ORACLES P3 Flight Scientist Post-Flight Status

Date: **08/26/2017**

Flight number: **PRF09Y17**

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: **Jens Redemann**

Ground scientist: **Sarah Doherty** Asst. Ground scientists: **Jianhao Zhang**

Take-off: 07:59:57 UTC

Landing: 17:27:49 UTC

Quick summary:

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

How many of the following maneuvers took place?

Ramps 0

Square spirals 2.5

MBL legs 2

Cloud legs 2

Above cloud legs 2

Sawtooth legs 0

Plume legs 4

Above plume legs 2

Instrument status:

Instrument	Comments
P3	No issues
4STAR	Worked perfectly; AOD 0.6
HiGEAR	“No real surprises”
HiGEAR-AMS	No issues, worked well.
HSRL-2	“Ran really well”
RSP	Great day for RSP
APR3	W-band all good. Ka&Ku issues early; recovered quickly
Cloud probes	Great day
CCN	Ran well, no supersaturation/overflowing issues
PDI	Fabulous cloud passages
Vertical winds	
WISPR/CVI	fine
COMA	Good day; got cal system working; instrument working nominally at all altitudes
SSFR	Good day; everything worked
data	Mostly as expected; some forward cam issues
filters	3 filters exposed for 10-20 mins each

PRF09Y17 date 08/26/2017 day-of-week Mission Report
flight scientist: Jens Redemann
ground scientist: Sarah Doherty

flight plan and objective: 1-2 line synopsis, image of proposed flight plan
•Radiation walls (3x) along constant latitude line
•Terra overpass to the E at 10:04, Aqua to the W at 12:59UT
•Expect constant cloud fraction E-W but lower cloud fractions on constant-latitude legs farther N
•Walls were envisioned to be E-W oriented for ease of communication with pilots

Flight Summary:
A semi-successful radiation-oriented flight day. We deliberately targeted a region with broken low clouds, significant aerosol loading, and free of high clouds. Morning forecasts and satellite imagery showed greatest chance of high Ci North of 5S, so we set out for 5S and 5E. The long transit to there (relative to working along 0S) ended up preventing the third radiation wall. Two successful radiation wall modules were flown. The first one, near 5S was oriented on a 135deg heading, due to flexibility of P3 pilots in flight. This was to orient legs more along lines of constant/significant cloud fraction. During this wall module, low clouds were scattered to broken, no Ci. During second wall module, there was a significant Ci streamer in the direct beam for the center part of the legs. Good low clouds for most of wall. Ended up the flight with in-plume legs near 2S along the routine track.
See end of Flight Report for diagrams of 2 radiation walls flown.

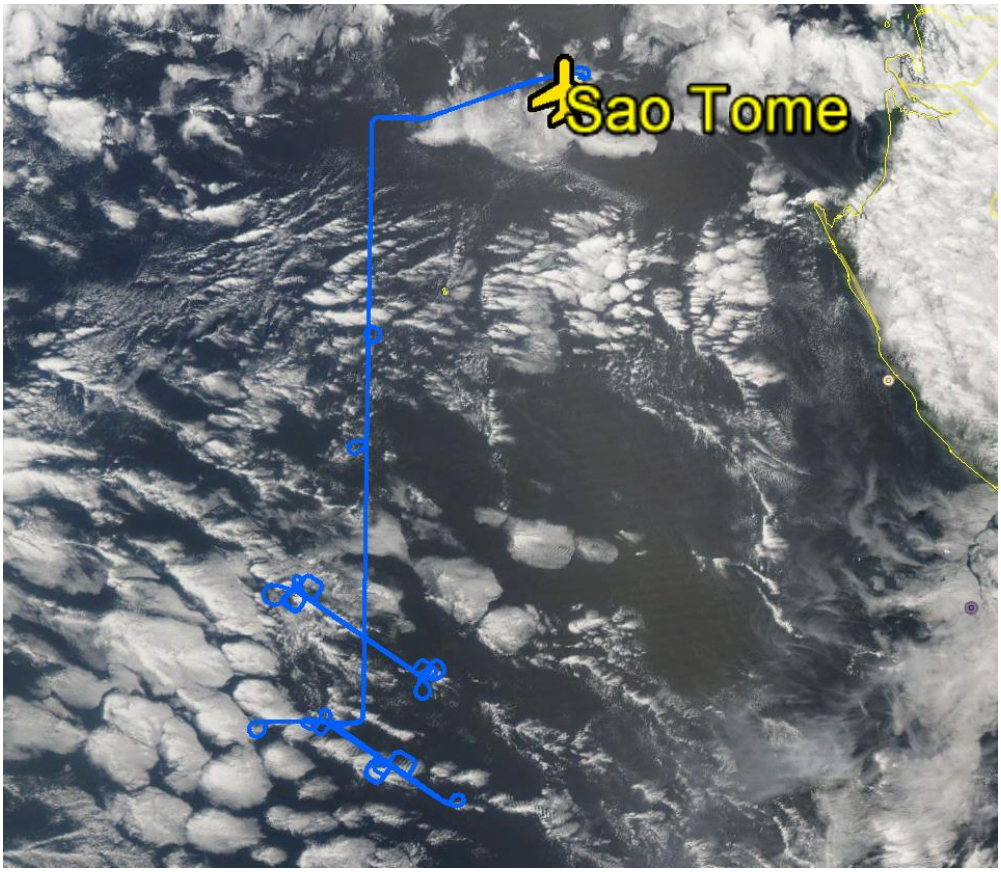


Figure 1: Flight track overlaid onto MODIS-Aqua RGB

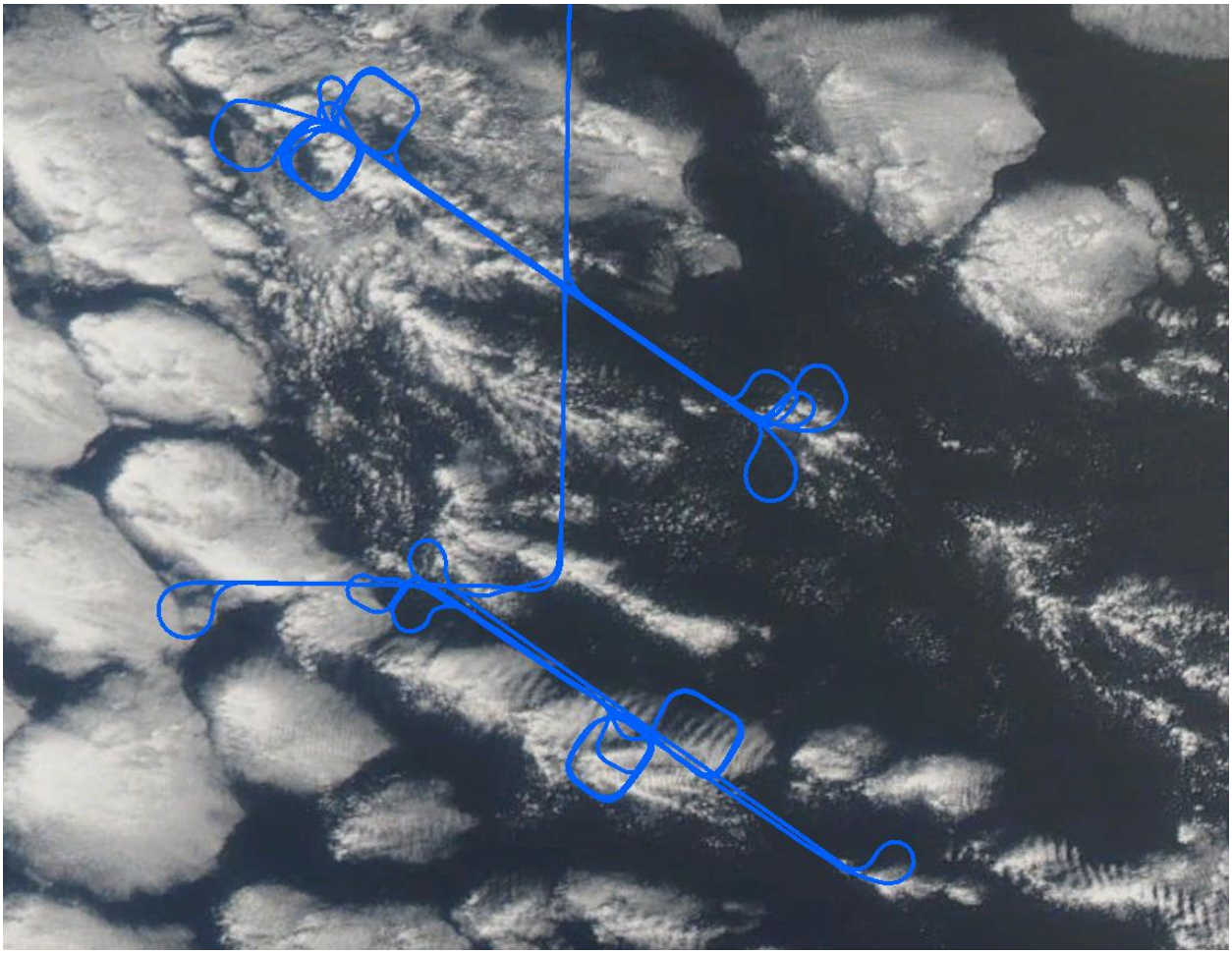


Figure 2: Zoomed image of radiation walls, showing cloud structure affected by wave activity

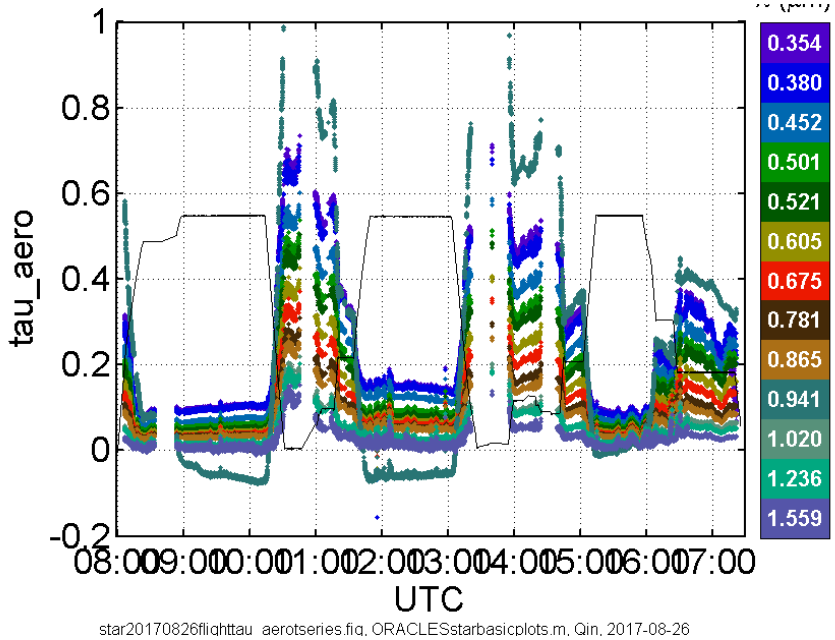


Figure 3: AOD as a function of time of flight

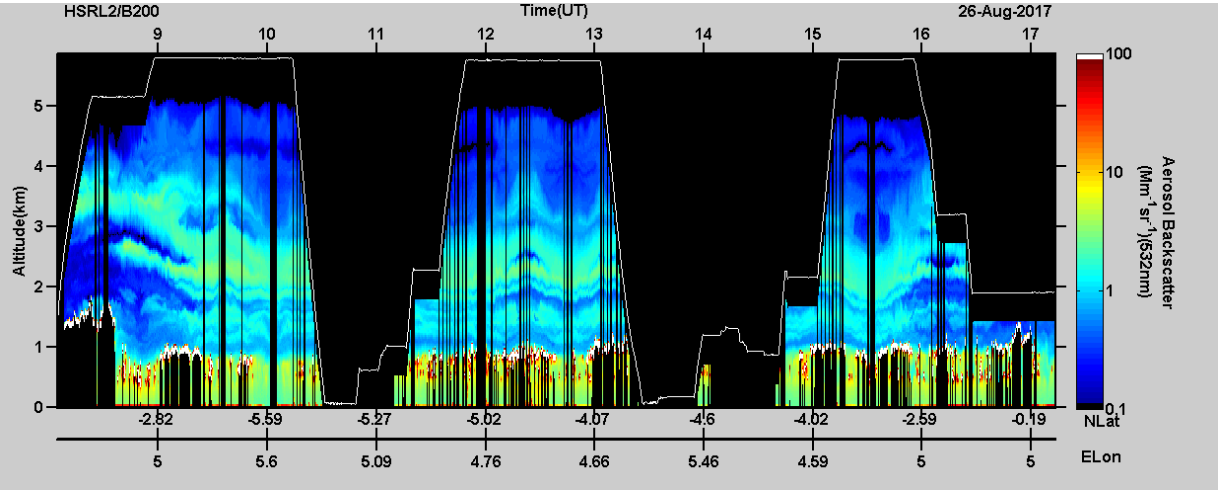


Figure 4: Lidar 532 nm backscat curtain plot for entire flight

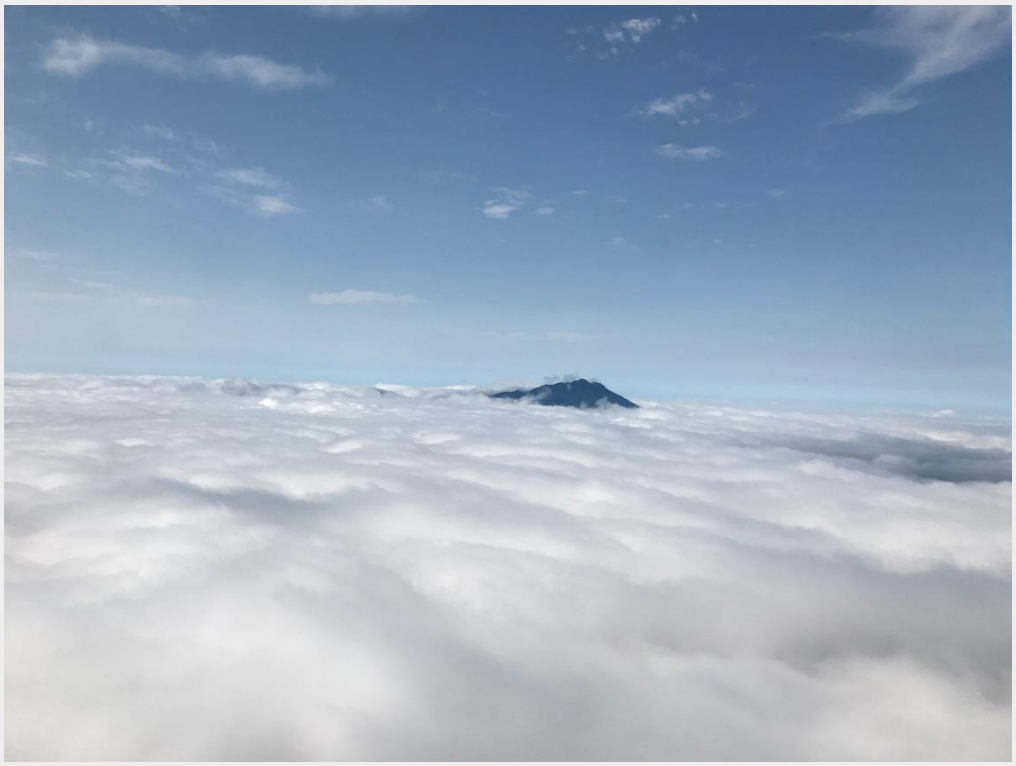
A-Priori Forecast: 4-5 line synopsis with selection of images taken from the forecast briefings, Available at http://bocachica.arc.nasa.gov/ORACLES/oracles_2017.html, bottom of page
e.g.,

- Clouds for Saturday. Similar to 8/24 fcst for the mid level clouds: (1) unlike 8/24, there is nothing east of the prime meridian; (2) higher cloud fractions than 8/24 just west of the prime meridian.
- Models disagree on high cloud east of prime meridian. EC has more cloud. Neither model is truly reliable for high level cloud at 48 hours
- Rei: EC model does not fully capture the diurnal clearing of mid-level cloud (which played a role in 8/24 overestimate of mid-level cloud). Based on this, we discount the importance of the mid-level cloud to our operations. High level cloud is likely to be occasional streamers, much like 8/24.

Flight Instrument status: see table above

Flight Instrument/logistics notes: 4-5 lines on anything of note

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	07:59:57 UTC	X	To max alt	Local to TMS, aerosol scattering peaked at only ~60Mm^{-1} below 2km altitude then dropped to ~5Mm^{-1}; well-defined layer 3-3.5km altitude (140Mm^{-1}); narrow cleaner layer; then layer 3.6km-4.5km layer that slowly tapers out from a peak of ~90Mm^{-1} at 3.6km. cloud top at 4.4kft All of this on ramp from TMS to EREGO. NOTE: COMA doing calibrations on climb-out.
	08:05			pix of low clouds near TMS
				
	08:12			Significant aerosol layer visible in forward camera

description	beginning time	end time	altitude	notes
				
	08:15			HiGEAR saw layer 10.5kft between 12.4kft; climbing to 16kft pressure alt
At 0S, 5E	08:27	X	5150m/17,000’	Turn and head south on 5E (8:30 HSRL runs calibrations)
	08:38			during transit from 0S/5E to 5S/5E, mid-level cloud where we are now is at ~18kft (guessing from 17kft flight level)
At 2S, 5E	08:50	X	5150m	High cloud deck (~18,000’) down to 2S. Doesn’t show on HSRL because flying below it (!) As of 8:47, COMA 03 valid.
	08:51			edge of south edge of 18kft cloud deck is in sight – pix

description	beginning time	end time	altitude	notes
				
Ascend	08:52	08:57	to 5800m	Increase altitude from 5150m to 5800m
	08:55			we are clear of high&mid clouds in the direct beam; Ci streamer at 10 o'clock
At 4S, 5E	09:13:30	X	5800m	Seeing mid-level clouds at 2o'clock from P3, so continuing south.
	09:20			heading for Southern edge of low cloud thick patch – pix

description	beginning time	end time	altitude	notes
				
At 5S, 5E, turn and head west	09:25	X	5800m	Approx. exited south edge of thicker bands of clouds. Hoping to get away from remaining cirrus streamers & get to more broken low cloud.
	09:34			reversing course - we liked the first half degree longitude W of 5E. will try to work 4.5E to 5.5E along 5S
Turn from west-bound to east-bound	09:35	09:38	5800m	
East-bound high alt leg along 5S	09:38	09:45	5800m	Transit eastbound to work radiation wall 4.5E to 5.5E along 5S. Note: COMA is running cals every 15min.
SE-bound high alt leg	09:45	10:04	5800m	Turn and head SE at 5.0S, 4.72E Cirrus streamers at 9 o'clock at ~5.4S, 5.3E

description	beginning time	end time	altitude	notes
	09:45			We are going to try something more ambitious yet. We will pick a point along this track. Probably 4.75E and give the pilots a heading of 135. Mark the start and end points and will have the pilots work between those two.
	09:56			some Ci at 9 o'clock – pix and very thin streamer in direct beam for a few seconds
Turn and head NW	10:04	10:13:30	5800m	At 5.65S, 5.75E turn from SE heading to NW heading.
Square spiral descent	10:13:30	10:32	80m	Descending to mid-point of radiation wall. Spiral is centered on 5.4S, 5.1E. AOD ~0.45 (need to verify, after post-flight screening)
	10:25			most clouds on SW leg of square spiral, overall very broken - pix

description	beginning time	end time	altitude	notes
				
Get on Wall	10:32	10:38:30	80-100m	Completing spiral to get back on NW/SE radiation wall track.
	10:35			very lightly polluted BL, lots of sea salt towards A (north-western most point of wall)
MBL leg	10:38:30	10:48:30	~80m	Headed NW from ~5.32S, 5.17E to starting low level run from D (half-way between A and C) towards A, AOD = 0.4, very scattered cloud • Winds observed on P3 are ~10knts from SSE at surface, ~8knts from SSW at 3000'. • scattering ~55-65Mm-1 • CO ~120ppb • SP2 ~150-180/cc

description	beginning time	end time	altitude	notes
Turn and climb to in-cloud leg	10:48:30	10:53:30		Turn centered on 5.1S, 4.7E
Cloud leg	10:53:30	11:04	620m	5.05S, 4.75E – 5.35S, 5.2E SE-bound leg in cloud
Turn	11:04	?	To 1025m	Turn from SE heading to NW heading
Above-cloud leg	11:06	11:15:25	1025m	NW-bound leg ~5.3S, 5.22W to ~5.0S, 4.67E Just above cloud. Above-cloud AOD ~0.36-0.37
Turn & climb	11:15:25	11:22:30	To 2280m (7.2kft)	90-270 Turn from NW heading to SE heading centered on 5.0S, 4.55E
Plume leg	11:22:30	11:34:30	2280m	SE-bound leg 5.0S, 4.6E to 5.43S, 5.35E Concentrations along leg declined at this altitude: Scattering ~175-110 Mm^{-1} CO 360-280ppb …then went back up/leveled off to: Scattering: ~125 Mm^{-1} CO: ~310ppb Filter sample
Spiral up	11:34:30	11:50		Square-spiral up to 18kft and get on NW heading; 7.5kft was definitely heart of the plume
High altitude leg	11:50	11:56	5.7km, 19,000’	NW-bound leg 5.52S, 5.12E to 5.0S, 4.6E SNL @ 18kft towards point A
Turn and reposition	11:56	12:03	5.7km	Turn, head east along 5S for 5E routine track.

description	beginning time	end time	altitude	notes
	12:00			significant Ci in direct beam
Transit to next wall area	12:03	12:11		Heading north along 5E from 5S.
Turn	12:11	X		Turn NW on 315deg heading
Transit to next wall area	12:11	12:18:30	5.7km	End transit at 3.9S, 4.4E
Turn (90-270)	12:18:30	12:26	5.7km	Turn centered on 3.95S, 4.2E Setting up next wall on 135deg heading. first point (NE) is F
High alt. survey leg	12:26	12:42	5.7km	“POINT F”, 3.9S, 4.4E NW end of NW-SE Wall; Transit to 4.6S, 5.48E
	12:30			some whispy Ci ahead and at 9 o’clock
Turn	12:42	12:47	5.7km	SE to NW heading
High alt. leg	12:47	13:03	5.7km	Heading NW-bound to POINT F From 4.6S, 5.5W to 3.9S, 4.4E. Right after turn, P3 reports Ci at 10 o’clock, 20deg above horizon
Spiral descent	13:03	13:27	To 75m	Spiral centered on 4.0S, 4.4E Note: decreased descent rate to 500ft/min below ~1.2km, for clouds.
	13:22			end of square spiral which was moved to point F (instead of middle of wall, because of Ci)
repositioning	13:27	13:38	75m	Completing spiral at ~Point F (3.9S, 4.5E) and getting back onto track to head SE in BL

description	beginning time	end time	altitude	notes
BL/below-cloud leg	13:38	13:55	75m-100m	SE-bound leg from POINT F 3.9S, 4.5E to 4.6S, 5.4E Cleaner BL: Scattering ~50-60Mm^{-1} (~40 Mm^{-1} sub-micron only) CO ~120ppb SP2 counts ~150-170/cc Cloud bases very low pix
				
Turn and ascend	13:55	14:00	To 1200m	
Above-cloud leg	14:00	14:18	1200m	NW-bound leg to POINT F 4.6S, 5.5E to 3.9S, 4.4E Above-cloud AOD ~0.3 Scattering ~50-70 Mm-1 CO 220-230ppb SP2~300-550/cc
Turn and drop into cloud	14:18	14:20	To 880m	
Cloud leg	14:20	14:41	880m	SE-bound leg from POINT F 3.9S, 4.4E to 4.6S, 5.45E

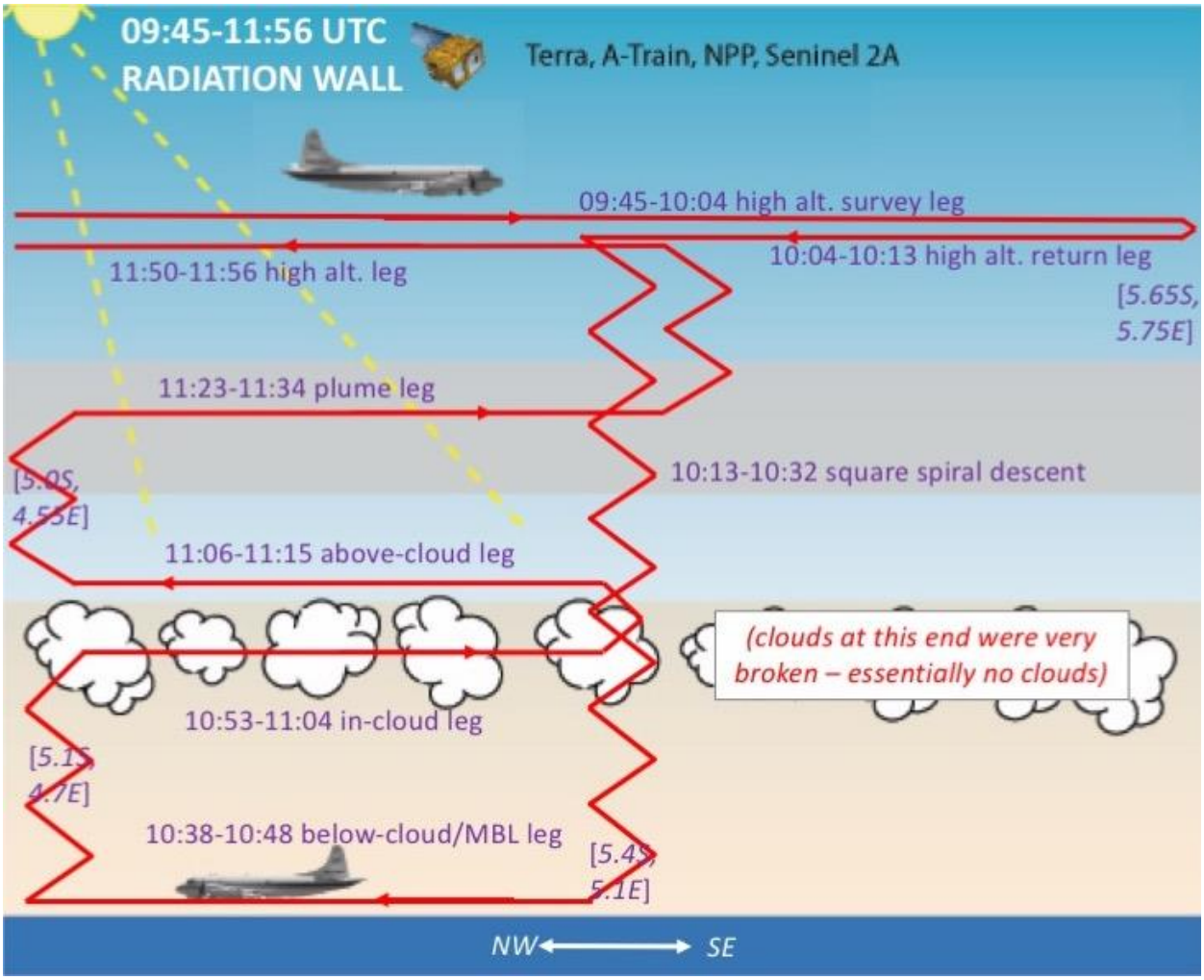
description	beginning time	end time	altitude	notes
				Rose: “super dope cloud leg!” 400/cc in cloud, LWC = 0.5 – 0.9 g/m3
	14:32			Cloud tops variable, descending 200ft to get us back into top of clouds
Turn and ascend	14:41	14:46	To 2.16km	
Plume leg	14:46	15:01	2.16km	NW-bound leg to POINT F setting up at 7kft for in-plume run G to F 4.6S, 5.4E to 3.9S, 4.4E scattering 100-120 Mm^{-1} CO 250-300ppb SP2 ~600-700/cc (increased from this right at end of leg; e.g. scattering to ~130 Mm^{-1})
	14:48			broken clouds – pix; very variable along the track, much thicker to the NW of the track
				

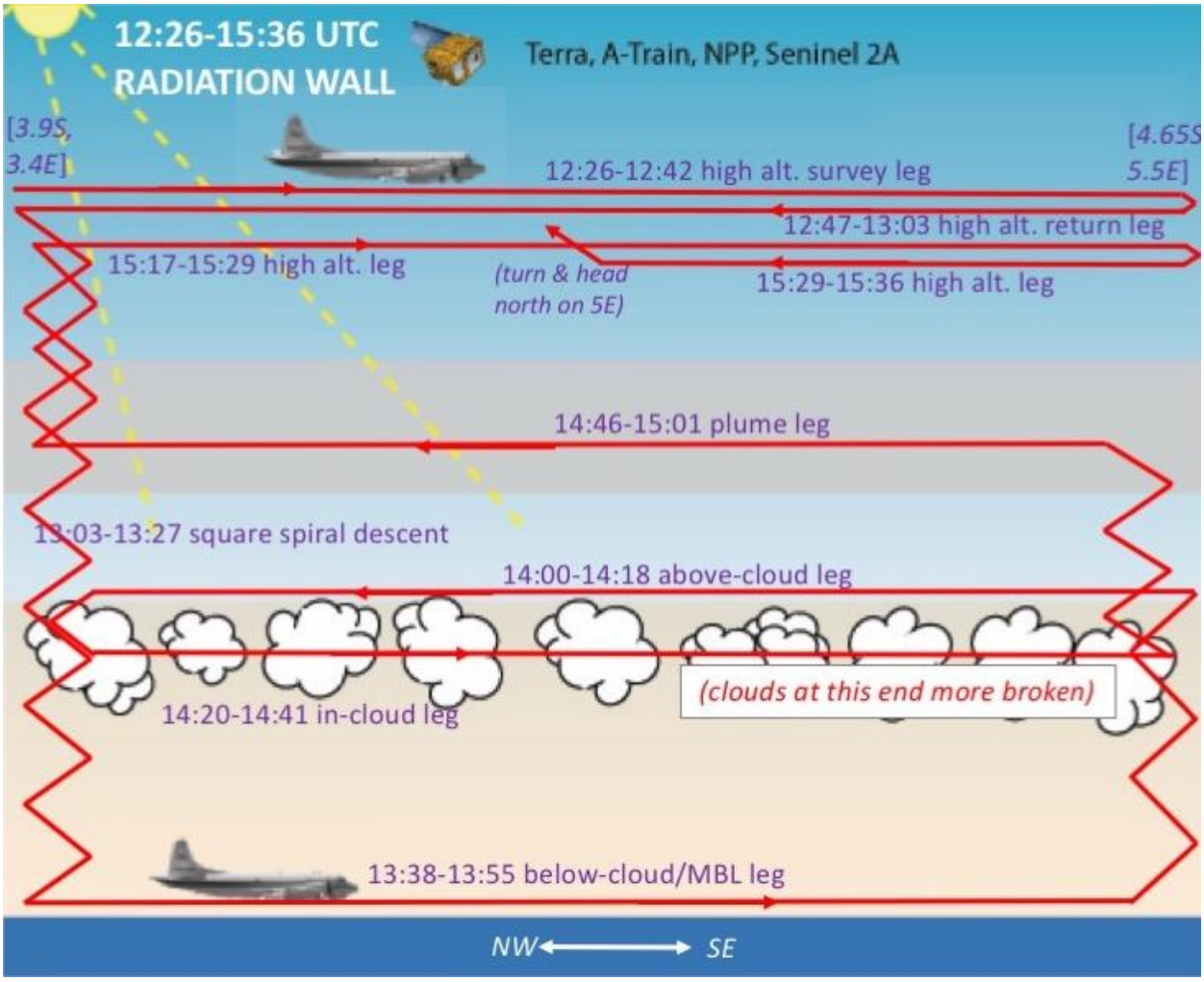
description	beginning time	end time	altitude	notes
Square Spiral ascent	15:01	15:15	To 5.8km	Centered on 3.9S, 4.5W (just to NE of POINT F).
repositioning	15:15	15:17	5.8km	To get back on line at 4.05S, 4.623E
High altitude leg	15:17	15:29	5.8km	SE-bound leg from just SE of POINT F 4.05S, 4.623E to 4.6S, 5.45E
	15:18			during high level run F to G, low level clouds have moved off the track (or dissipated?) – pix
				
Turn	15:29	15:36	5.8km	From SE-bound to NW-bound
Turn	15:41:30	X	5.8km	Turn north-bound at 5E (Routine track)

description	beginning time	end time	altitude	notes
High-altitude leg	15:41:30	15:56	5.8km	North-bound from 4.25S, 5.0E to 2.9S, 5E.
Ramped descent	15:56	16:08	To 3.2km	At 2.9S start descent; following 5E; starting slow descent (500ft/min) towards 2deg S to 10kft, some Ci all around
Turn 180deg	16:08	16:15	3.2km	At 1.9S, turn from north-bound to south-bound at 10kft
	16:13:15			Filter sample
Plume leg	16:15	16:24	3.2km	South-bound leg on 5E From 1.95S to 2.65S Concentrations decreased along leg Scattering dropped from ~80 to ~65Mm^{-1} CO dropped from 260 to 220ppb SP2 counts from ~500 to 350/cc
Turn 180deg & descend	16:24	16:27	To 1.9km	At 2.65S, turn from south-bound to north-bound, and descending to 6.0kft for Northbound run RTB – pix

description	beginning time	end time	altitude	notes
Plume leg	16:27	17:02	1.9km	North-bound leg on 5E From 2.65S to Equator 2.65S to 0.5S: Scattering ~20Mm^{-1} CO ~170ppb SP2 ~170-200/cc (16:56 scattering to zero; switch to filtered air? CO stayed at 170-180ppb; SP2 had brief blip to zero then back to ~170/cc)
Turn east	17:02	X	1.9km	Turn east at 0S, 5E towards EREGO
EREGO	17:07:30	X	1.9km	At EREGO (0S, 5.433E)
Start descent for landing	17:18	X	From 1.9km	~0.4N, 6.5E
LANDED	17:27:49			

DIAGRAMS OF TWO RADIATION WALLS FLOWN:




12:26-15:36 UTC
RADIATION WALL
Terra, A-Train, NPP, Seninel 2A
[3.9S, 3.4E]
[4.65S 5.5E]
12:26-12:42 high alt. survey leg
12:47-13:03 high alt. return leg
15:17-15:29 high alt. leg
(turn & head north on 5E)
15:29-15:36 high alt. leg
14:46-15:01 plume leg
13:03-13:27 square spiral descent
14:00-14:18 above-cloud leg
(clouds at this end more broken)
14:20-14:41 in-cloud leg
13:38-13:55 below-cloud/MBL leg
NW
SE