ORACLES P3 Flight Scientist Post-Flight Status

Date: **08/31/2017**

Flight number: **PRF12Y17**

Routine flight or target of opportunity?: **Target of Opportunity – Resample plume sampled yesterday at 3.5km and 3.2km between 4S and 10S along 5E (Routine Track).**

Flight scientist: **Sarah Doherty**

Asst. Flight scientist: **Jens Redemann**

Ground scientists: **Paquita Zuidema & Meloë Kacenelenbogen**

Take-off: 08:00 UTC

Landing: 15:52 UTC

Quick summary:

Representative ACAOD or ACAOD range for flight:
Unclear. 4STAR appears to have had a window contamination problem that accumulated during the flight, and was likely responsible for ~0.2 of AOD by end of the flight. Regardless, AOD was likely 0.5-0.7 for much of the flight.

Do the models predict crossing a gradient in aerosol age?
Yes/**No**/Unclear

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** Flight was concentrated on in-plume sampling, and HSRL was not functioning on this flight so no curtains available.

How many of the following maneuvers took place?

Ramps take-off & landing only

Square spirals 1 @09:22-09:45UTC

MBL legs none

Cloud legs 13:20-13:25 for ATrain overpass (+ 500'/min during spiral descent/ascent)

Above cloud legs 13:14-13:18: ATrain overpass

Sawtooth legs none

Plume legs 10:09-11:59 2.8-3.2km alt. south-bound; 12:07-13:05 2.6-3.1km altitude north-bound; 13:30-13:50, 13:55-14:05 & 14:11-14:41 stacked legs at 2.7km, 2.9km & 3.0km altitude

Above plume legs ferry leg 08:23-09:22

Instrument status:

Instrument	Comments
P3	All good.
4STAR	Functioned well. Again had an apparent issue with window contamination after much time in the aerosol plume. At end of flight went up to 14k' and still had mid-vis AOD=0.2.
HiGEAR	Lots of good data! Brief issue with the PSAP but quickly solved and only lost a few minutes' data.
HiGEAR-AMS	Clogged critical orifice identified shortly after takeoff. Solved on the transit to the start of the Lagrangian plume points. All great after that.
HSRL-2	Broken chiller so did not operate on this flight.
RSP	Instrument all good. (Not a lot of optimal conditions (no cirrus; above plume) on this flight.)
APR3	All well after initial Ku, Ka band issues seen previously.
Cloud probes	All good. 7min of great data on our cloud leg!
CCN	All seemed good.
PDI	All seemed good.
Vertical winds	All seemed good.
WISPR/CVI	All good. Cloud top run super useful for entrainment study!
COMA	All good.
SSFR	All good.
data	All good.

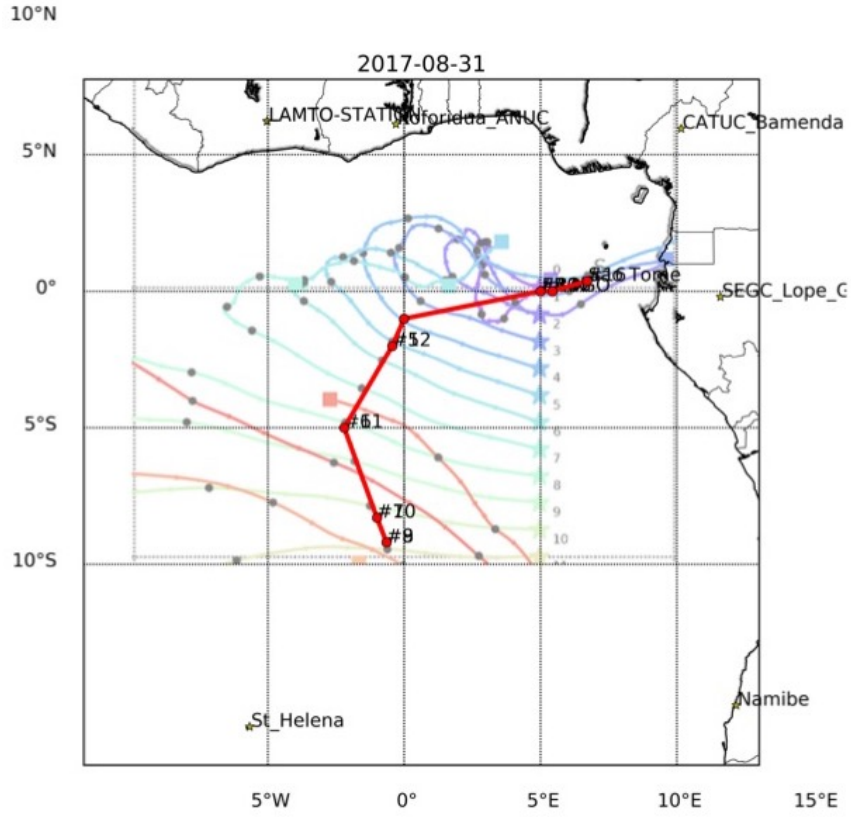
PRF09 08/31 2017 Friday **Mission Report**

flight scientist: Jens Redemann (FS)
assistant flight scientist: Sarah Doherty (AFS)
ground scientist: Paquita Zuidema (GS)
assistant ground scientist: Meloë Kacenelenbogen (AGS)

Flight plan and objective:

The goal today was to resample plume sampled yesterday at 3.5km and 3.2km between 4S and 10S along 5E (Routine Track). HISPLIT forward trajectories were used to determine the latitude, longitude and altitude of these same airmasses on 31 August.
HSRL was not working (cooler problem) so decided against a high-altitude survey leg, and instead focus was on in-situ sampling.

On Aug 30 the P3 sampled the plume south-bound along 5E between 4S and 10S (stars marked 5-11 on map below) at 3.5km altitude. On its return (northbound) leg on 5E the plume was sampled at 3.0km altitude between 7S and 3S (stars marked 8 to 4 on map below). HISPLIT forward trajectories (colored lines below; each black dot corresponds to 24hrs transport) were used to set the flight track for the resampling on today's flight.
The plume sampled at 3.5km altitude 5E, 4-10S on 30 Aug were projected to be at between 2.9km (at the north end) to 3.1km (at the south end) today. The plume sampled at 3.0km altitude 3-7S on 30 Aug were projected to be at 2.3-2.4km altitude (at the north end) to 2.6km altitude (at the south end). We planned to sample them at the higher altitudes on our south-bound leg and at lower altitudes on the north-bound leg.



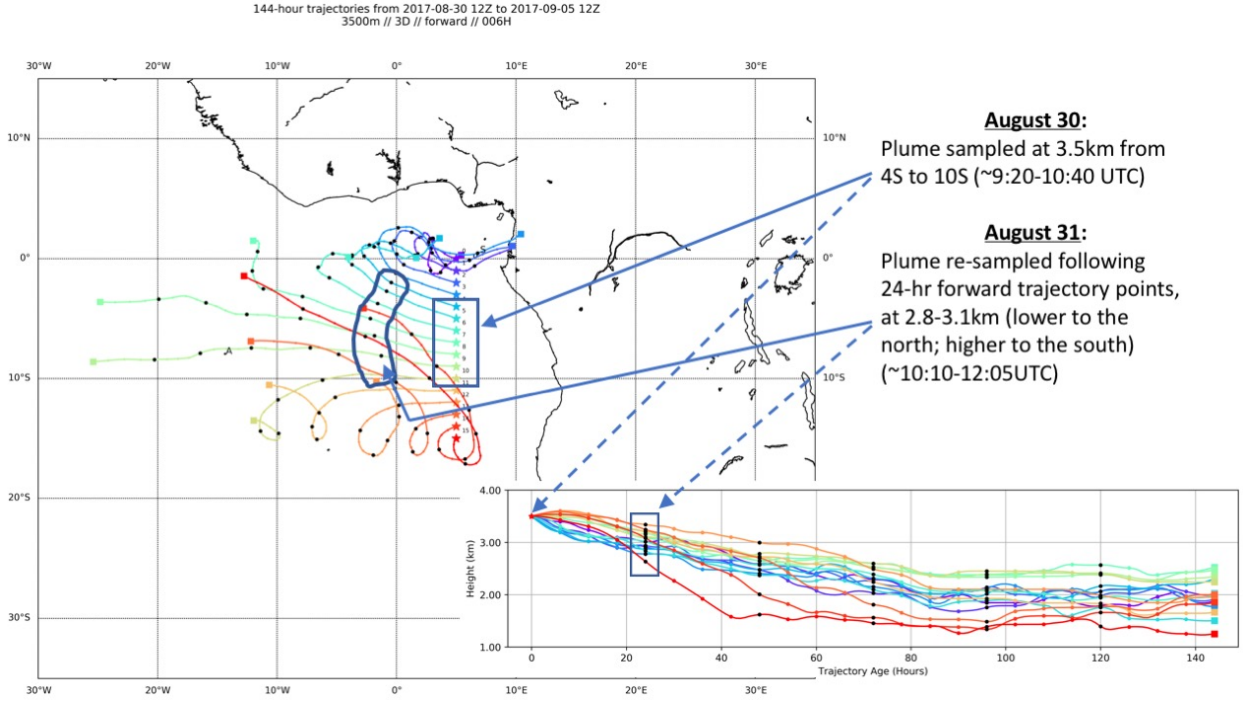
August 31, 2017

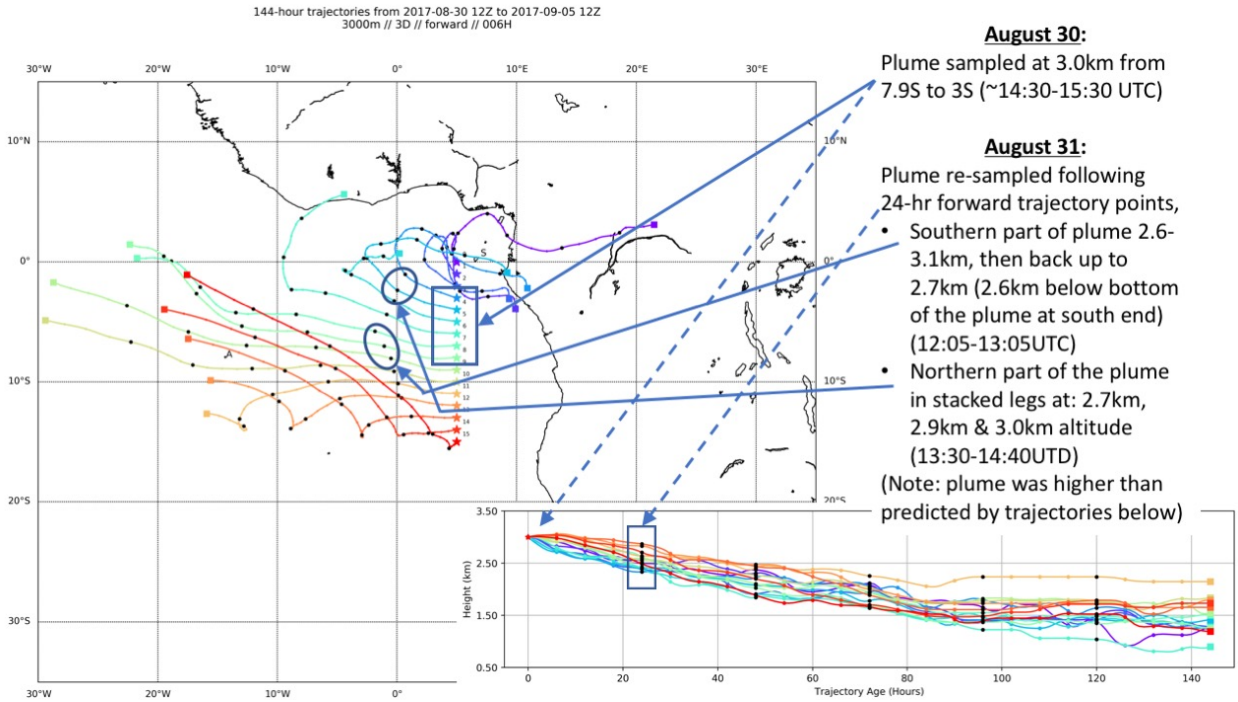
P3 Flight Track over-layed on forward trajectories

Flight Summary:

On Aug 30 the P3 sampled the plume on its south-bound leg along 5E between 4S and 10S at 3.5km altitude. Today, we resampled this plume approx. 25 hours later, also headed south-bound, between 2.8 and 3.1km altitude.

On Aug 30 the P3 then sampled the plume on its north-bound along 5E between 8S and 3S at 3.0km altitude. Today we resampled this plume approx. 25.5 hours later, also headed north-bound, between 2.7 and 3.1km altitude. While the plume was projected to be lower than this, we found that at 2.6km we had dropped out of the bottom of the plume. In the middle of this north-bound leg we descended to just above cloud, then in-cloud, in order to get remote sensing measurements and cloud measurements in coordination with the A-Train overpass. At the northern end of the in-situ plume leg (corresponding to airmasses sampled at 3-5S on 30 Aug) we did a series of stacked legs at 2.7km, 2.9km and 3.0km to check for vertical variations in aerosol properties.



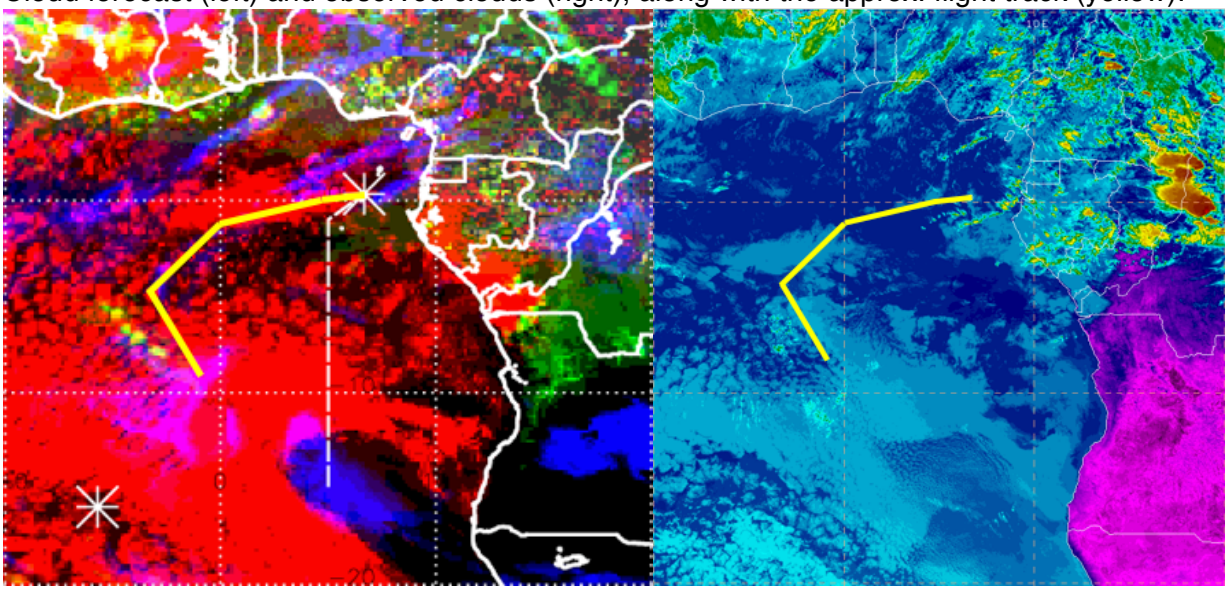


A-Priori Forecast & Forecast Verification::

Cloud forecast:

Cloud forecast was not critical to this flight, since the goal was to focus on in-situ, in-plume sampling.

Cloud forecast (left) and observed clouds (right), along with the approx. flight track (yellow):

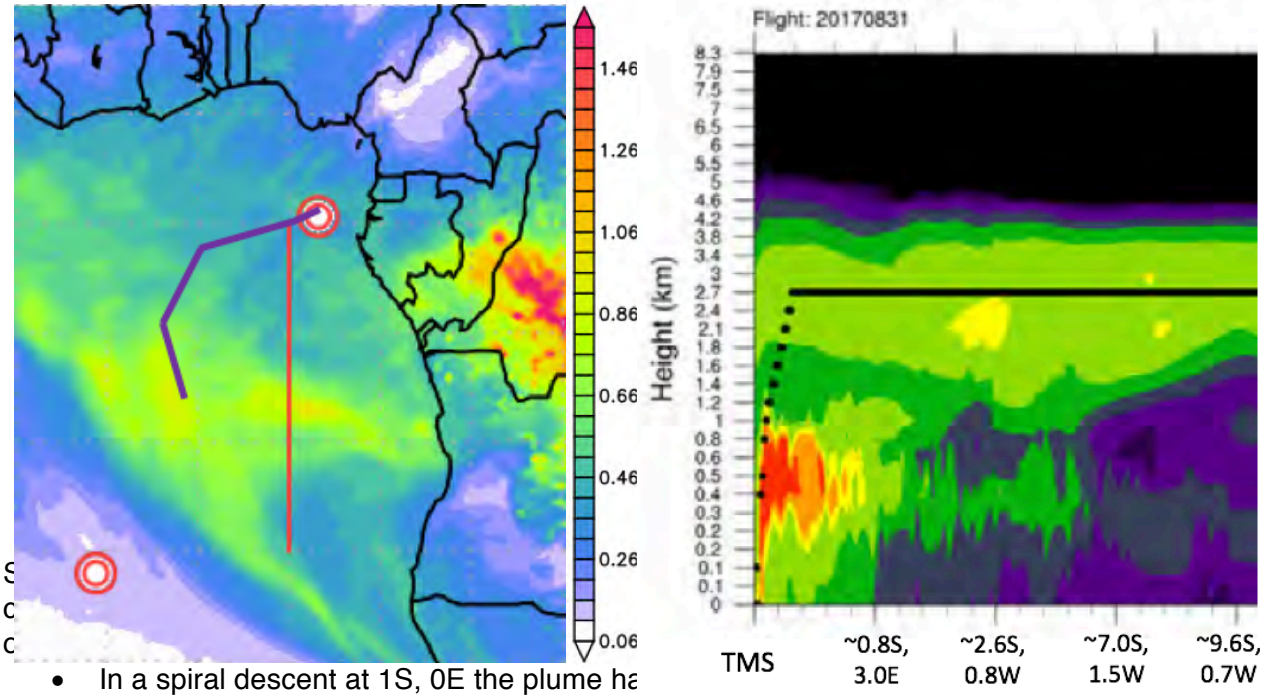


24-hour forecast for clouds (red=low; yellow/green=mid; pink/blue=high), for 12:00UTC 08/31

Satellite image colored for cloud top temperature from 12:00UTC 08/31. (blue=warm/low cloud; red=cold/high cloud)

Aerosol Forecast:

GEOS-5 Forecast AOD, initialized 18UTC on 2017-08-03 (left) and forecast aerosol altitude along the planned flight track (right). The left panel shows the approximate planned flight track (lat/lon) and the right panel the approximate location (lat/lon) where the curtain applies.



- In a spiral descent at 1S, 0E the plume ha
  - 3.6-3.9km
  - 3.0-3.6km → highest conc. (~140Mm^{-1})
  - 2.7-3.0km → about same conc. as 3.6-3.9km layer
    → The model curtain above has approx. the correct altitude for the top of the plume, but it extends the plume to much lower altitudes than was observed.
- The bottom of the plume was at higher altitude to the south than to the north. At 2.6-2.7km we were in the plume at the north end of the dog-leg track that runs north-south west of 0E; as we moved south along this track, we dropped out of the bottom of the plume. This general tendency is shown in the model forecast curtain, but it had the bottom of the plume at much lower altitude than was observed.
- Observed above-cloud AOD was (we think; see notes above about 4STAR window contamination) ~0.5-0.7, which is largely consistent with the range of total-column AOD forecast along the flight track (south of 1S, 0E) of ~0.5-0.9.

Flight Instrument status:

No major issues except for lack of HSRL on entire flight.

Flight Instrument/logistics notes:

HSRL would have been useful for determining actual aerosol altitudes along north-south extent of flight plan, given that it deviated from the forecasts.

Selection of cloud for sampling:

Only cloud sampling was selected for coordination with A-Train overpass.

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 	08:00 UTC	X	To max alt	On ascent passed through a layer of scattering ~190Mm^{-1} SP2 counts had 3 peaks of ~145, 265 and 810 /cc Two layers of clouds (low and relatively high, >20k') during climb-out (picture to left)
Ferry leg 	08:23	09:22:44	5.2km	TMS → EREGO → 0S, 5E → 1S, 0E At 5.4km AOD 0.03; scattered cirrus At 08:32 we were clear of cirrus 08:37UTC: APR & RSP report likely polluted cloud below with narrow droplet size distribution 08:47UTC patchy low clouds, few cirrus streamers and apparent two-layer aerosol system (visual; pic to left)
Spiral descent	09:22:44	09:45	5.2km to surface	At 1S, 0E Spiral turn to the **right**. All other spirals have been turn to the **left**. On the edge of a cloud bank; small broken clouds below. Small peak in scattering of ~50Mm^{-1} 4.2-4.4km. Then three layers:

description	beginning time	end time	altitude	notes
				• 3.6-3.9km • 3.0-3.6km → highest conc. (~140Mm^{-1}) • 2.7-3.0km → about same conc. as 3.6-3.9km layer → Selected levels of ~3.0-3.4km and ~2.9km for targeting in-situ sampling look good. In clouds at 2.1km on descent. 09:44-09:52 Did full circle at surface. 4STAR AOD 0.47 Two cloud layers (pic to left)
Spiral ascent	09:52	10:08:45	Surf to 2.8km	Ascended at 500'/min until above cloud; then at 1000'/min. Two cloud layers; lower layer bottom at ~0.4km; top of clouds at ~1.1km.
Plume leg	10:08:45	10:22	2.8km	Start at 1S, 0E; to 2S, 0.44W Green scattering 120Mm^{-1} slowly increased to 150Mm^{-1} CO ~275ppb
Plume leg	10:22	11:07	2.8km to 2.9km	2S, 0.44W to 5S, 1.1W pretty solid cloud deck below Scattering varied ~100-150Mm^{-1} then held steady at 150Mm^{-1} SP2 ~2.3 ug/m^3 10:50 UTC started creeping up from 2.8km to 2.9km As ascended, scattering creeped up from ~150Mm^{-1} to ~190Mm^{-1} AOD above ~0.7 11:04 seeing cloud signal in 4STAR and can see mid-level puffs streaming by out front window. At end of leg, scattering ~200Mm^{-1}

description	beginning time	end time	altitude	notes
Plume leg	11:07	11:59	2.9 to 3.1 to 3.2 km	Turn from SW-bound to SE bound at 5S, 2.2W; heading for 8.3S, 1W then 5min past that. 11:12 UTC ascend 2.9 to 3.0km? Scattering increased to 250Mm^{-1} then to 275Mm^{-1}, then 300Mm^{-1} Simone reporting drizzle or rain below. AOD went from 0.85-0.92 (!) Not clear this is real – may be window contamination 11:30 UTC ascend to 3.1km 11:33 UTC: AMS reporting possibly highest organics concentrations of the campaign, yet scattering is not appreciably higher; CO is lower. SOA formation? 11:42 UTC ascend to 3.2km Scattering back down to 250Mm-1 So peak in plume seemed to be at 3.0km 11:53 UTC cross 8.3S, 1W; precip from clouds below
Turn and descend	11:59	12:04	3.2 to 2.6km	Start turn & descent at 8.3S, 0.83W Dropped out of bottom of main plume; scattering dropped to ~50Mm^{-1}

description	beginning time	end time	altitude	notes
Plume leg	12:04	12:52	2.6 to 3.1km	~8.5S, 0.9W to 5S, 2.2W 12:10UTC ascend from 2.6km to 9.2k' to get back in bottom of plume. Yesterday we sampled the 3.2km level between 4S and 7S; so at south end of this leg we're not resampling anything from yesterday. And it was noted that the plume was at higher altitude south than north. So, ascended to catch bottom of plume until 5S; then descend back to 2.6km press alt to see if plume is there. AOD along this leg ~0.75-0.8 Toward end of leg, the scattering dropped a bit and AOD creeped up to 0.86. Scattering peak of almost 300 Mm^{-1} SP2 counts >1100/cc
Plume leg	12:52	13:05	3.1km to 2.7km to 2.6km to 2.7km	At 5S, 2.2W turn slightly from NW heading to NE heading and descend from 9.2k' to 8.2k'. Plume here is lower in altitude and higher AOD than further south AOD >0.9-1.0 Scattering appeared to be highest at 2.7km, ~200 Mm^{-1}; SP2 counts ~1000/cc
Descent	13:05	13:13	To 1.5km	Descent to just above cloud-top for A-Train overpass legs
A-Train overpass above-cloud leg	13:13	13:18	1.5km	Started off above cloud but cloud went away… then returned Above-cloud AOD 0.8
Slight descent	13:18	13:20	~1.5km	Drop into cloud
A-Train overpass in-cloud leg	13:20	13:25	1.5km	In-cloud leg Very thin cloud. Uniform LWP and CDNC

description	beginning time	end time	altitude	notes
Ascent back to plume	13:25	13:30	1.5km to 2.7km	
Plume	13:30	13:50	2.7km	Scattering not as high: ~100-130 Mm^{-1} SP2 counts ~720/cc 4STAR AOD ~0.6
Turn and ascend	13:50	13:55	2.7km to 2.9km	At 1S,0.1E turn and ascend Doing a bit of vertical exploring in case models got plume altitude off in trajectory; so will have 3 stacked legs at 8k', 8.5k', 9.0k' between ~1S and 2S.
Plume leg	13:55	14:05	2.9km	SW-bound 1S, 0.1E to 2S,0.3E SP2 ~675/cc Scattering ~125 Mm^{-1} AOD ~0.45 above us
Turn and ascend	14:05	14:11	2.9 to 3.0km	At 2S, 0.3E turn and ascend
Plume leg	14:11	14:41	3.0km	AOD ~0.46 Scattering about the same on this leg as on the 2.9km leg 14:24 At 1S, 0E – turn towards 0S, 5E & continue at 9.0k'
Ascend	14:41	14:58	To 6.0km in steps	~1.1S, 1.7E start ascent to get out of haze layer for 4STAR to check for "zero". Concerned their window is dirty again. 14:55-14:58 at 6.0km AOD bottomed out at ~0.2
Descent	14:58	15:28	To 3.0km	~0.5S, 2.5E started descent; slow descent w/ some level legs in between; Hit low conc. aerosol layer at ~4km then more significant layer at 3.7km. Scattering back up to 150-200Mm-1 at 3.3km Ended descent at 0S, 5E.

description	beginning time	end time	altitude	notes
Plume leg	15:28	15:33	3.0km	0S, 5E to EREGO scattering holding at ~170Mm^{-1}
Approach TMS in plume	15:33		3.0km	Scattering still holding at 170Mm^{-1}
Landed	15:52	X		