

ORACLES P3 Flight Scientist Post-Flight Status

Date: **10/12/2018**

Flight number: **PRF08Y18**

Routine flight or target of opportunity?: **Target of Opportunity – Lagrangian smoke resample and cloud sampling**

Flight scientist: **Mike Poellot**

Ground scientist: **Paquita Zuidema** Asst. Ground scientists: **Michael Diamond**

Take-off: 121212

Landing: 172530

Quick summary:

Do the models predict crossing a gradient in aerosol age?

Yes/No/Unclear

Unclear

Did the flight cross a gradient in macroscopic cloud properties, like cloud fraction?

Yes/No/Unclear

Yes

Did the flight cross a gradient in aerosol loading?

Yes/No/Unclear

Yes. Particularly noted in last set of sawtooth cloud profiles.

At any point during the flight, was there a clear separation between the smoke plume(s) and cloud tops?

Yes/No/Unclear

Yes. Smoke did not extend down to cloud in first operational area. There was also a gap at the second square spiral and start of sawtooth maneuvers.

How many of the following maneuvers took place?

Ramps _____

Above cloud legs 2

Square spirals 2

Sawtooth legs 2

MBL legs 3

Plume legs 1

Cloud legs 1

Above plume legs 2

Science manifest: Mike Poellot, Ousmane Sy, Greg Dobrowalski, Andrzej Wailewski, Steve Howell, Steffen Freitag, Amie Dobracki, Pui Shan Wong, Art Sedlacek, Dean Henze, Jim Podolske, Rose Miller, Sabrina Cochrane, Eric Stith, Sam LeBlanc, Tony Cook, Dave Harper

Instrument status:

Instrument	Comments
P3	
4STAR	ACAOD ~0.3, mostly cirrus,
HiGEAR	Some confusion early on with CVI, but latter part was great, TDMA went down,
HiGEAR AMS	Worked great, great flight
RSP	Functioning well, some rolling issue at small part
APR3	Good day, measured clouds, precip, virga, all along
Cloud probes	Worked great besides CAPS instrument, tried to cycle power 3 time, but not successful.
CCN	Ran well, saw gradient in number CCN in the diagonal, interesting to look at data
PTI	Great flight, boring first half, got into some aerosol after, 0.85-0.86 SSA back of the envelope
PDI	
Vertical winds	
WISPR	All instrument working, sawteeth worked great. Slow descent through cloud really good, might be a good part of thesis
COMA	Worked well - bug in the operator - CO up as high as 240ppb in the aerosol layer, interesting things in CO2 at the lower layer
SSFR	Good day, everything worked, under cloud for most of the first part of the flight.
HSRL	Worked well, no issues to report.
data	Worked well.

PRF08 10/12 2017 Friday Mission Report

flight scientist: Mike Poellot (FS)

ground scientist: Paquita Zuidema (GS), Michael Diamond (AGS)

Flight plan and objective: This was a target of opportunity flight to: a) resample boundary layer air first sampled on PRF#07, and b) sample cloud properties across aerosol boundaries.

Flight Summary: The departure was significantly delayed by the failure of an engine driven compressor. The P-3 crew did a fantastic job of expediting the repair, which allowed this mission to take place at all. Because of the delay, the flight duration was shortened by about 3 hours. Therefore, flight decisions were centered around finding suitable conditions further north than normal.

The outbound transit was flown nearly straight south of Sao Tome to an initial point at 2.5 °S, 6.5 °E where the trajectory indicated resampling of boundary layer air. A square spiral was done at 2 °S, 5.75 °E. Boundary layer was sampled followed by a sawtooth set up on a 030°/210° track through decoupled cloud layers (stratus above Cu). The upper stratus was about 300m thick and the Cu coverage was generally less than 2 oktas. The cloud patch was thicker and precipitating at the north end of the runs. The sawtooth pattern included a level below cloud segment. This was followed by a return level leg above cloud, with much higher cloud tops at the north end. Air was quite clean above cloud. Return leg sampled level in upper stratus layer with speed runs near the north end in thicker cloud. Only three speeds were flown due to the limited extent of the cloud. In general, droplet concentrations were low.

Based on guidance from the ground, we climbed and transitioned to point further southwest where there was a more uniform stratocumulus layer. A square spiral descent was conducted at 4.5 °S, 5.5 °E. This was followed by a run northbound that started with a level period below cloud and above cloud. A sharp sawtooth was then flown north to the northern edge of cloud. The sawtooth crossed a distinct boundary between clear and polluted air, "like hitting a wall" as commented on board. There were corresponding changes in cloud properties. The transit home was flown in the aerosol plume at 11,500 feet.

A-Priori Forecast: The trajectory forecast indicated that boundary layer air from PRF07 could be resampled in the vicinity of 2-3 °S and 5-6 °E. Good stratocumulus would be found south of approximately 7-8 °S.

Forecast Verification: The actual boundary layer winds were a bit stronger and more southwesterly than forecast, which meant that the air mass for resampling was actually east and north of where the measurements were taken. Fortunately, a nearly solid deck of Sc thickened rather than dissipated farther north than expected.

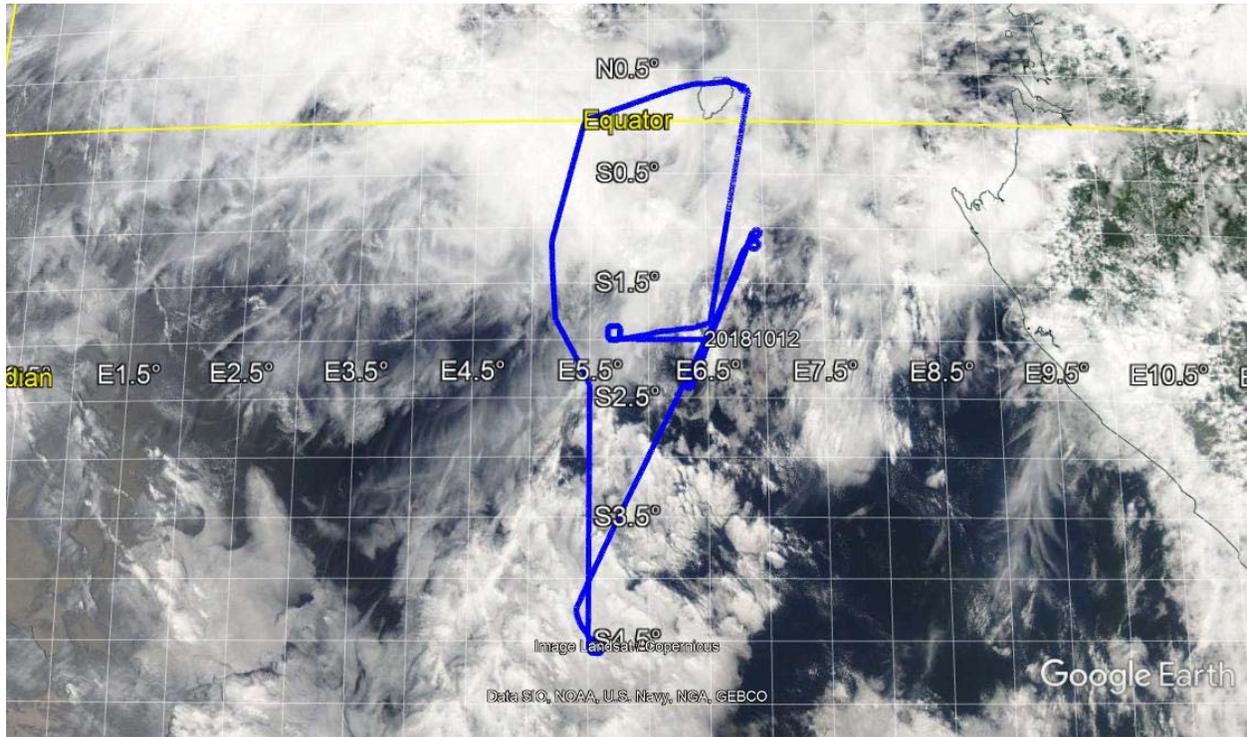
Flight Instrument status: Most instruments worked well during the flight. The exceptions were the DMA and the CAPS probe.

Run Table [UTC; approximate times okay, lack of detail okay. Just note major transitions, such as takeoff, time at point of furthest extent, time at beginning and end of major profiles with their detail relegated to the notes, such as spirals, level legs, straight profiling, and landing time]

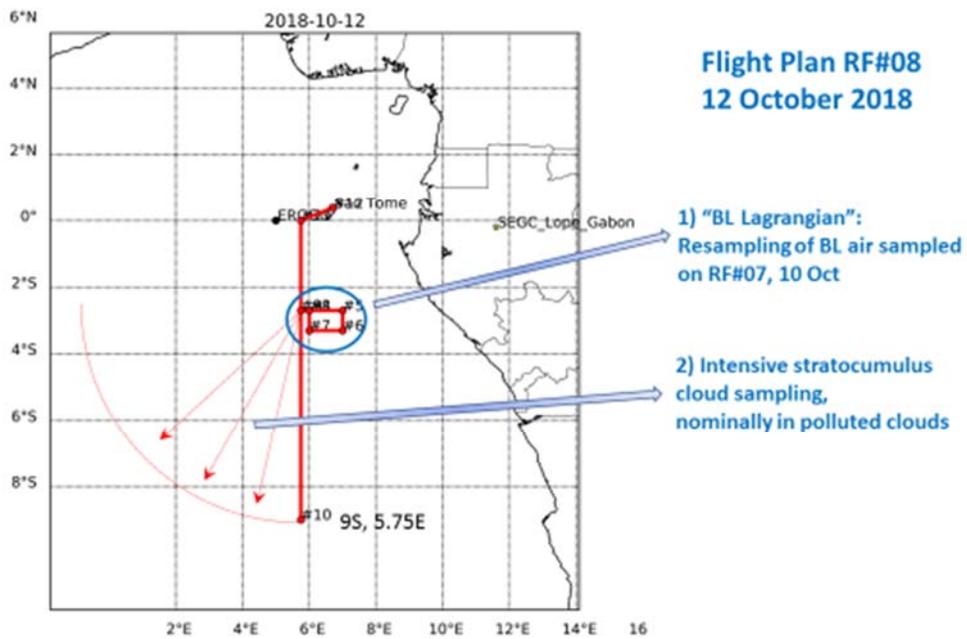
description	beginning time	end time	altitude	notes
Takeoff	121212 UTC	X	To 16,000'	
Ferry leg				
Square spiral	1252	1307	To minimum (200')	Cloud top 5100'. Cu below stratus
Level boundary layer leg	1307	1309	200'	
Dull sawtooth	1309	1347	5100'/800'	
Level leg above cloud	1349	1413	7000'/5200'	
Level leg in cloud	1421	1437	4200'	
Speed run	1430	1437	4200'	

description	beginning time	end time	altitude	notes
Below cloud	1440	1452	900'	
Transition	1452	1529	19,000'	
Square spiral	1529	1551	Down to 900'	
Level below cloud	1553	1557	900'	
Level above cloud	1601	1605	5000'	
Sharp sawtooth	1605	1621	5500'/ 3200'	
Transition to dirty air	1610			
Climb for ferry home	1618		11,500'	
Landing	172530			

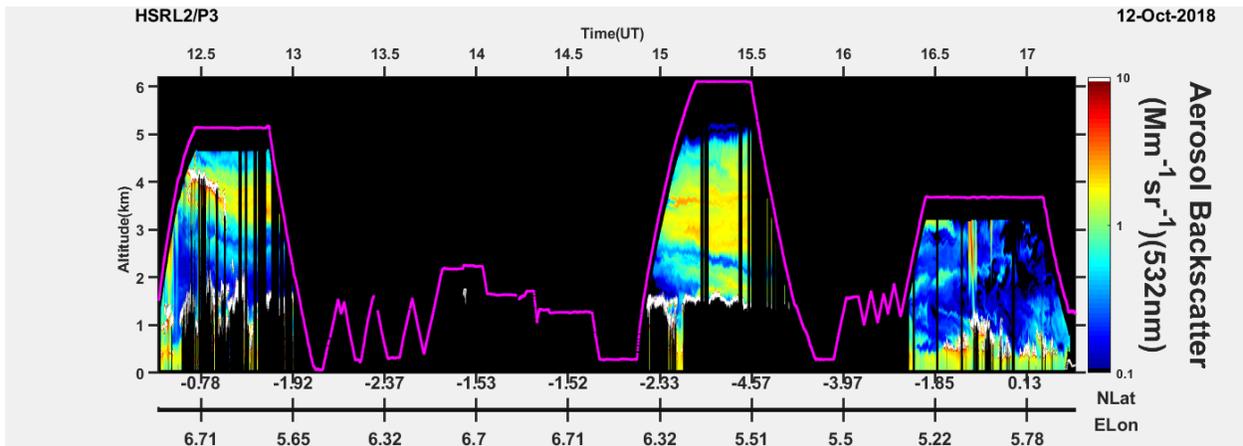
visual notes:



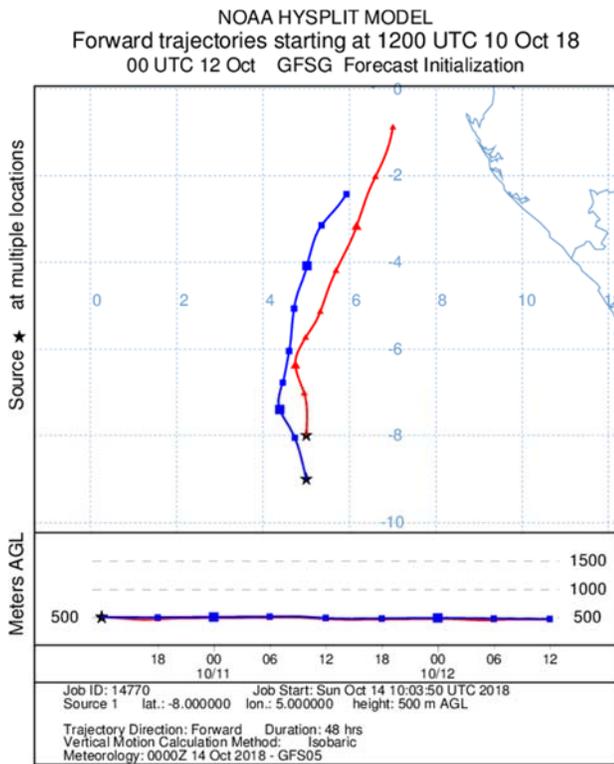
Flight track with visible image from 134553.



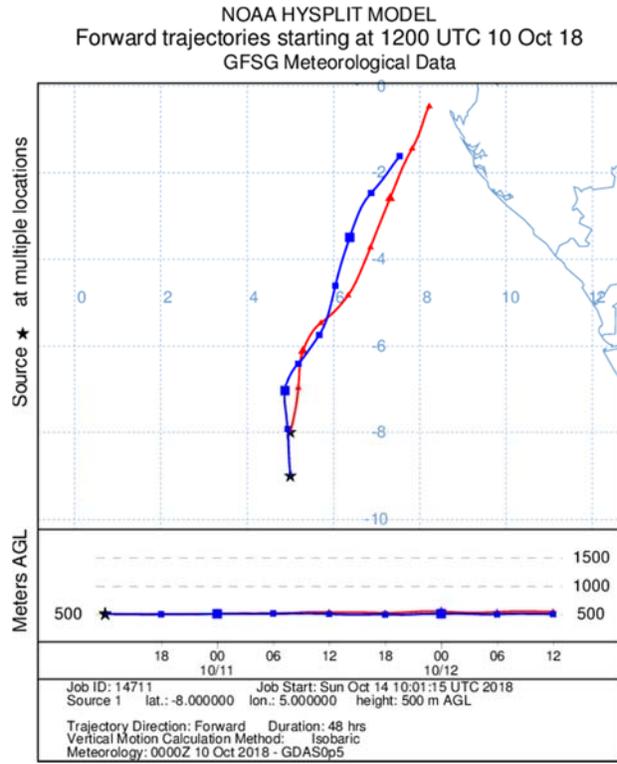
Planned flight track.



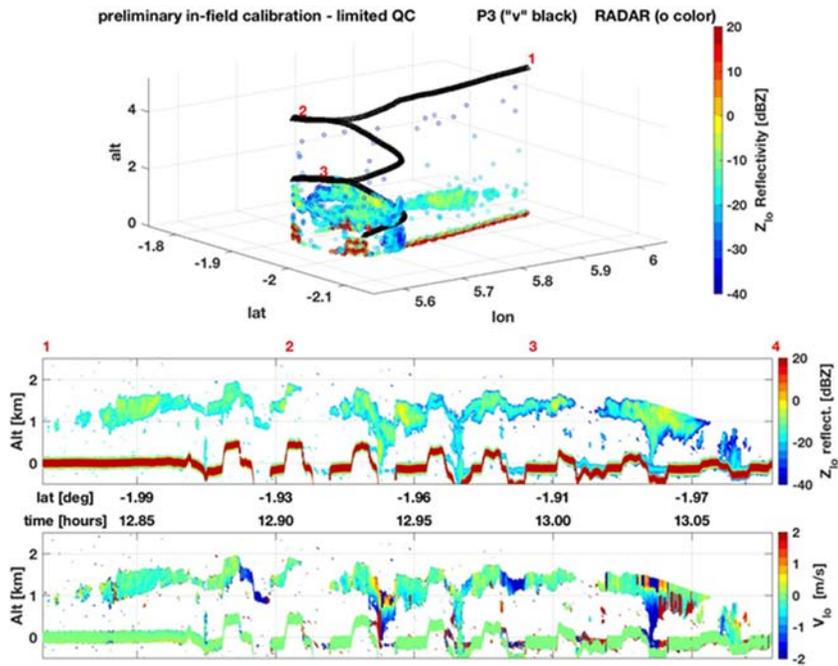
HSRL image for full flight.



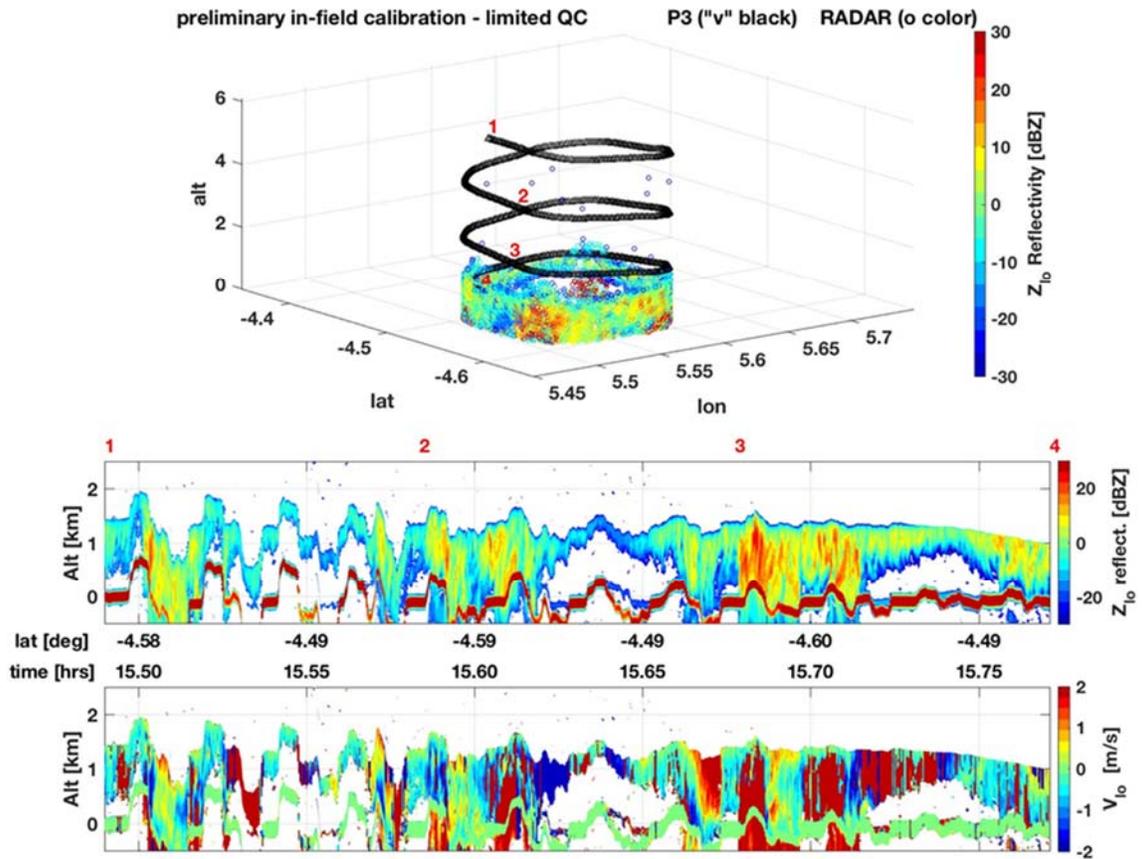
Forecast trajectory



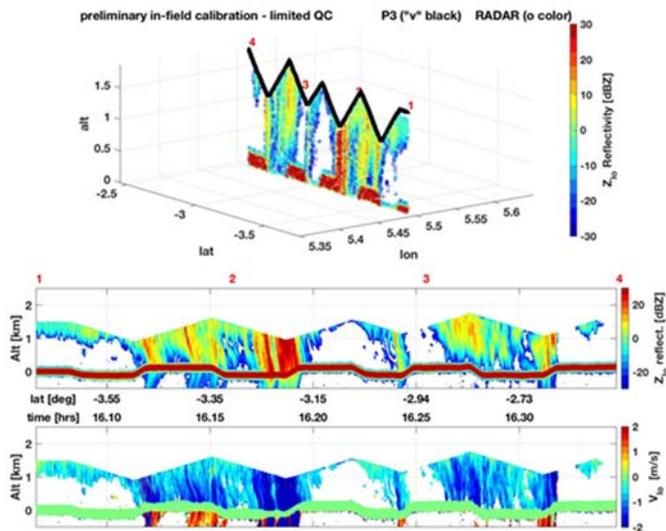
Actual trajectory



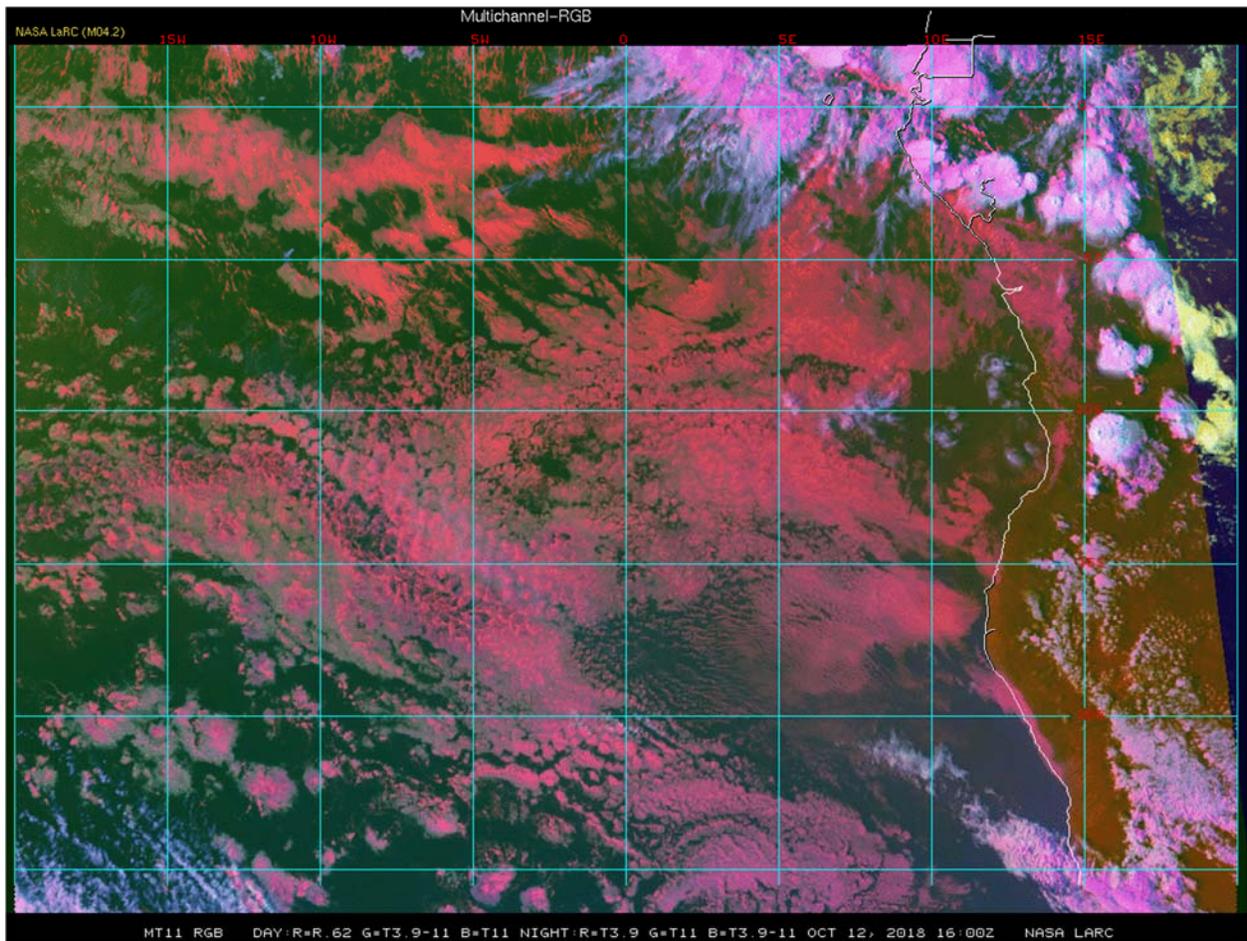
APR3 for first square spiral.



APR3 image for second square spiral.



APR3 image for sawtooth in stratocumulus.



Cloud classification image from 1600 UTC.

Notes and images from Sam LeBlanc:

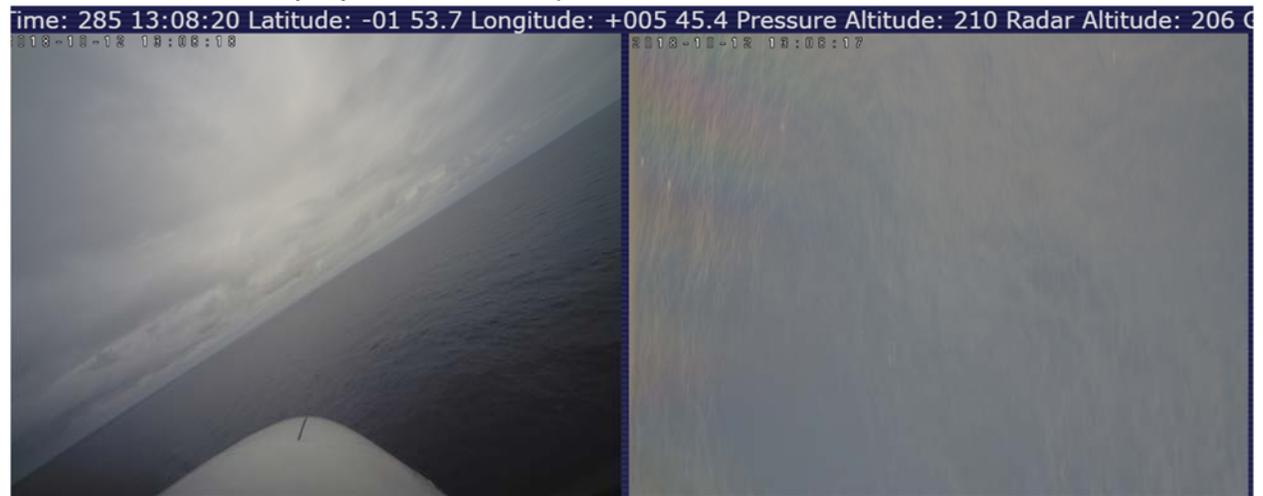
12:52 - square spiral start, under nearly overcast cirrus

12:53 - start of aerosol layer at 14kft,

12:57 - max aerosol at around 11.5kft

13:02 - In cloud at about 1.8km,

13:05 - lower boundary layer is a bit more polluted



13:14 - sawtooth

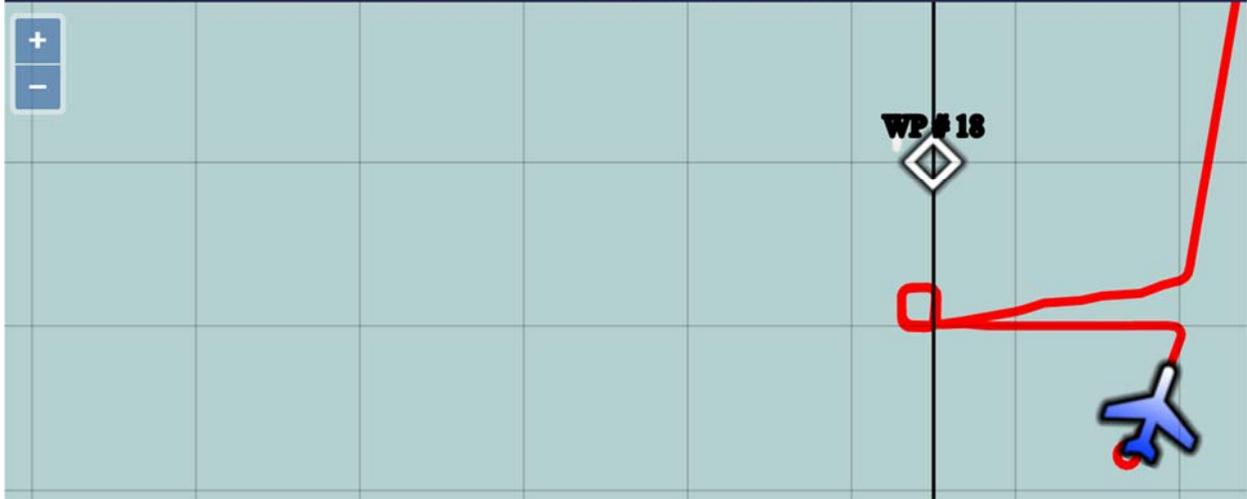


13:22 - Turning southwest to do cloud work., CO below cloud is about 108ppbv

13:26 - cloud wasn't very polluted.

13:27 - observe some AOD of about 0.2

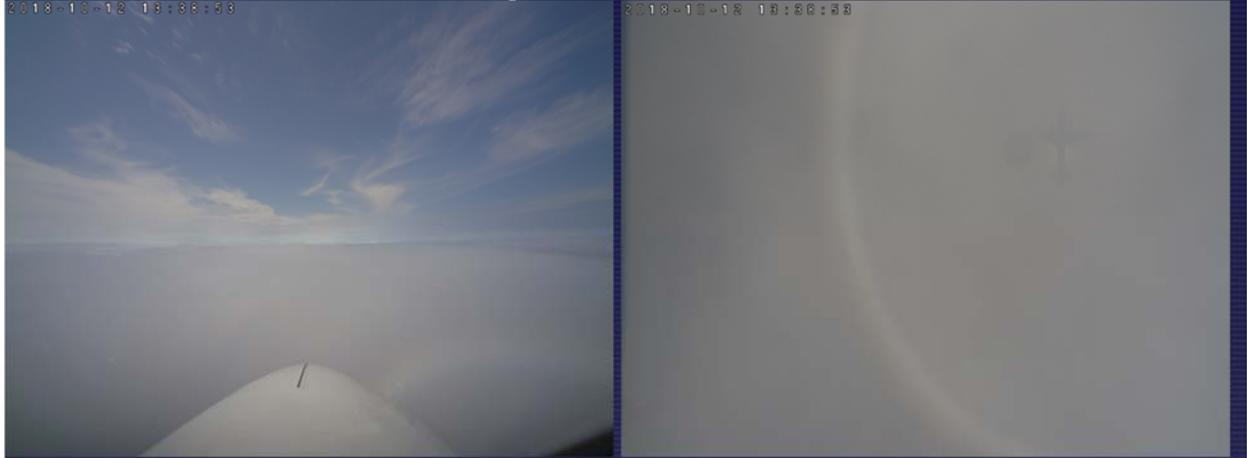
Time: 285 13:32:30 Latitude: -02 14.8 Longitude: +006 25.4 Pressure Altitude: 1006 Radar Altitude: 1045 Ground



13:35 - very thin clouds.

13:39 - above cloud, clean low aerosol

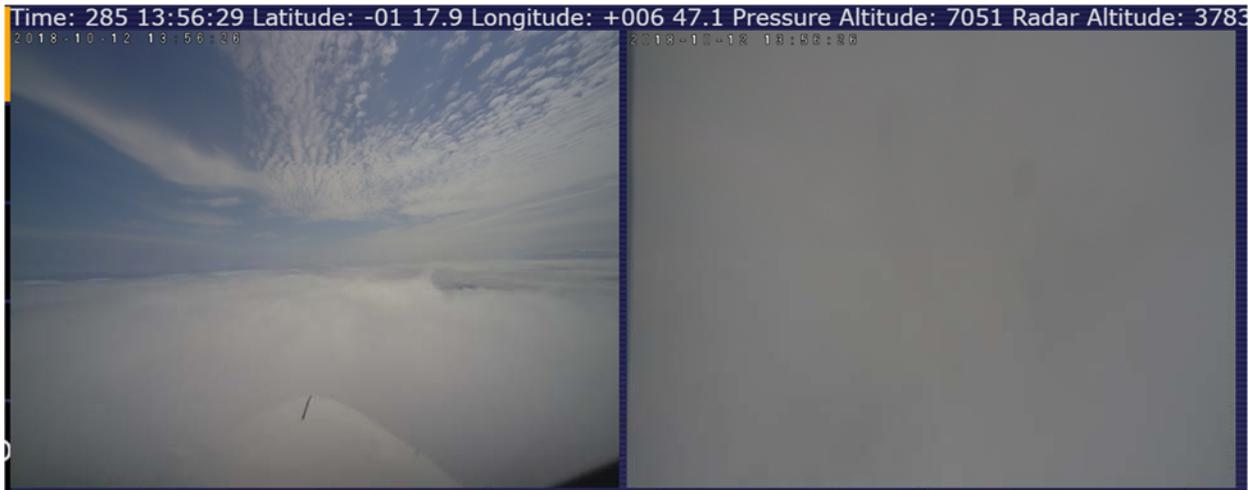
Time: 285 13:38:55 Latitude: -01 51.2 Longitude: +006 34.1 Pressure Altitude: 4809 Radar Altitude: 3783



13:41 - in cloud $\sim 0.3\text{g}/\text{m}^3$, $N_d \sim 60$

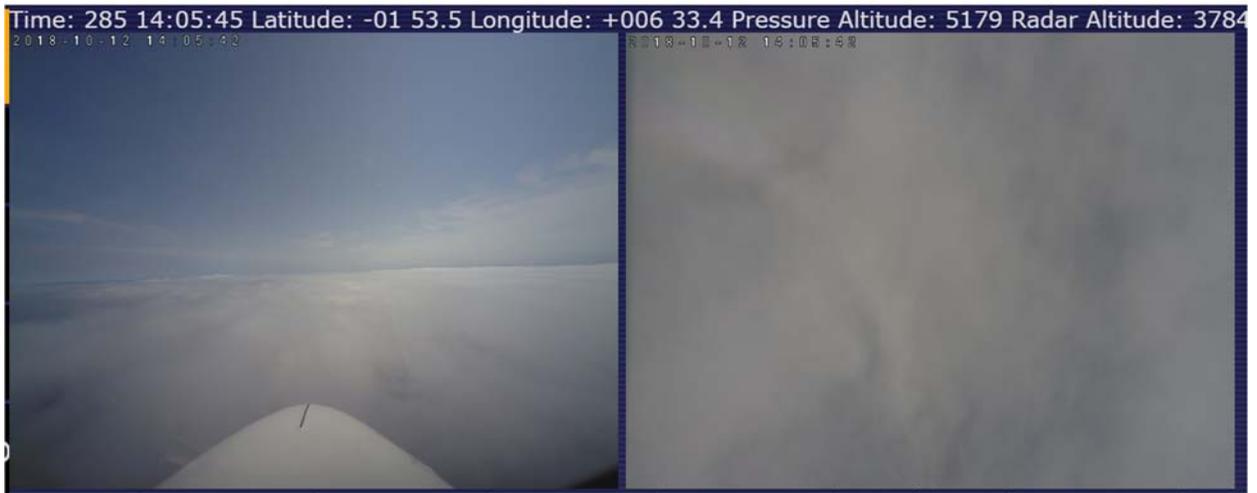
13:49 - cloud thickened on north end,

13:56 - very clean right above cloud



13:59 - aerosol here very low, but not very volatile, likely old pollution

14:02 - AOD above cloud ~0.15, some cirrus



14:07 - ultra clean layer here, RH ~84%, 4ppb aerosol concentration, likely washout from clouds, 110 ppb CO, near no aerosol, BC, AOD above cloud 0.15(ish)

14:20 - in cloud Nd~50#/cc

14:34 - below cloud sampling, clean, but zenith showed large particles, yet in situ cloud probe mode was about 15um diam.

14:58 - climbing up.

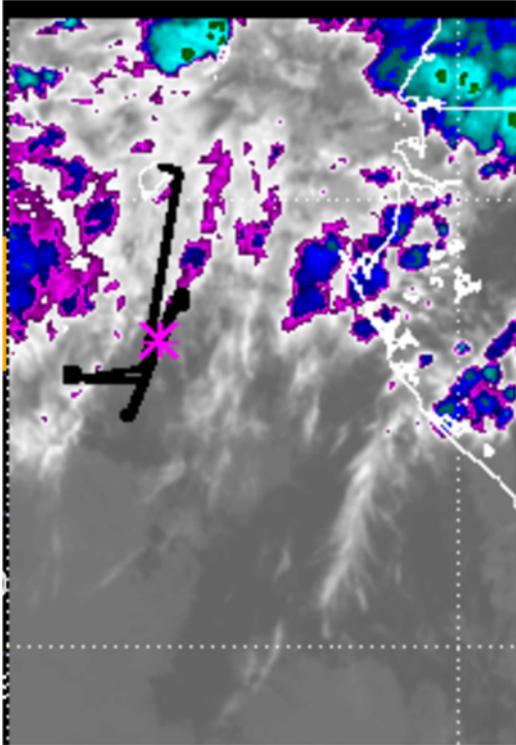
Time: 285 14:58:53 Latitude: -02 15.5 Longitude: +006 21.5 Pressure Altitude: 9393 Radar Altitude: 378



15:03 - some cirrucumulus above,

Time: 285 15:05:36 Latitude: -02 41.9 Longitude: +006 08.6 Pressure Altitude: 15368 Radar Altitude: 378



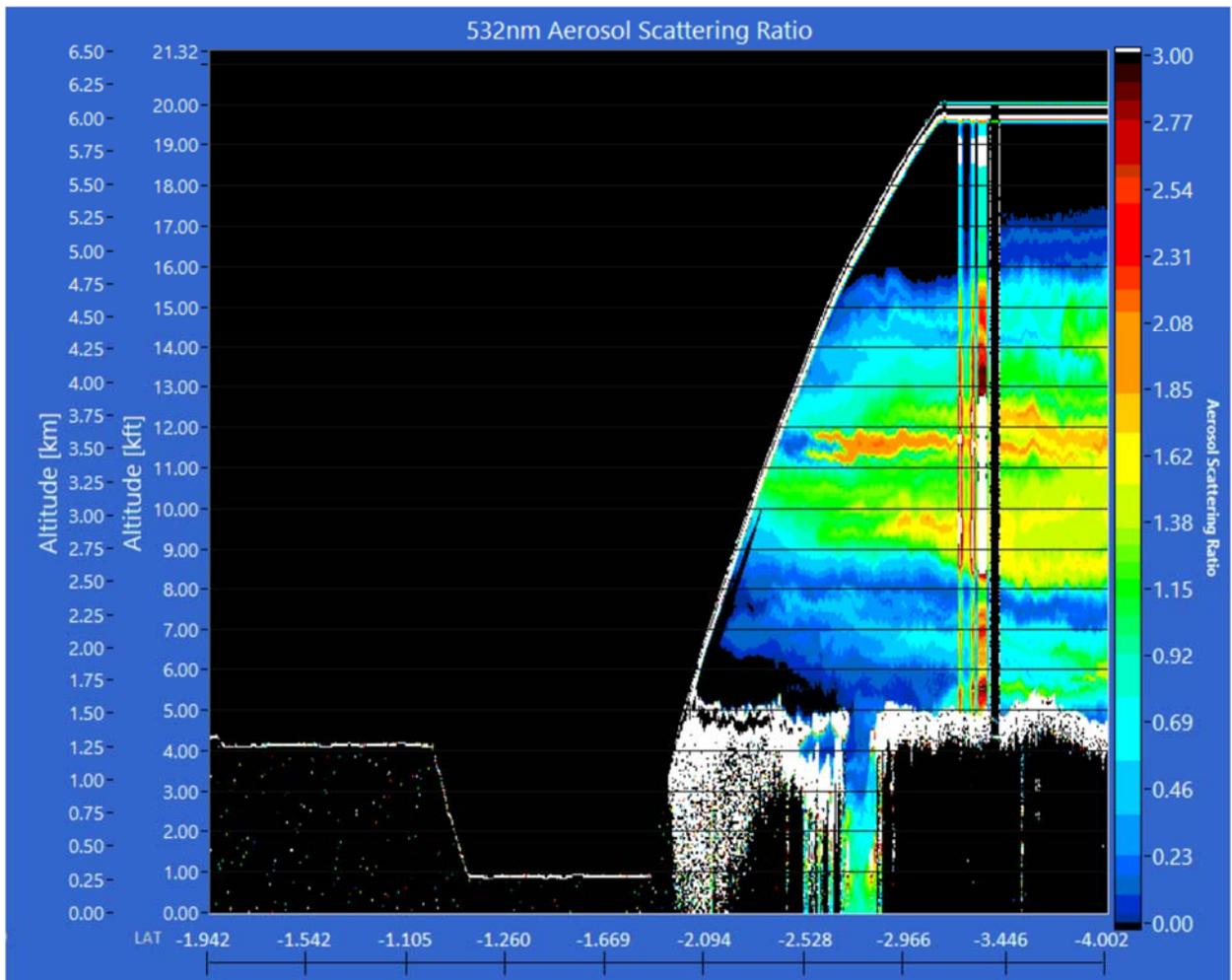


15:06 - out of plume, at 16kft, with particules getting increasingly volatile

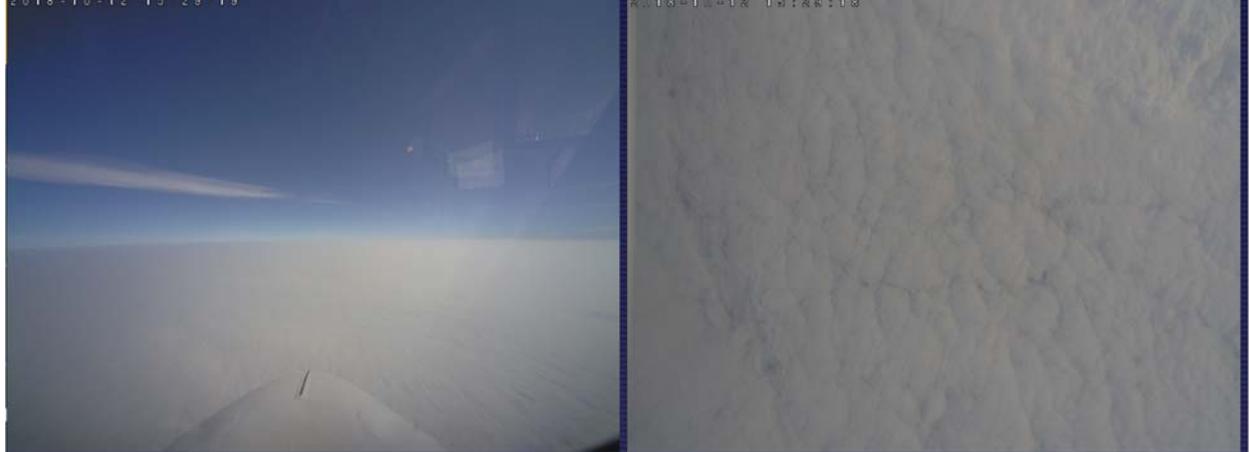
Time: 285 15:16:40 Latitude: -03 28.5 Longitude: +005 45.7 Pressure Altitude: 18989 Radar Altitude: 37
2018-10-12 15:16:38 2018-10-12 15:16:50



15:16 -high alt, mostly clear, AOD~0.037



Time: 285 15:29:21 Latitude: -04 31.6 Longitude: +005 30.4 Pressure Altitude: 18978 Radar Altitude: 378



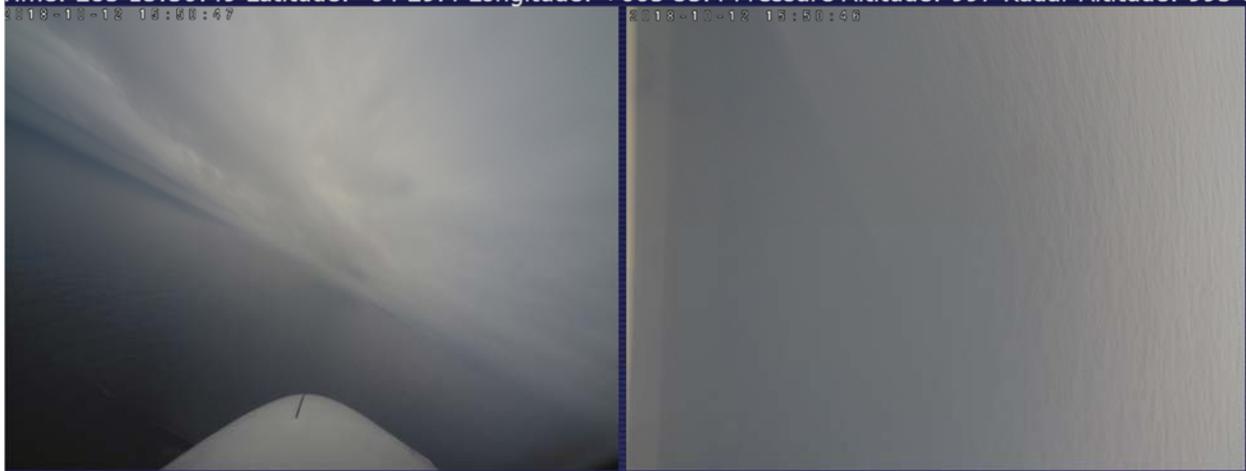
15:30 - square spiral start
 15:33 - start of aerosol layer, 14.5kft

Time: 285 15:39:22 Latitude: -04 29.2 Longitude: +005 32.1 Pressure Altitude: 8762 Radar Altitude: 3785
2018-10-12 15:39:40 2018-10-12 15:39:10



15:45 - ACAOD ~0.34, ND~100/cc

Time: 285 15:50:49 Latitude: -04 29.4 Longitude: +005 35.4 Pressure Altitude: 997 Radar Altitude: 995 C
2018-10-12 15:50:47 2018-10-12 15:50:50



15:51 - 0.3/0.5 ng of organics - 98 ppbv CO, scattering ~40/Mm, 150 ng of BC. wind speed 10knots some light rain

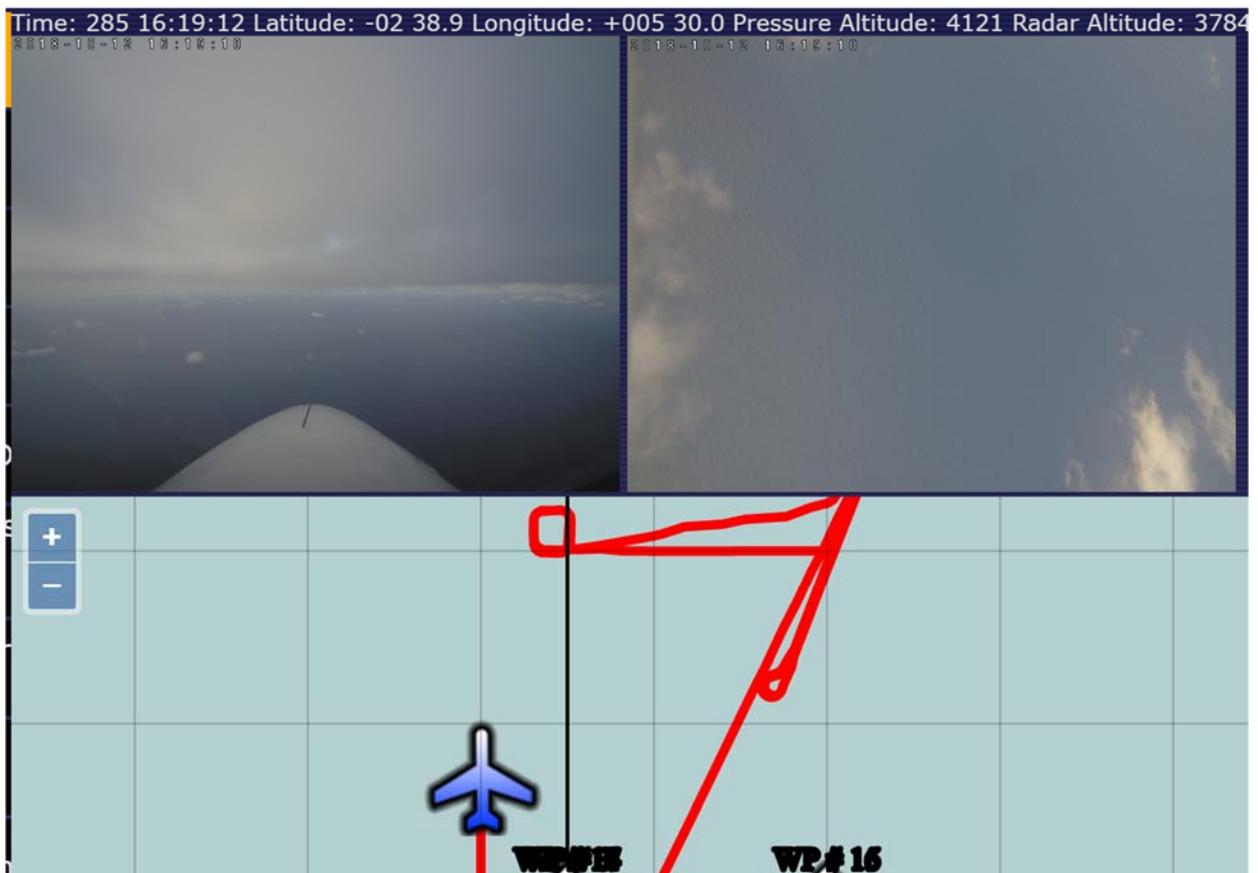
15:58 - possible evidence of decoupled boundary layer here, change in water vapor and BC.

16:06 - ACAOD ~0.3, some good skyscans, CO variations along the horizontal, cloud ND ~100, 'clean cloud,

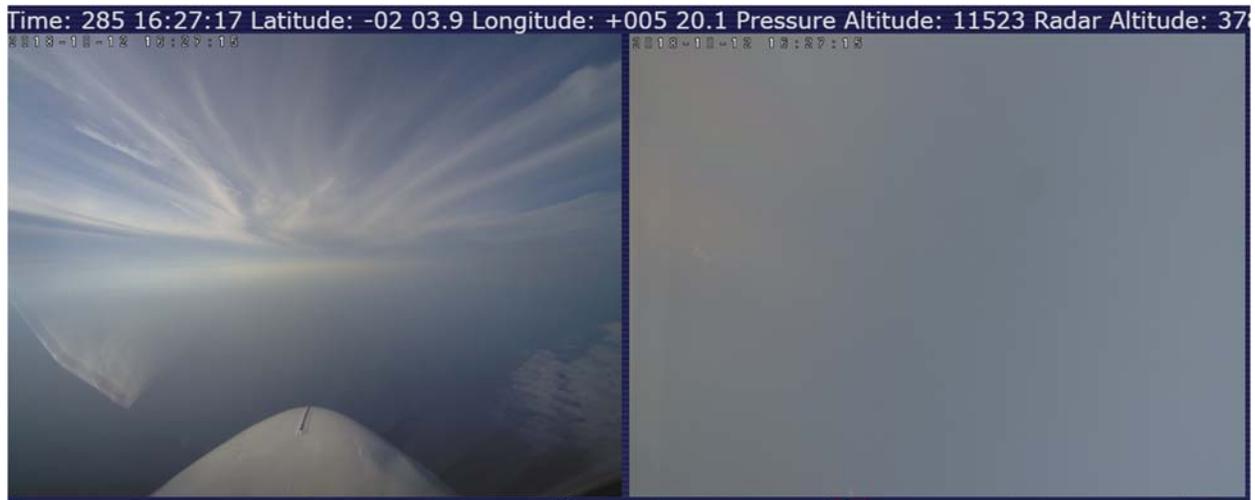
16:10 - again above cloud, CO ~125ppb, ACAOD ~0.28, layered cloud



16:13 - high BC in this last cloud,



16:26 - as we go up in altitude, peak aerosol 11.5Kft, cirrus around



16:35 - change in pitch,

16:42 - doing landing gear drills for teaching - got into a small cloud

16:49 - into some clouds/droplets

Chat captured by Michael Diamond:

(*Note: Chat timestamps in US Pacific*)

Sawtooths around 2 S:

- [06:04am] **Sam 4STAR P3**: scattering below clouds only slightly above above clouds - but pretty clean
- [06:06am] **Sam 4STAR P3**: lower boundary layer a bit more polluted
- [06:19am] **pzuidema**: what's the CO you're measuring?
 - [06:19am] **amiedobracki**: 105-107ish
- [06:29am] **Sam 4STAR P3**: Saw AOD at one point of about 0.2
- [06:39am] **Sam 4STAR P3**: clear above cloud according to in situ
 - [06:40am] **Sam 4STAR P3**: *clean
- [06:40am] **Sam 4STAR P3**: Nd of cloud low, ~60
- [06:48am] **Sam 4STAR P3**: clouds tops at this end about 2kft higher than more south
- [06:50am] **Sam 4STAR P3**: Co at 119ppbv above cloud

- [06:53am] **Sam 4STAR P3**: Many weird layers/clouds
- [06:53am] **Sam 4STAR P3**: horizontal variations and vertical too
- [07:02am] **Sam 4STAR P3**: cleanish air above cloud

Cloud work around 2 S:

- [07:09am] **Sam 4STAR P3**: very clean layer right above cloud
- [07:10am] **Sam 4STAR P3**: RH 85%, about 40#/cc of aerosol
- [07:10am] **Sam 4STAR P3**: 106 ppb of CO
- [07:20am] **Sam 4STAR P3**: Nd~50/cc
 - [07:21am] **Sam 4STAR P3**: 0.3 g/m³ of LWC
- [07:21am] **Sam 4STAR P3**: very low aerosol concentration while on CVI
- [07:22am] **Sam 4STAR P3**: aerosol max is 100#/cc
- [07:38am] **Sam 4STAR P3**: LWC ~1g/m³
 - [07:38am] **Sam 4STAR P3**: Nd ~70

Transit to 4 S, 5.5 E:

- [07:56am] **Sam 4STAR P3**: aerosol layer started at about 6kft
- [08:00am] **Sam 4STAR P3**: CO breaking 200pm at 11kft
- [08:30am] **pzuidema**: SEVIRI Nd ~50/cc below you: clean
- [08:30am] **pzuidema**: SEVIRI LWP of 300 g/m²: high
- [08:30am] **Sam 4STAR P3**: humm... APR is saying clouds below is 1.5 km thick
- [08:32am] **mdiamond**: the cloud tops are at 1.5 km... surface precipitation?
- [08:33am] **Sam 4STAR P3**: ... not sure right now, but maybe a bit right before the start of square spiral
- [08:36am] **pzuidema**: Nd more consistent, is what I meant as well, with ~50/cc, to 5S

Second square spiral at 4 S:

- [08:37am] Sam_4STAR_P3: in the peak of the aerosol
- [08:37am] Sam_4STAR_P3: rh~60%
- [08:38am] Sam_4STAR_P3: CO 250 ppb
- [08:40am] Sam_4STAR_P3: Change in CO to CO2 ratio at 8kft
- [08:45am] Sam_4STAR_P3: 100/CC cloud particles
- [08:46am] Sam_4STAR_P3: ACAOD ~0.34
- [08:47am] Sam_4STAR_P3: 1.3 g/m³ LWC, now at Nd5
- [08:47am] Sam_4STAR_P3: *Nd 75
- [08:50am] Sam_4STAR_P3: 0.3-0.5 ug of organics
- [08:51am] Sam_4STAR_P3: precipitating here
- [08:52am] Sam_4STAR_P3: 98 ppbv CO
- [08:55am] Sam_4STAR_P3: that square spiral was not very near any cirrus, just some streaks on the horizon
- [08:58am] Sam_4STAR_P3: possible evidence of decoupled boundary layer here

Sawtooths from 4 S back north:

- [09:00am] **Sam 4STAR P3**: intermediate level is cleaner, Scavenged because CO not much different
- [09:06am] **Sam 4STAR P3**: ACAOD ~0.3
 - [09:06am] **Sam 4STAR P3**: Nd 100/cc
- [09:12am] **Sam 4STAR P3**: bottom of cloud had 250/cc
 - [09:15am] **Sam 4STAR P3**: there was a second layer of cloud
 - [09:15am] **Sam 4STAR P3**: under
- [09:15am] **Sam 4STAR P3**: this last cloud was dirty
 - [09:15am] **Sam 4STAR P3**: previous was not
 - [09:15am] **Sam 4STAR P3**: 'dirty' as in high BC
- [09:16am] **mdiamond**: was there more aerosol in general in lower portion of the MBL?
 - [09:16am] **Sam 4STAR P3**: yes

- [09:17am] **Sam 4STAR P3**: but not right below cloud
- [09:17am] **mdiamond**: which cloud?
- [09:17am] **Sam 4STAR P3**: Nd 160 now
- [09:17am] **Sam 4STAR P3**: lowest cloud
- [09:17am] **Sam 4STAR P3**: , and the upper cloud was first just one
- [09:18am] **Sam 4STAR P3**: now had a small cloud layer with high ND just below/embedded
- [09:18am] **Sam 4STAR P3**: and the upper cloud is getting dirtier as we go north
- [09:21am] **Sam 4STAR P3**: only 'scud' clouds left below us
- [09:24am] **Sam 4STAR P3**: last cloud had 70ng/m³ of BC
 - [09:24am] **Sam 4STAR P3**: 'pretty significant' according to Art
- [09:26am] **jenny CCN**: the CCN from the residuals from those dirty clouds also smaller (about <0.5 um or so)
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