ORACLES P3 Flight Scientist Post-Flight Status

Date: **09/30/2018**

Flight number: **PRF02Y18**

Routine flight or target of opportunity?: **Target of Opportunity – Radiation wall flight. Focus on radiation walls over broken cloud decks of varying albedos and (nominally) relatively invariant aerosol.**

Flight scientist: **Sarah Doherty**

Ground scientist: **Sebastian Schmidt** Asst. Ground scientists: **Michael Diamond**

Take-off: **07:12:04**

Landing: **14:35:39**

Quick summary:

Do the models predict crossing a gradient in aerosol age?
Yes/No/Unclear (aerosol age plot not provided in forecast)

Did the flight cross a gradient in macroscopic cloud properties, like cloud fraction?
Yes/No/Unclear

Did the flight cross a gradient in aerosol loading?
Yes/No/Unclear

At any point during the flight, was there a clear separation between the smoke plume(s) and cloud tops?
Yes/No/Unclear

How many of the following maneuvers took place?

Ramps 1 (descent from ~4.5km to below-cloud)

Square spirals _____1_____

MBL legs 2 below-cloud

Cloud legs __3: 2 sawtooth + 1 level_

Above cloud legs _____1_____

Sawtooth legs 2 in clouds

Plume legs _____4_____

Above plume legs 2 in-transit; 1 overpass of study area

Instrument status:

Instrument	Comments
P3	**Power bank outage at 11:06UTC; repaired shortly after landing. Following instruments had no power after 11:06: HSRL, APR3, 4STAR, COMA, PDI.**
4STAR	Good ACAOD ranging 0.33 - 0.42. Power went out at around 11:16UTC
HiGEAR	Everything working great, except for ongoing sub-micron neph lamp outage. Very thin aerosol layer, didn't have to change PSAP filter once.
HiGEAR-AMS	**AMS had leak diluting the aerosol concentrations due to PTI before ~11:00. Before this, anything above ~3000ft is not accurate.**
PTI	Instrument had a leak due to faulty gasket. **No data this flight.**
HSRL-2	All good until power outage at 11:06
RSP	Operated well throughout, interesting data, good sun angle near focus area.
APR3	W band lost with power outage at 11:06UTC. Ku and Ka band good the whole flight.
Cloud probes	Everything worked great. HVPS was operational.
CCN	Instrument worked fine, but **affected by PTI leak before 11:00UTC**
PDI	Working fine until power out at 11:06UTC.
Vertical winds	All good.
WISPR/CVI	Instrument & CVI worked well. Lots of CVI and isotope measurements
COMA	Things went well until power issue at 11:06. Boot-up issues but did not affect data in-flight
SSFR	All good
CVI	Tip heater of CVI died at some point but wiggled and it came back to life
data	Litten not working. Everything else working well (including hygrometer)

PRF02 09/30 2018 Sunday Mission Report

flight scientist: Sarah Doherty (FS)
ground scientist: Sebastian Schmidt (GS), Michael Diamond (AGS)

Flight plan and objective:
Radiation flight down south along routine line. Module: High-altitude overpass of "wall" area; overshoot area of spiral by 3min for RSP; square spiral down to surface then up above cloud; cloud legs, in following order: above, below, in; then 3 in-situ aerosol legs. All nominally in the vicinity of ~50% cloud cover, with ACAOD>0.3.

Flight Summary:

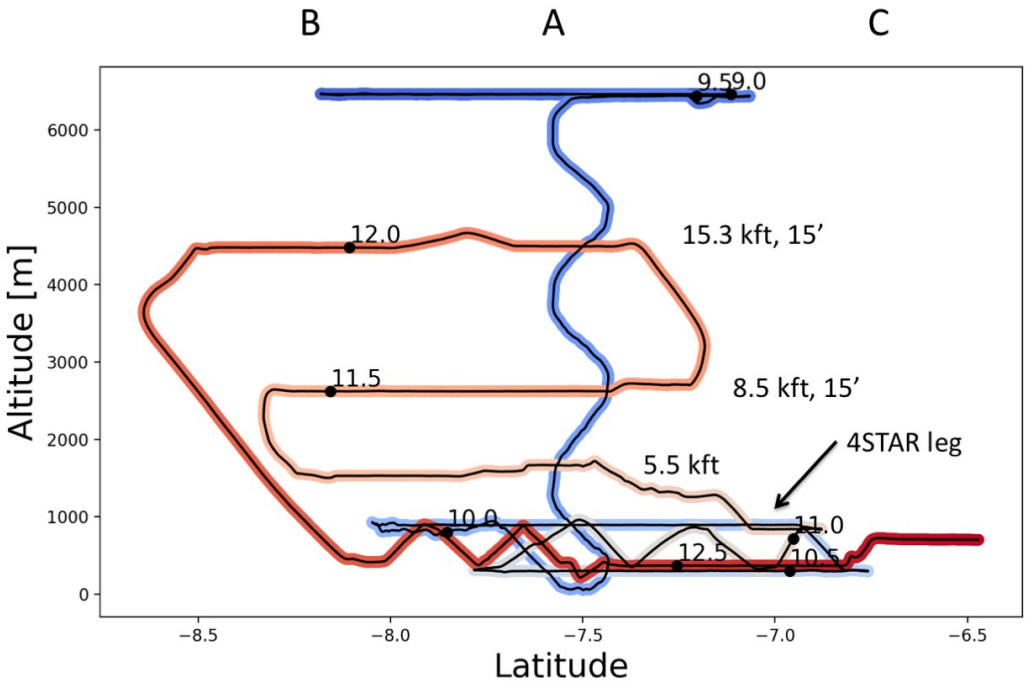
- Flight 7:12-14:35UTC
- High-altitude transit for HSRL
- Found somewhat broken clouds at ~7.5S.
- Radiation wall module components:
    - Spiral in somewhat heavier cloud field.
    - Ramped ascent south-bound to just above cloud.
    - Above, below, then sawtooth in-cloud 2-sawtooth leg. Chose sawtooth to capture variability in microphysics.

    {AMS, CCN compromised below 3000' altitude by PTI leak up until end of cloud legs}
    - 2 min above clouds for 4STAR AOD, then ramped ascent south-bound to start first, north-bound in-situ leg south of spiral.

    {11:06UTC, at start of ascent: Power bank failed affecting HSRL, APR3, 4STAR, COMA, PDI; no data from these instruments after this. Also forced a slightly early return and cancellation of final high-altitude leg over wall area.}
    - 3 ~15min in-situ legs ~1/3 to south of spiral, 2/3 to north of spiral.
    - AOD 0.42 at spiral location; 0.36 at south end of wall & 0.32 at north end of wall.
- At north end of last in-situ leg / north of "wall", descend to measure cloud/aerosol in transit on way home:
    - ~30sec below-cloud, then 2 sawtooths, below-cloud leg, in-cloud level leg w/ HiGEAR/AMS/CCN on CVI.
    - Ascend to aerosol layer but it petered out really quickly
- Transitioned east to hit CALIPSO overpass for RSP; got on their track ~8min after overpass
- {No PTI data this flight due to leak (gasket issue).}

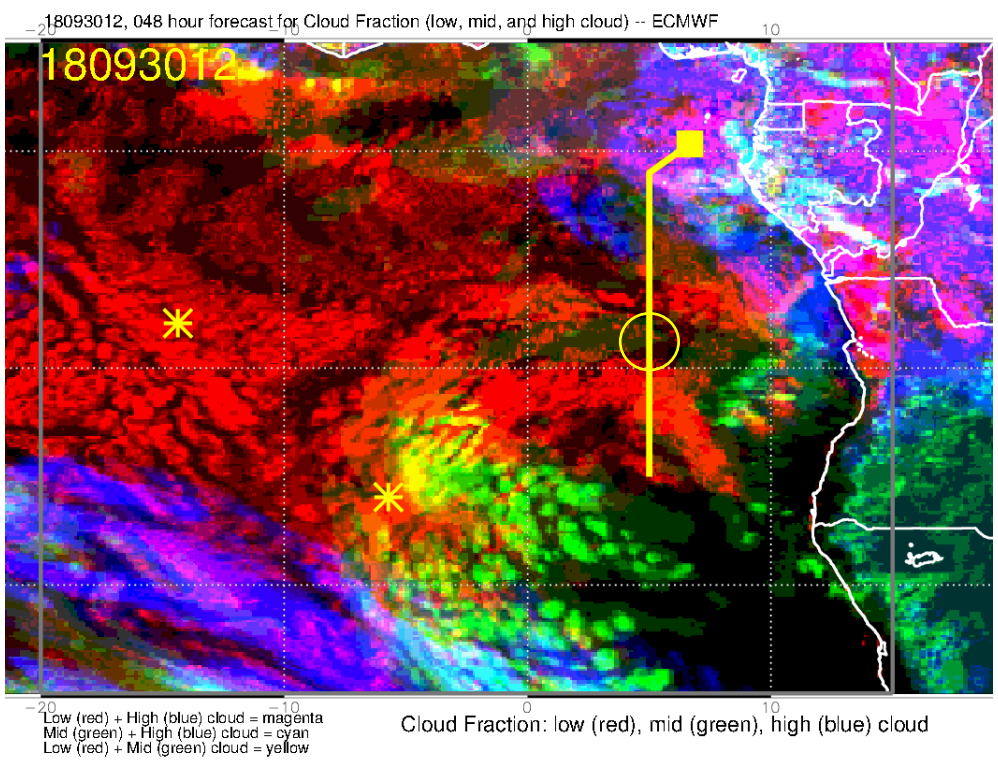
NOTE: Coordinated with MISR local mode. Did square spiral near 7.5S, well coordinated with MISR overpass, in an area of solid low cloud cover.

Radiation Wall module as flown (below), colored by time UTC



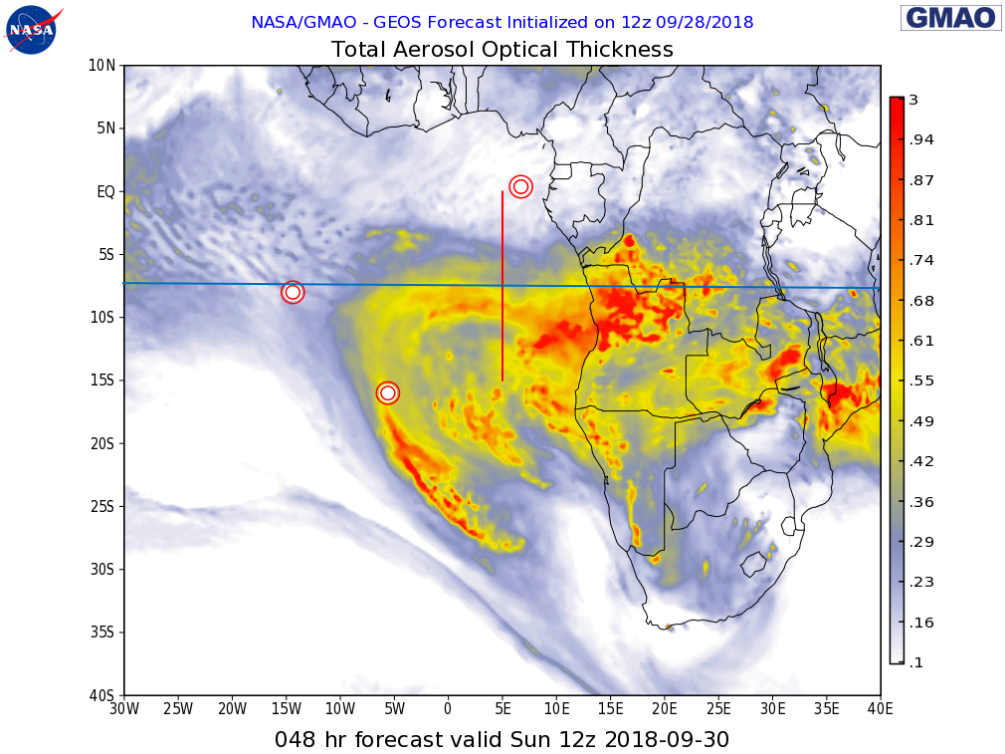
A-Priori Forecast:

Best chance for clear to partly cloudy sky with no middle or high clouds: 5E, 9S:

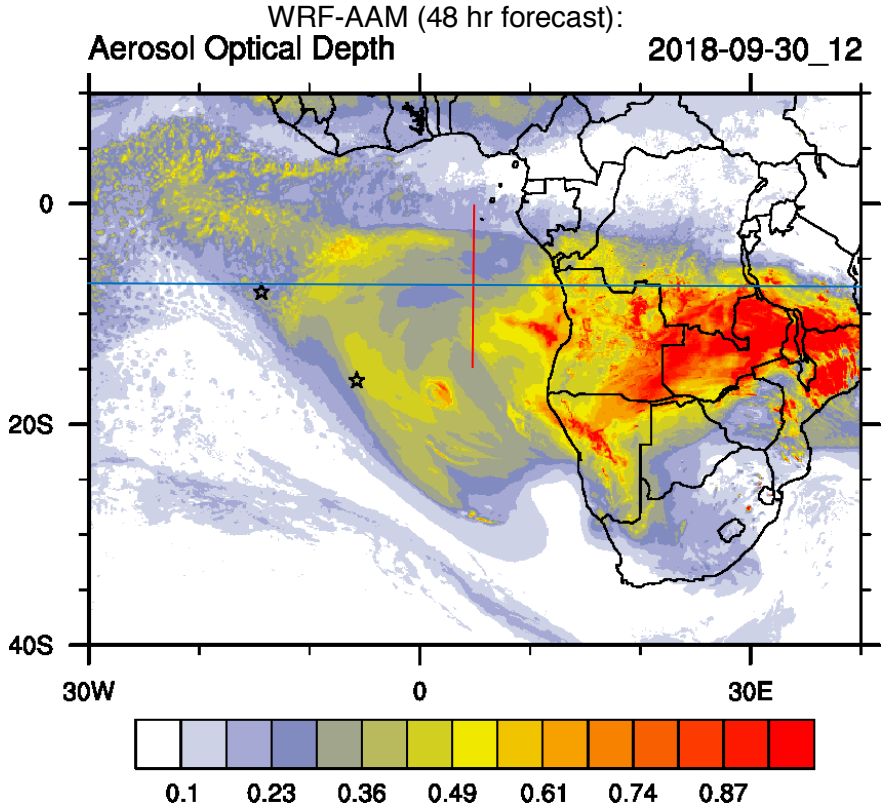


AOD forecast for 30 Sept 2018 12Z. (*7.5S line overlayed on all figures for reference)*

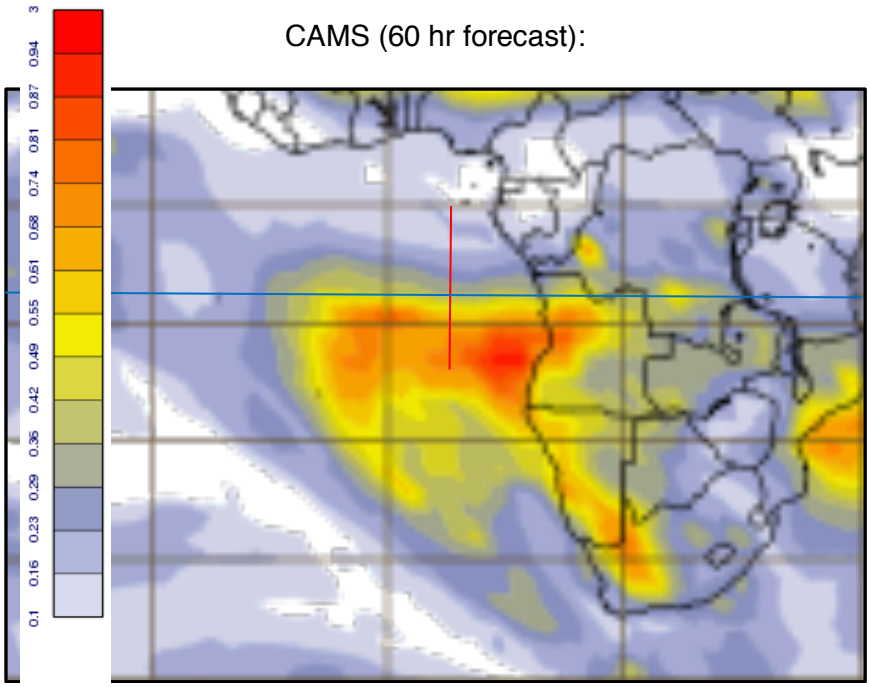
GEOS-5 (48 hr forecast):



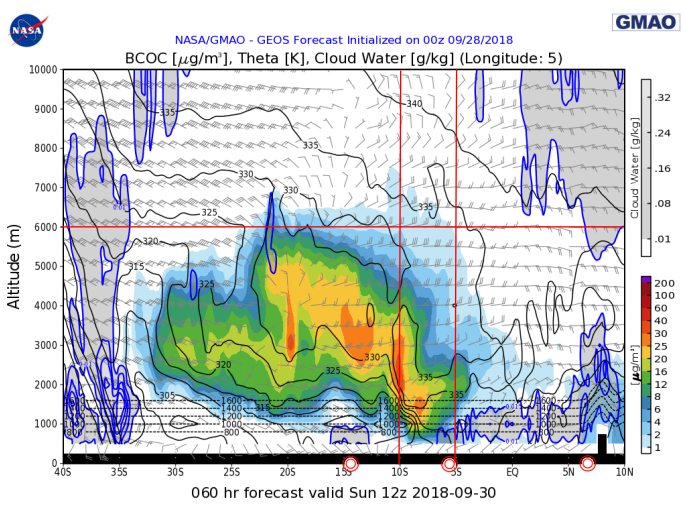
WRF-AAM (48 hr forecast):

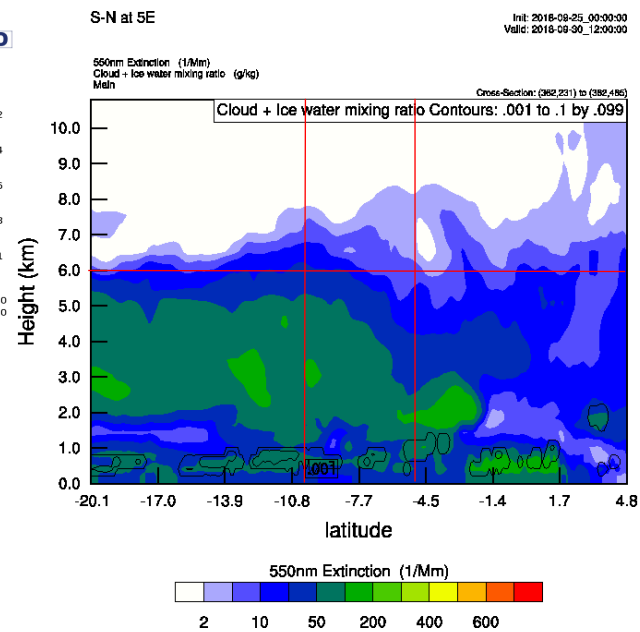


CAMS (60 hr forecast):



Vertical cross-sections along 5E: GEOS-5 (BC/OC mass; left) & WRF (extinction; right).
(*5S, 10S & 6km altitude lines overlaid on both for reference*)

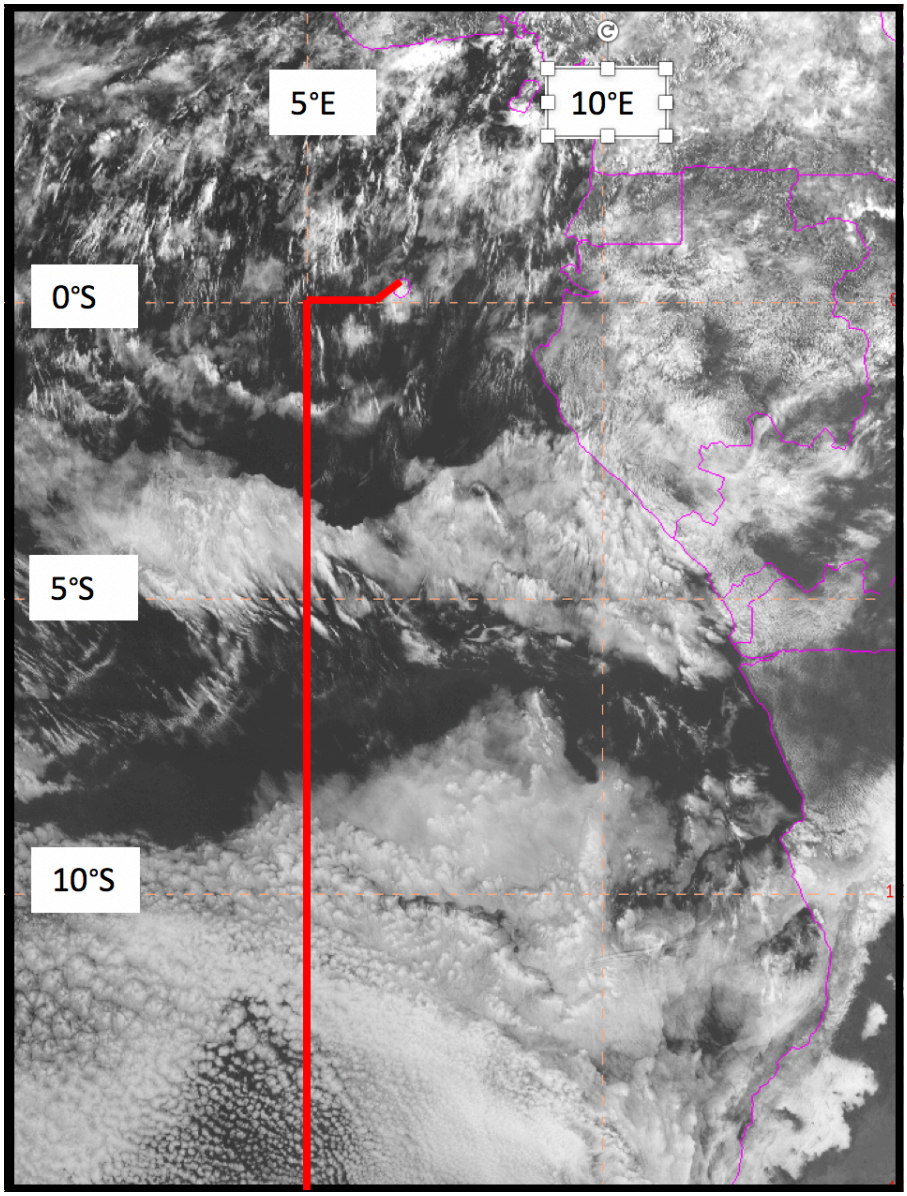




GEOS-5 has plume top somewhat lower in altitude than WRF.
Both have aerosol potentially in contact with clouds, though WRF shows a gap between plume bottom and cloud from ~7.5S to ~9.5S.

Forecast Verification:

CLOUDS:



Forecast had bank of clouds straddling Routine track (5E), running east-west centered on ~7S with partly-cloudy bands to the north and south of this, then more solid stratocu deck starting at 10S.
Verification: Overall pattern correct, but with a) east-west band of clouds was north of forecast location (~4S vs. 7S).
Consistent with other days, ECMWF over-forecast cirrus.
Did have mid-level clouds at take-off to ~0.4S and bits of mid-level cloud showed up at ~8S on the 5E line as shown (very faint yellow) in forecast plot.

AEROSOL:

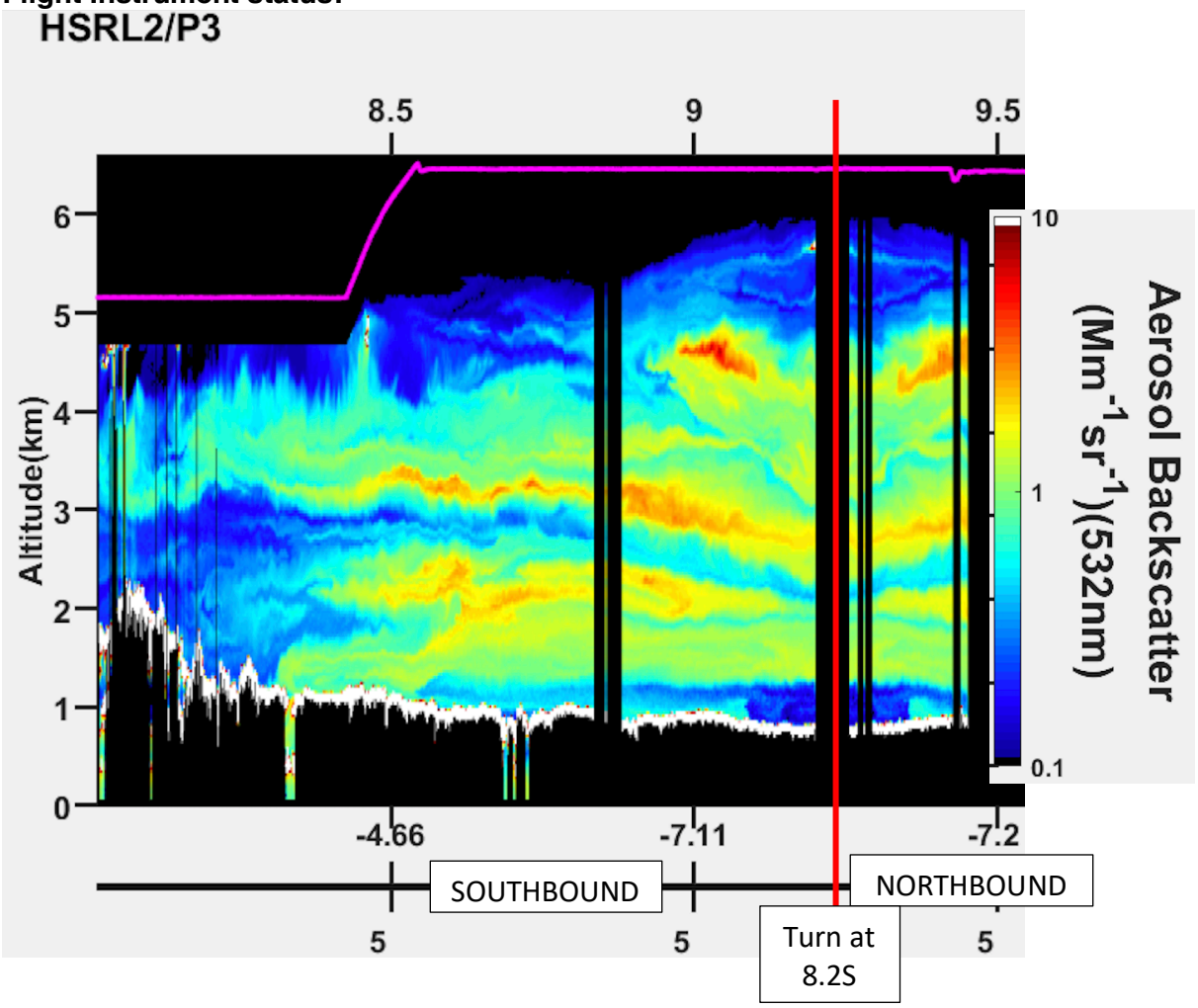
4STAR above-cloud AOD ~0.32, 0.42 & 0.36 at north, middle and south ends of radiation wall at 7.5S, 5E.
On forecast maps above, AOD in:
GEOS-5: ~0.5
WRF-AAM: ~0.3-0.35
CAMS: ~0.45

Aerosol plume north edge at 4.4S, somewhat south of where WRF put it.

Aerosol vertically more layered than in either model.

Plume top height slopes up from ~4.25km at 4.5S to ~5km at 8S in HSRL obs. The top of the plume is too low in GEOS-5, and has a stronger gradient in plume top altitude from 4.5S to 8S (~2km to ~4.75km) than observed. Plume top altitude approx. correct in WRF at south end, but WRF also has a stronger gradient in plume top height north to south (~2.75km to ~6km) than observed.

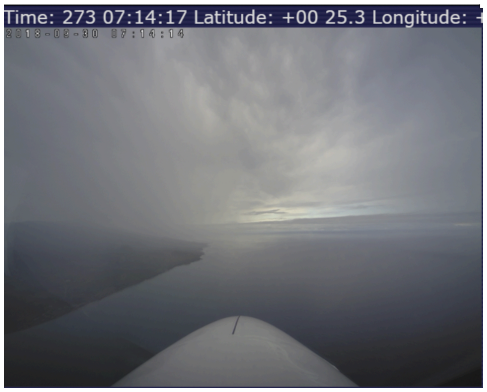
Flight Instrument status:



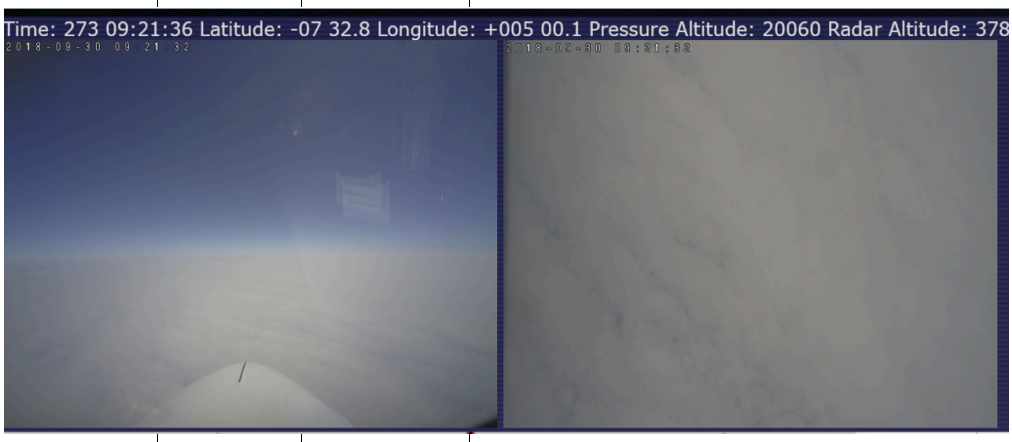
Flight Instrument/logistics notes:
11:00 (approx.) Leak in PTI discovered and PTI isolated; AMS and CCN data from here forward okay.
11:06 POWER OUTAGE on P3 power brick
11:06-11:16 4STAR, HSRL, APR, COMA, PDI all down for the rest of the flight because of P3 power bank issue. (some stayed up for a few minutes on UPS~)

Selection of cloud for sampling:
Based on getting a combination of partially-cloudy stratocumulus & ACAOD nominally >0.3.

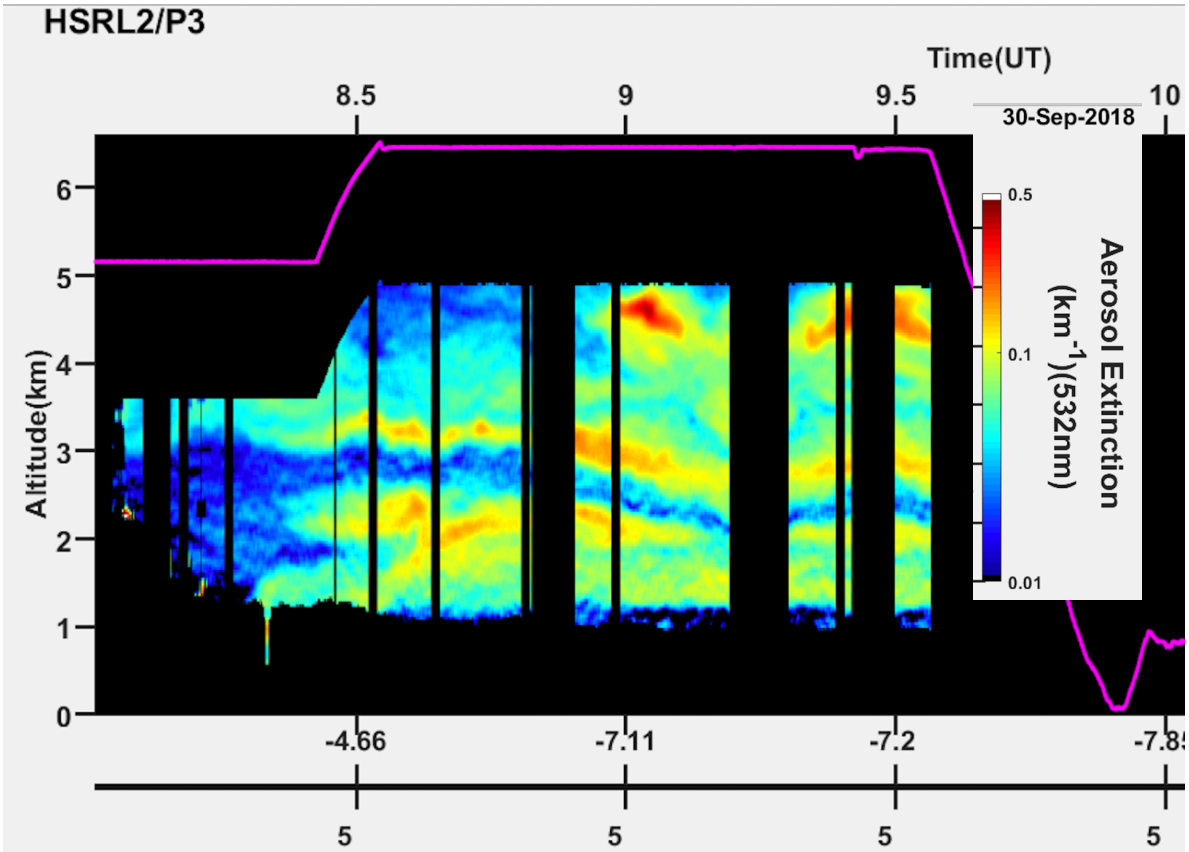
Run Table [UTC].

description	beginning time	end time	altitude	notes
Takeoff	07:12:04 UTC	X	To max alt	On taxi, raining big drops. Rain stopped right after take-off; showers spotty around the area 
	07:34	X	~6km	Transitioning out of higher density of mid-level clouds
	07:32		~6km	At EREGO
HIGH-ALTITUDE SOUTH-BOUND TRANSIT TO ~8S	07:50		~6km	had waypoint entry error on P3 so overshot 0S, 5E a bit
	07:51			APR says clouds have been drizzling with some patches of rain
	08:03			overflying fairly uniform mid-level cloud deck; tops about 250m below us (at 16,000'); APR reports decoupled BL cloud deck (below the mid-level cloud) that is raining (not drizzle; rain)
	08:14			skimming tops of cloud at 16k'; APR reports very active cloud deck below that. Not broken puffy Cu.
	08:16			mid-level clouds breaking up and lower level clouds a bit more broken but still active/drizzling

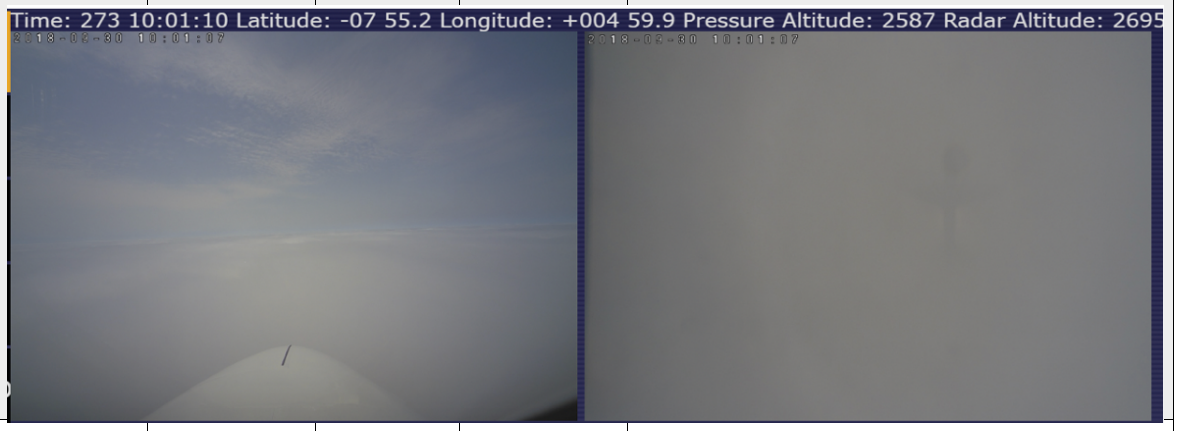
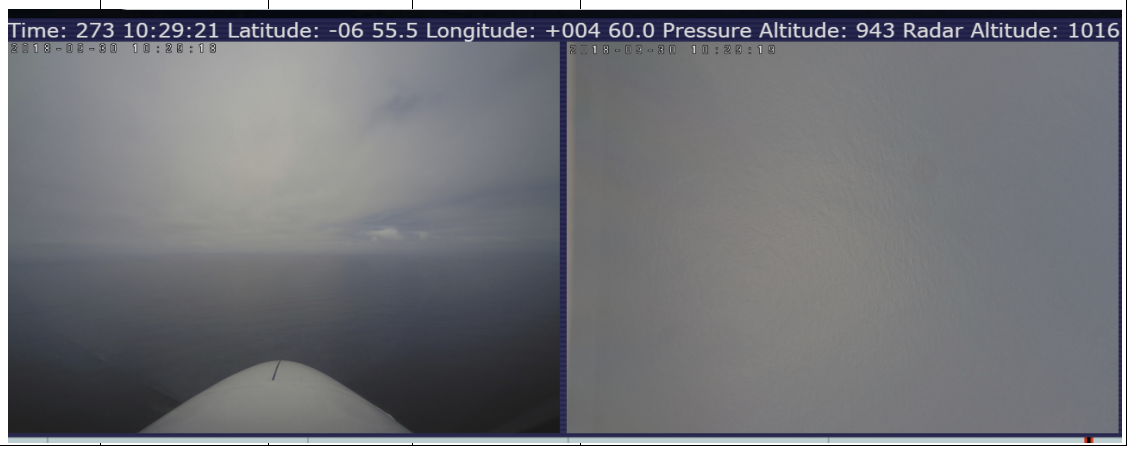
description	beginning time	end time	altitude	notes
	08:25			at ~4.2S started seeing aerosol layers on HSRL; one at 4-4.25km altitude; one at ~2.2km altitude; one at ~1.6km; gap between that and clouds
	08:26			4.4S Approaching fairly tall patch of midlevel cloud; climbing to get above it, nominally by 700' for APR; APR says low cloud deck below has become more broken; still active but less so. COMA reported significant decrease in water vapor; not clear if that was all due to higher altitude or if we entered lower RH region w/ transition away from heavier mid-level cloud layer.
	08:55			6.7S, low clouds becoming less active (less drizzle)
	09:01			Still no cirrus, HSRL AOD is high below.
	09:07			Just past 7.5S Start seeing mid-level clouds ahead and to left (to SW) and, later to the right (E/SE)
	09:12			At 8.18S turn back north, slightly more north because of mid level clouds. Pretty solid low cloud deck below at this point:

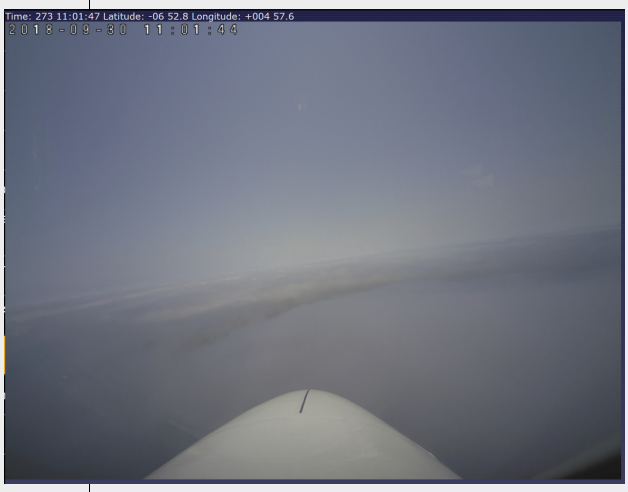
description	beginning time	end time	altitude	notes
HIGH-ALTITUDE NORTH-BOUND TRANSIT 8.18S TO 7.5S	9:23	9:26	~6km	At 7.5S 9:23; overshoot location of square spiral by ~3min for RSP
				
TRANSIT 8.18S to 7.5S	09:26	09:34	~6km	Back to square spiral location

HSRL curtain from take-off to bottom of square spiral



description	beginning time	end time	altitude	notes
SQUARE SPIRAL DESCENT	09:34	09:54	~6km-200m	*NOTE: PTI, AMS and CCN affected by leak in PTI; data during spiral down not valid above ~3,000'* At 7.5S, START square spiral • 14,400' press alt had a peak in scattering, BC (~750ng/m3) -- but thin layer that came and went; and Whisper is reporting high humidity, with signature of moist adiabatic processing • 10,200' decrease in aerosol concentration. Whisper reporting still very humid. Seeing lots of CO, BC and scattering in the elevated layer. • ~7500' pressure altitude/2.4km: very thin layer of very high aerosol counts (1.5 ug/m^3 of BC) • Below 3600' press alt/1.1km air cleaned out; winds dropped; had slight turbulence as descended down to that; so clean, low-wind slot *above* cloud • cloud top: ~2500' pressure altitude/800m • cloud bottom: ~1100' press alt/350m lots of drizzle END square spiral at 200' above surface
Ramped ascent south-bound to above-cloud	09:55:30	10:00		At 1800'press alt/580m altitude hit cloud base
ABOVE-CLOUD LEG	10:00	10:22	900m	Northbound heading • Sat image being viewed on ground indicates more broken cloud to south, so trying to nudge cloud legs south. • Saw mid-level clouds in SSFR and 4STAR signals so nix'd heading further south

description	beginning time	end time	altitude	notes
				• small increase in aerosol /AOD as we go north
				
Turn	10:03			At 8.05S; TURN south-bound to NORTH-BOUND to continue above-cloud leg
	10:06			Out of mid-level cloud signal on 4STAR
	10:22			END north-bound above-cloud leg at 6.9S
Ramped north-bound descent to ~920m press alt/300m	10:22	10:25	900m -> 300m	Turn to south-bound
BELOW-CLOUD LEG	10:26	10:43	300m	Leg from ~6.7S to 7.7S • Clouds drizzling lightly; spotty virga; less drizzle to south than to north • Very hazy below clouds – drizzle?
				

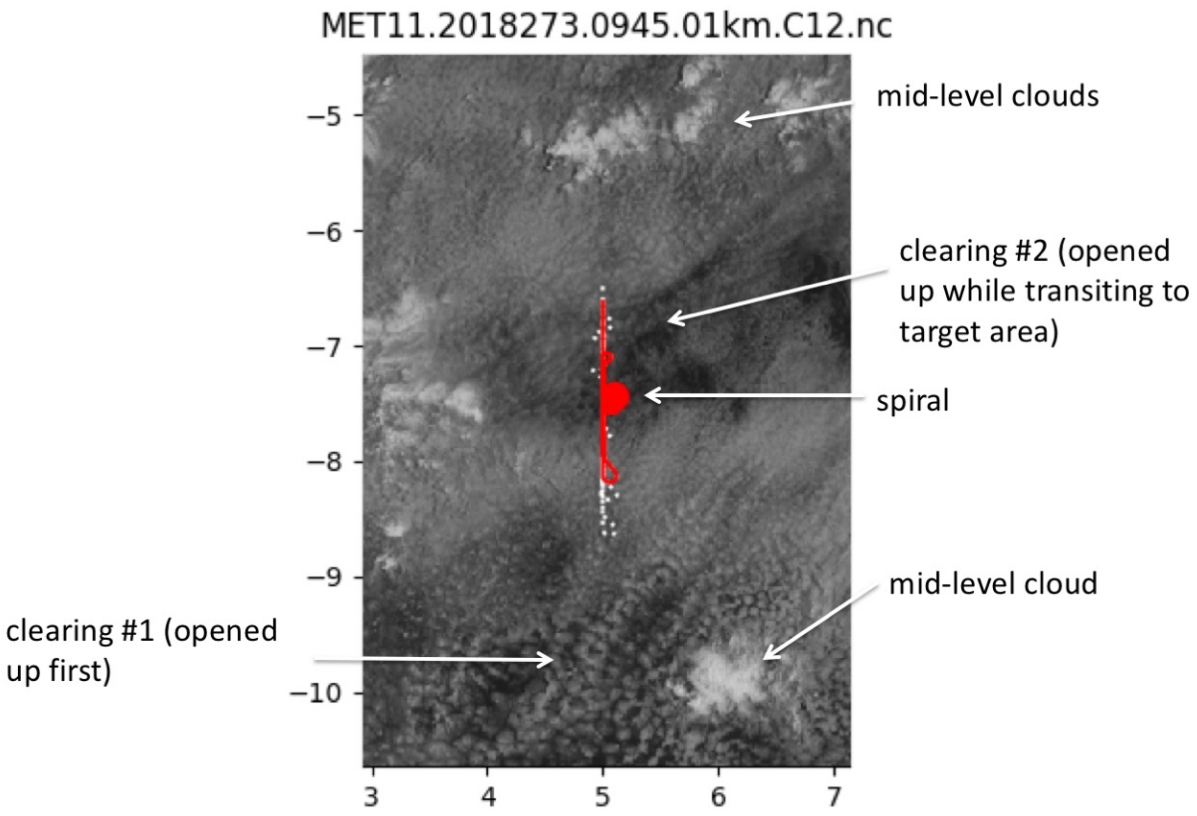
description	beginning time	end time	altitude	notes
Turn	10:44	10:46		South-bound to north-bound; ascent on turn to get from below-cloud to in-cloud
IN-CLOUD SAW-TOOTH LEG	10:46	10:58	300-900m	Two sawtooths cloud bottom to top End with 30sec level below-cloud run
Turn & ascend	10:58	11:02	300-840m	Ascend through cloud north-bound; turn to south-bound to ascent for in-situ aerosol legs 
	11:00 (approx.)			**Leak in PTI discovered and PTI isolated; AMS and CCN data from here forward okay.**
4STAR ABOVE-CLOUD LEG	11:03	11:06	840m	South-bound AOD ~0.32, 0.42, 0.36 at north, middle and south ends of wall
	11:06			**POWER OUTAGE on P3 power brick → 11:06-11:16 4STAR, HSRL, APR, COMA, PDI all down for the rest of the flight because of P3 power bank issue. (some stayed up for a few minutes on UPS~)**
Ascent	11:05	11:07	840m to 1.2-1.3km	Ascend south-bound to aerosol layer
IN-SITU AEROSOL LEG #1	11:07	11:22	~4000'pres alt/1.2-1.3km	South-bound: 7.2S – 8.1S • had a hard time getting into aerosol layer;

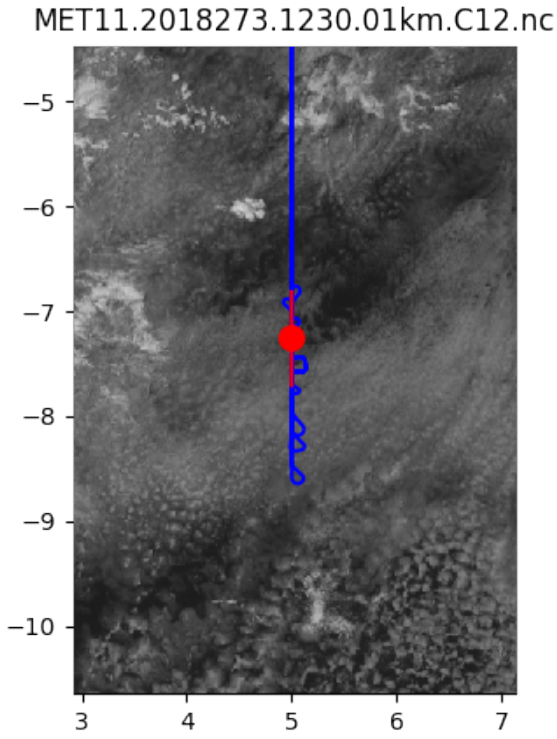
description	beginning time	end time	altitude	notes
				• did slow ascent from 4000GPS altitude to about 5400'/1.7km altitude • not finding high concentrations; descend back down in increments to ~4800'press alt/1.5km based on peak in BC and stayed there ~11:18-11:22.
Turn & ascend	11:22	11:28		north-bound for ~8,200' press alt aerosol leg
IN-SITU AEROSOL LEG #2	11:28	11:45	8200'-8500' press alt/2.6km	North-bound: 8.3S – 7.2S • again not finding very high aerosol concentrations~ • start at 8200'; 11:41:30 bump up altitude to ~8,500' press alt/2.7km
Turn and ascend	11:45	11:50	8500'-14,000'/2.6 km-4.5km	
IN-SITU AEROSOL LEG #3	11:50	12:05	~14,000'-press alt/4.5km	South-bound: 7.4S – 8.5S During our spiral we hit a high-scattering layer at 13,300'/4.3km-12,700'/4.0km that we didn't see on ascent… There was a lot of horizontal variability in AOD so may be what we're hitting here just wasn't there to the north.
→ Skipping planned high-altitude overpass of "wall" area since HSRL is down with the power outage. → Instead will do another in-cloud leg and another below-cloud leg in "wall" area, then an in-situ leg, then try to catch CALIPSO overpass at altitude for RSP				
BELOW-CLOUD LEG	12:17		~425m	~30 sec level below cloud at ~8.1S
SAW-TOOTHS through cloud	12:18:30	12:26	400-900m	North-bound: 8.0S – 7.5S
BELOW-CLOUD	12:26	12:38	~370m	North-bound: 8.0S – 7.52S Start of below-cloud leg is the location where we did the spiral down.

description	beginning time	end time	altitude	notes
				• dipped down to min altitude briefly for pilot training, then back up to just below cloud • hazy down here; RH ~90%
IN-CLOUD	12:38	12:48	710m	North-bound: 6.7S – ~6.0S • HiGEAR on CVI
Ascent	12:48	12:54		While in-transit north-bound 12:50: HiGEAR off CVI at 5.8S
IN-SITU AEROSOL LEG	12:54	12:58	~6,400' press alt/2km	Started in a layer of 100/Mm^{-1} green scattering -- lots of BC as well. 12:58 scattering was dropping off so went down in stages but it never came back; approaching 5S so probably flying out edge of it.
Ascent to high altitude	12:58	13:14		starting ascent while heading north-bound • aerosol really dropped off as we went north. Of course now it's going up as we ascend - ! Peak at ~7200'GPS
Direct heading for CALIPSO overpass	13:14	13:31	5,800m	Transit diagonally to NW from 5E Routine track line to CALIPSO overpass line to our NE
ON CALIPSO TRACK	13:31	X	5,800m	On the CALIPSO line at 3S6.0', 6E 2.4' ~8min after 13:23 overpass…
Return to 5E line	13:43:50	X	5,800m	Turning off CALIPSO track to head for 0S,5E. Headed northwest for 5E line; hit 5E at 1+S then headed straight for EREGO so ended up with a zig-zag. Not sure why.
	14:06	X		Descending through clouds with ice crystals; broke out bottom at 14:07, 15,056' press alt, just south of EREGO. Few raindrops as we headed E/NE from EREGO. Multi-layer clouds…lots of cloud around STM
LANDING	14:35:40	X		

visual notes:

Flight track superimposed on cloud fields from hi-res satellite imagery:

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