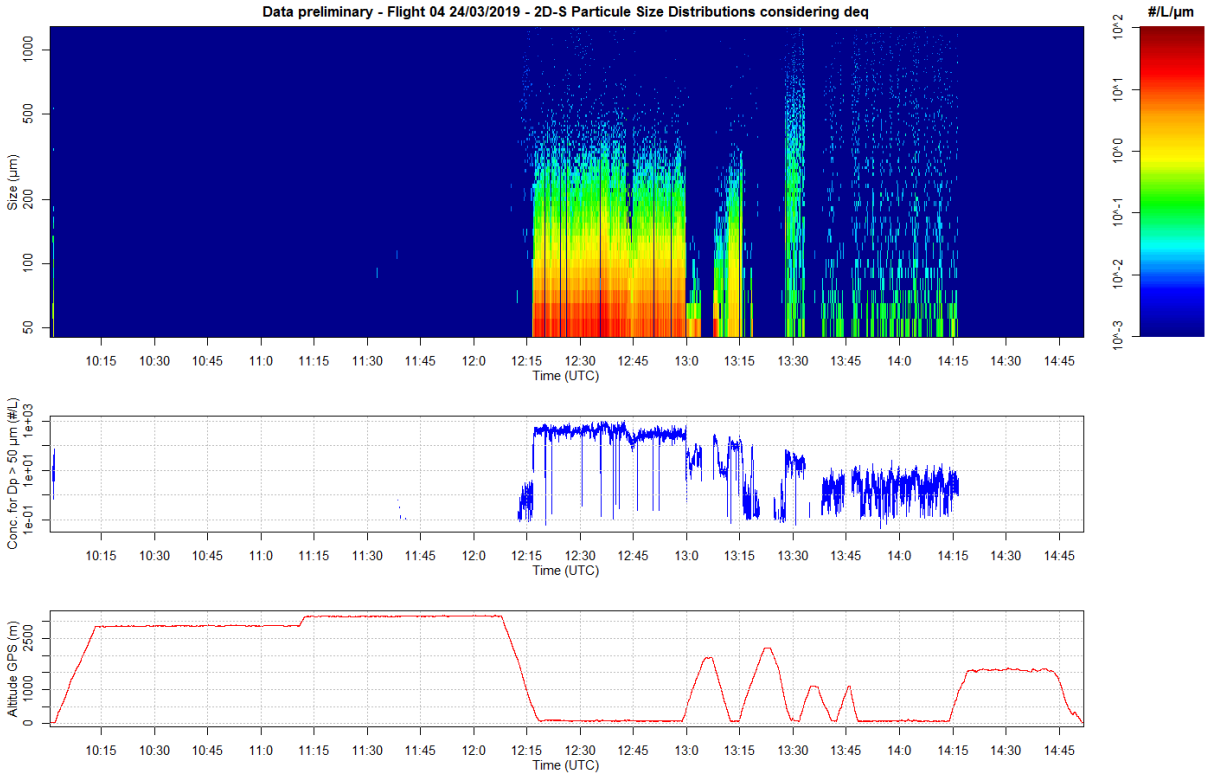
Turbulence (Jörg and Christof)



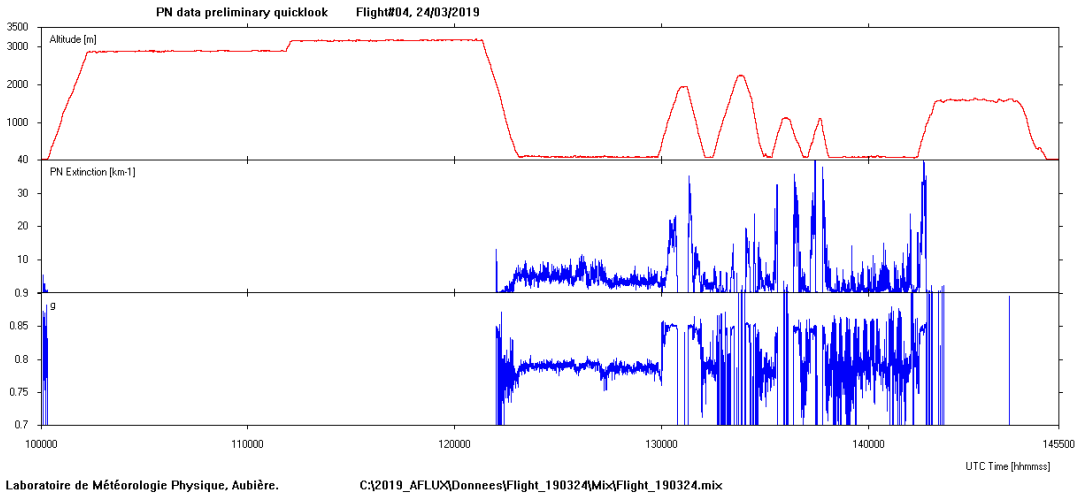


Microphysics (LaMP and DLR)

2D-S (Christophe)

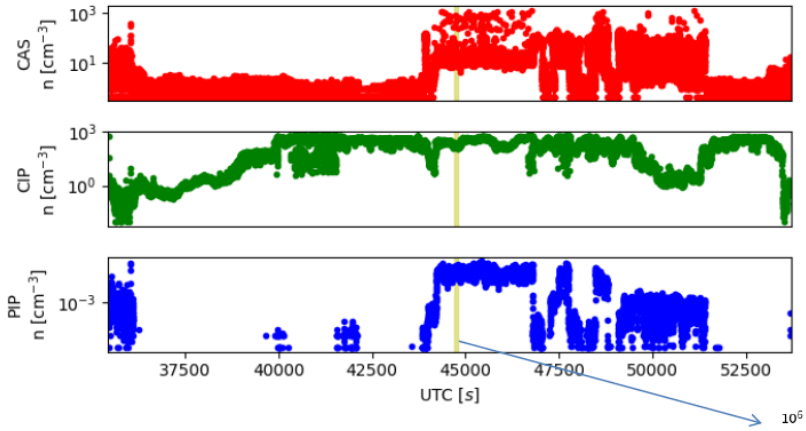


Polar Nephelometer (Christophe)

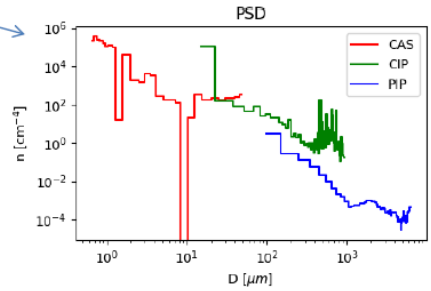


CAS, CIP, and PIP (Yvonne, Manu)

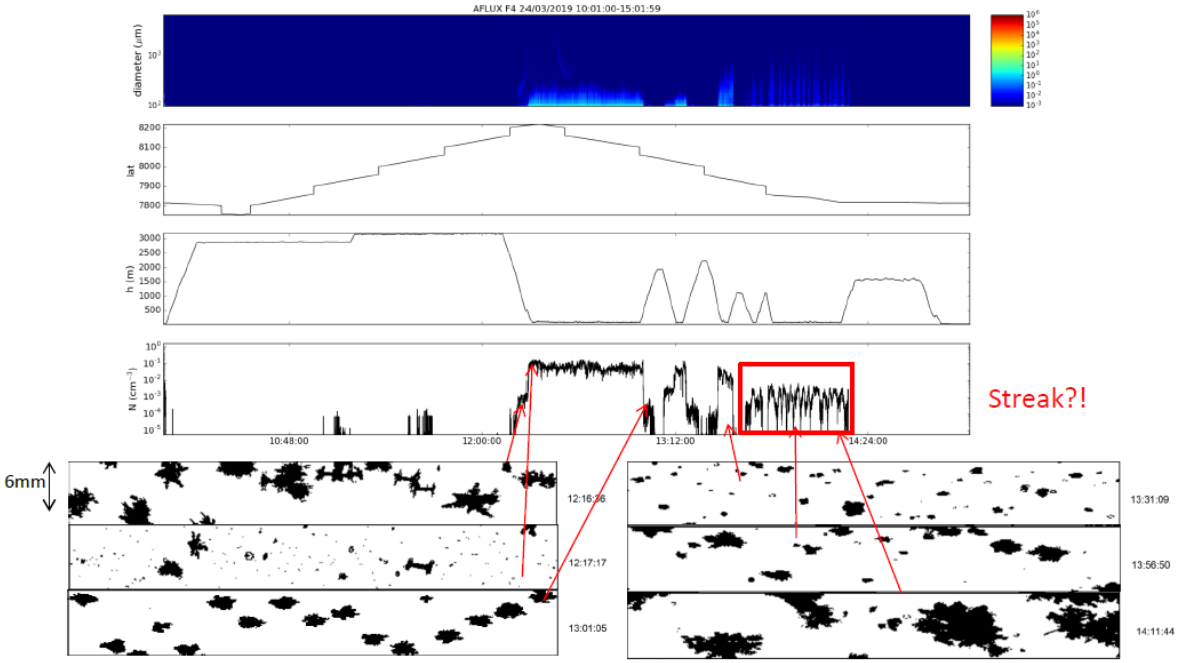
Preliminary data: 1Hz number concentration CAS, CIP, PIP



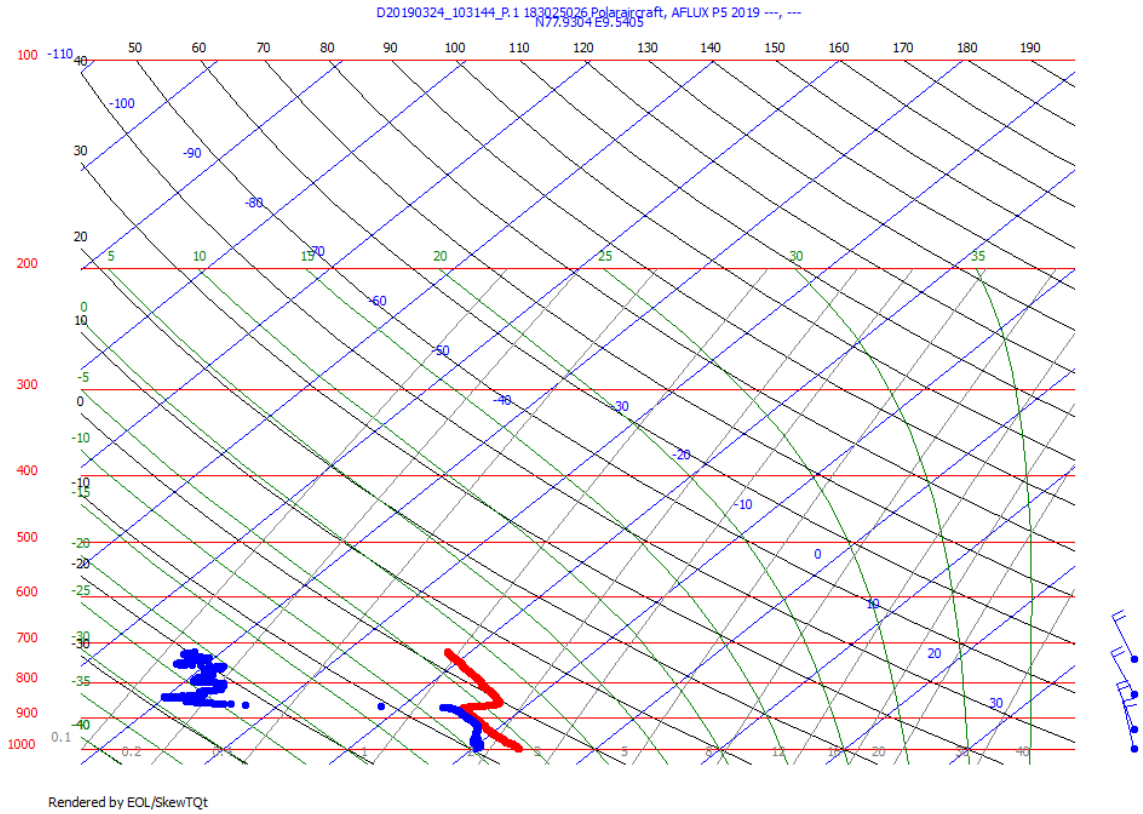
Particle size distribution (44700s – 44800s):

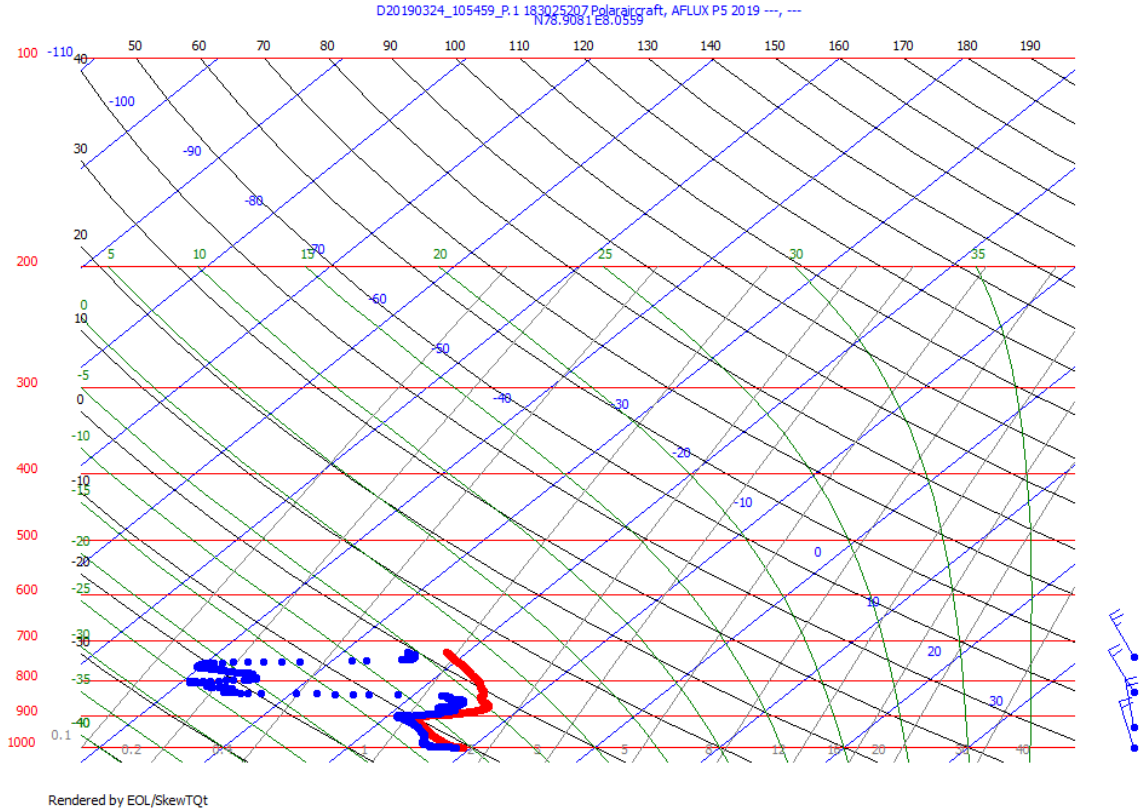


PIP (100 – 6000 µm) number concentration



Dropsondes (Mario)





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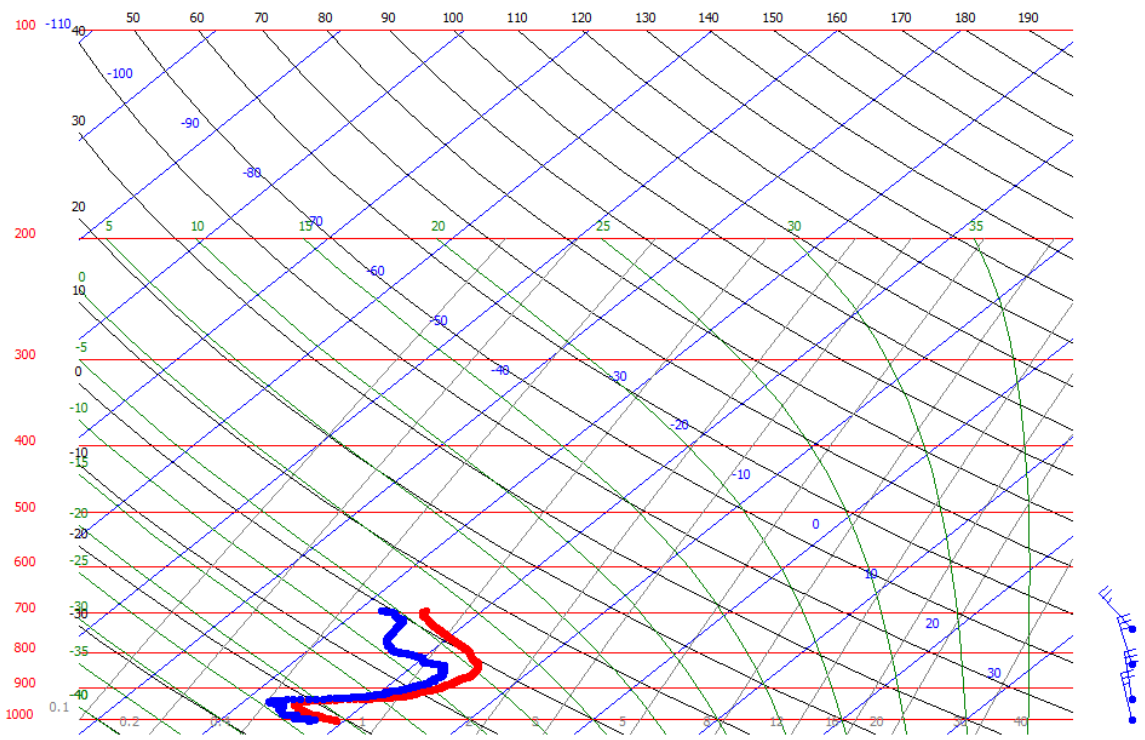

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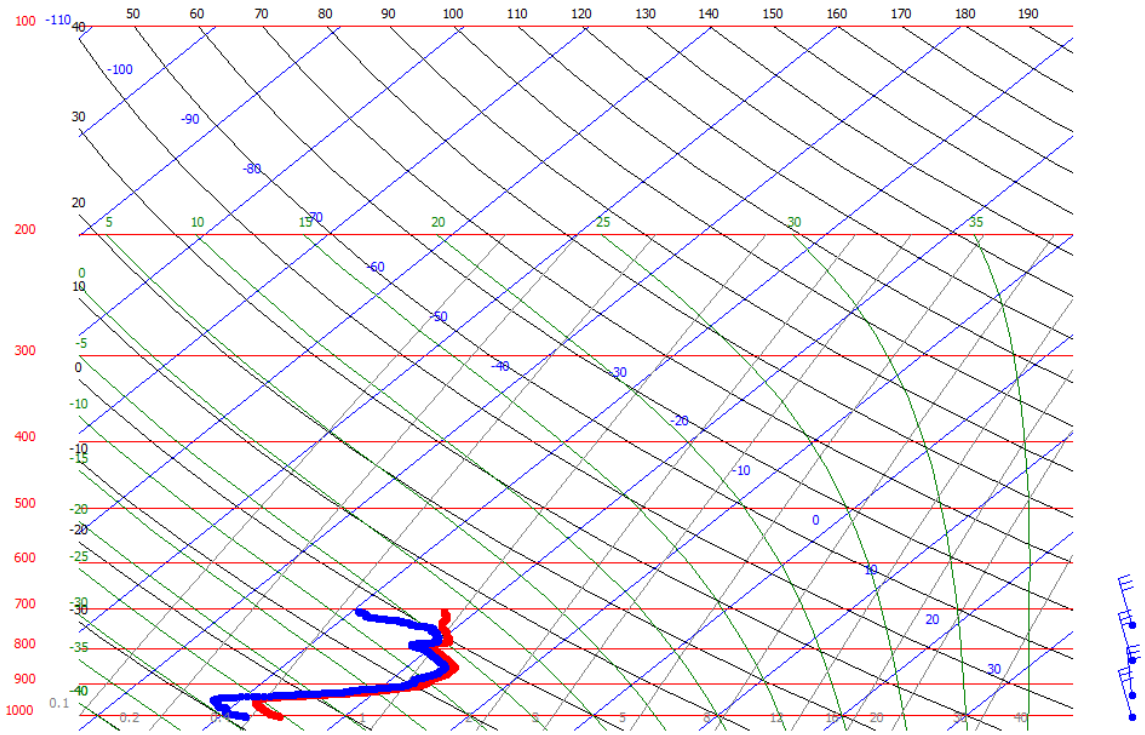

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