

## ORACLES P3 Ground Scientist Report

Date: 07 October 2018

Flight number: PRF06Y18

Routine flight or target of opportunity? Routine to 15S

If target of opportunity, what is the goal? \_\_\_\_\_

Flight scientist: Jens Redemann

Assistant flight scientist: n/a

Ground scientist: Greg Mcfarquhar

Asst. Ground scientist: \_\_\_\_\_

Take-off: 07:04:02UT (from TMS)

Landing: 15:08UT (at TMS)

### Quick summary:

Representative ACAOD or ACAOD range for flight: 0.4; 0.45 max full column

Do the models predict crossing a gradient in aerosol age? YES (older in boundary layer, younger above)

Yes/No/Unclear

Notes: yes, younger plume age between 10 and 15S at 10-15kft

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

Yes/No/Unclear

Notes: A clear patch was found on the return leg at 9S and used for radiation work

Did the flight cross a gradient in aerosol loading? YES

Yes/No/Unclear

Notes: higher AOD loading towards the S end of the track, likely driven by high RH feature:

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

Yes/No/Unclear

### How many of the following maneuvers took place?

Ramps 1 long stepped ramp

Plume legs >5

Square spirals 1

Above plume legs outbound transit to 15S

MBL legs 1+

\_\_\_\_\_

Cloud legs 1

Above cloud legs 1

Sawtooth legs 1

**Instrument status:**

<b>Instrument</b>	<b>Comments</b>
<b>P3</b>	No issues reported.
<b>4STAR</b>	Worked well; ACAOD >0.4 multiple times.
<b>HiGEAR</b>	Pretty good day; no failures. Lots of oscillations indicative of mixing changes;
<b>HiGEAR-AMS</b>	Great; no issues.
<b>PTI</b>	Recognized significant alignment issue after hard landing on previous flight. Will require work.
<b>HSRL-2</b>	Rough start; two problems: communication with data (4STAR AOD for ACAOD plot) & problem with interferometer.
<b>RSP</b>	Worked well all day; clear sky great; also good measurements of mid-level cloud.
<b>APR3</b>	Good day; not eventful; data from all three channels for some portion of flight.
<b>Cloud probes</b>	Good data during saw-tooth and in cloud.
<b>CCN</b>	Interesting day, observed range of hygroscopicities.
<b>PDI</b>	-
<b>Vertical winds</b>	-
<b>WISPR/CVI</b>	Worked flawlessly, fully functional; no idea why after recent failures.
<b>COMA</b>	Routine day; highest CO below cloud in 2018 so far.
<b>SSFR</b>	Good day, no issues.
<b>data</b>	Mostly good. Sat imagery script needs reworking.

## PRF06Y18 date 10/07/2018 day-of-week Mission Report

flight scientist: Jens Redemann

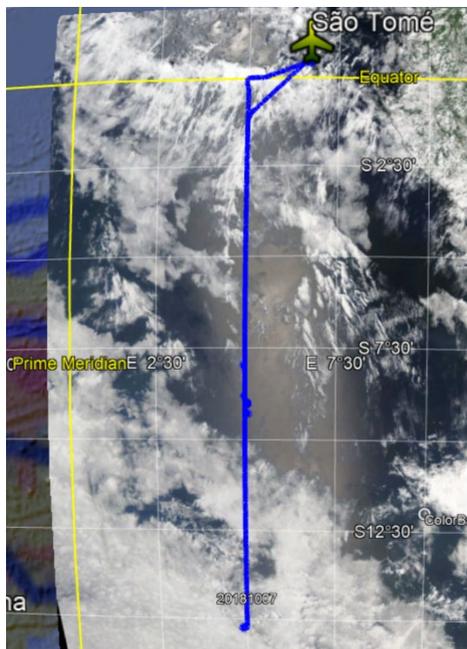
ground scientist: Greg McFarquhar

### flight plan and objectives:

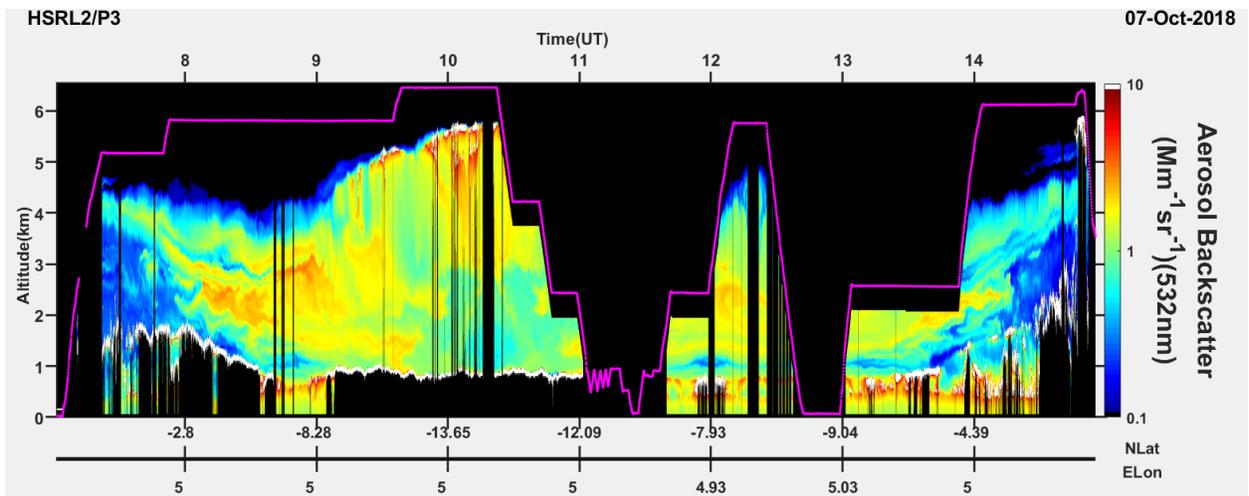
- Routine flight to 15S
- Extend as far S as possible and descend near 15S
- Verify model predictions of high RH, high aerosol loading between 10 and 15S
- Assess BL pollution levels during at least one low level run

### Flight Summary:

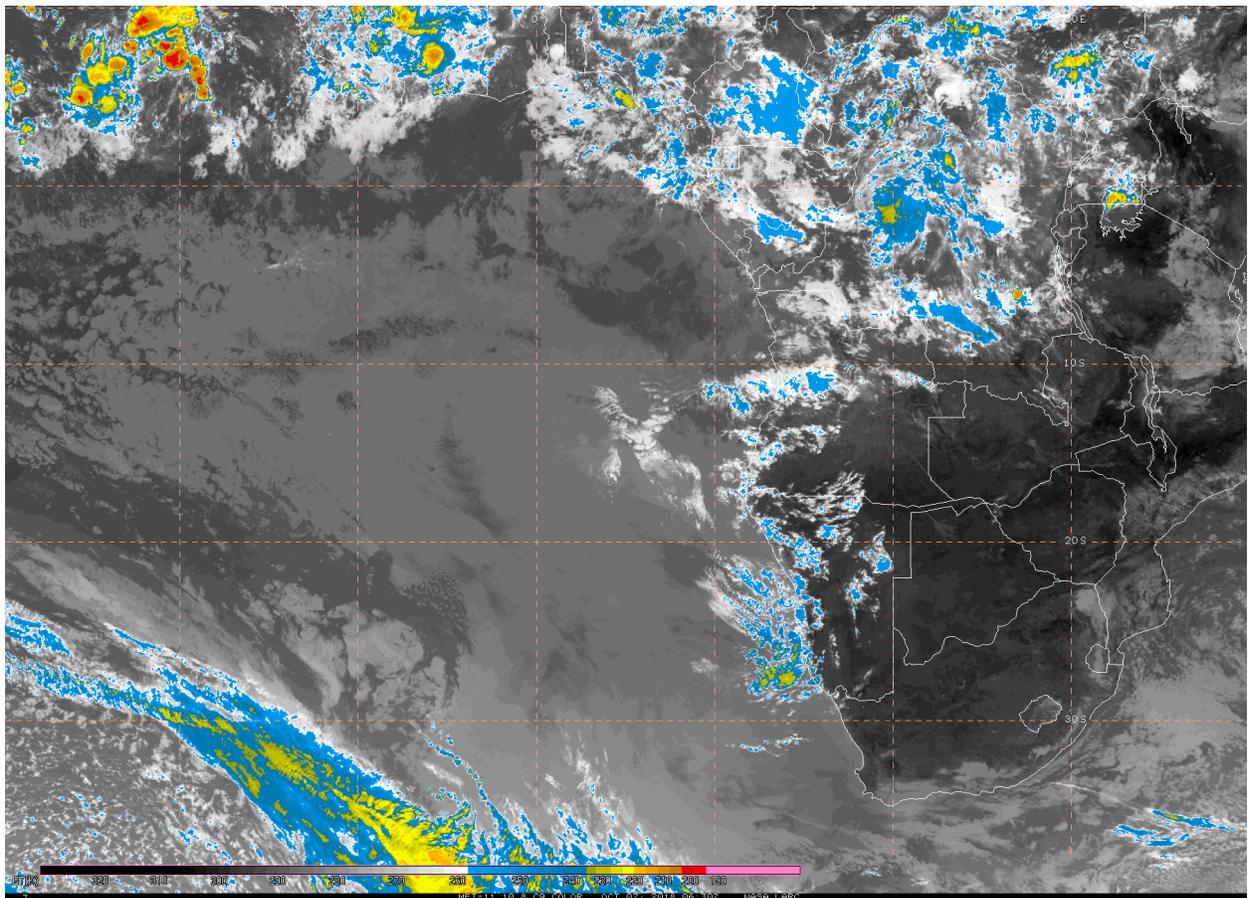
Take-off at 07:04UT. Found a pollution layer at 12-13kft during climb-out from Sao Tome. During transit to 15S we recognized sloping low cloud tops from 2S to 7S with sloping aerosol layers above. From 10 to 15S lidar curtain indicated mid-level clouds at the top of the outflow plume and embedded in the plume. This was verified during in situ sampling legs in the plume on the Northbound leg. First leg at 13kft was very polluted (80Mm<sup>-1</sup> scat, 230ppb CO). Second leg at 8kft was less polluted (40-60 Mm<sup>-1</sup> scat, ~200ppb CO). This was forecast qualitatively in WRF and GEOS-5, and linked to a younger plume at higher altitude. Boundary layer work between 12S and 9.5S found a fairly polluted BL (115ppb CO). Visual detection of low-level Cu well below flight level hinted at some decoupling of the BL. Profiling to the surface yielded different assessments on mixing state from different instruments. BL work was followed by extended run at 8kft, which HiGEAR used for extended testing. After ascent to 18kft and partial transit North, pilots informed flight scientists that there was an extra hour of time to use for science. Decision on-board was to use clear slot at 9S for square spiral and radiation work. This spiral happened in most clear conditions encountered in ORACLES-2018 yet, with minimal low-clouds in the FOV at low altitudes. During transit home, we flew an extended leg (1hr+) at 8kft, before ascending to transit altitude of 19kft. Landed at 15:08UT.



**Figure 1.** Flight track as flown, overlaid onto MODIS-Aqua image.



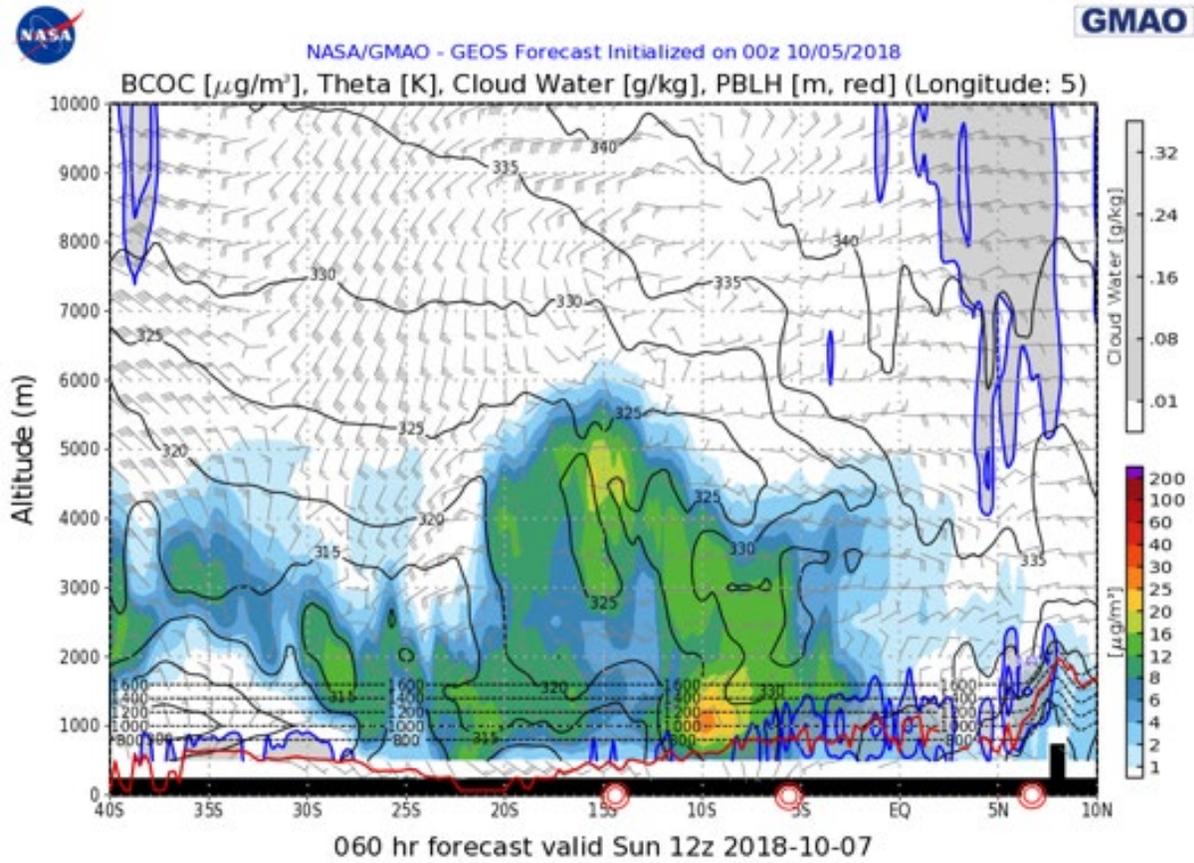
**Figure 2.** HSRL lidar curtain (532nm backscatter) for entire flight.



**Figure 3.** Satellite imagery near time of take-off.

**Forecast Verification:**

Minimum in aerosol loading at 8kft near 15S along routine flight track relative to higher altitudes was verified by two successive legs at 13kft and 8kft. Second leg (8kft) found significantly lower pollution levels (see full flight description).

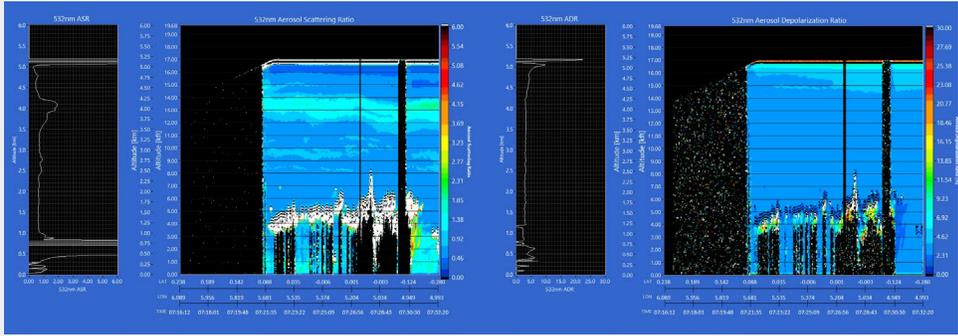


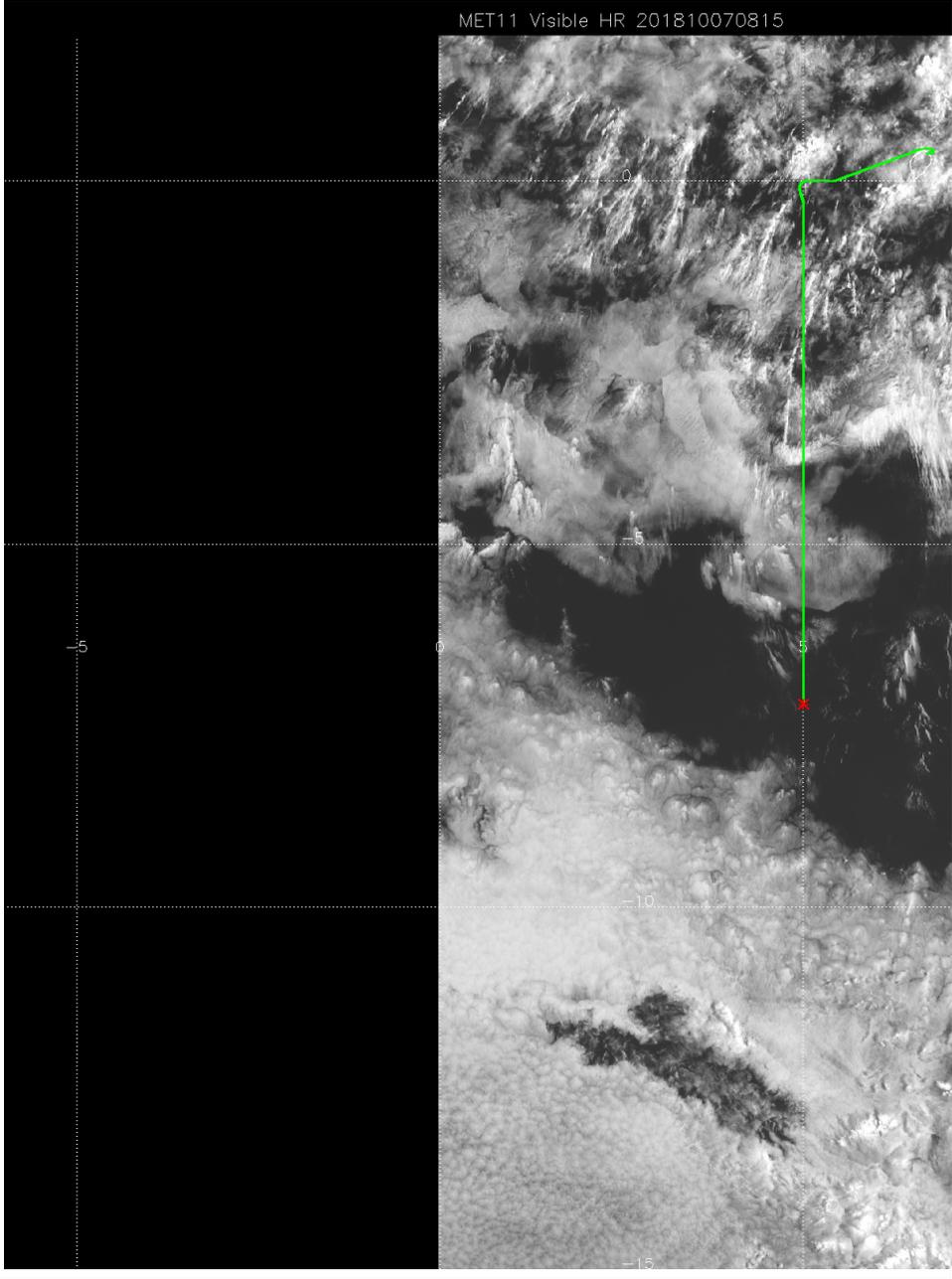
**Figure.** 60hr forecast of BC/OC curtain along routine flight track from GEOS-5.

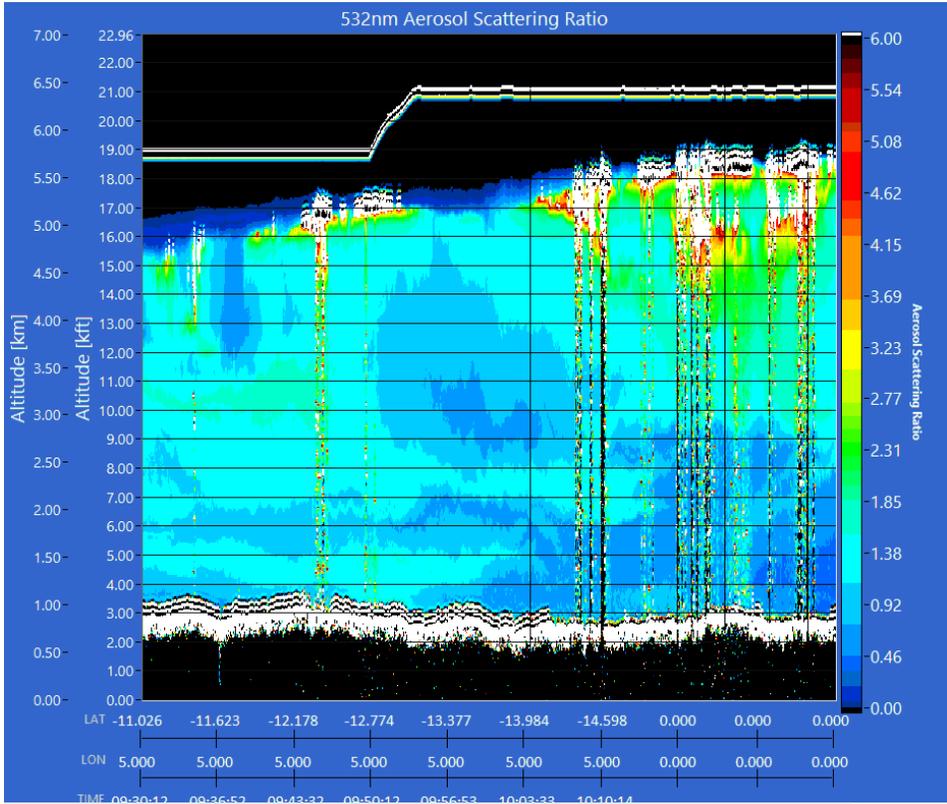
**Run Table [UTC]**

description	beginning time	end time	altitude	notes
	07:14			Multiple cloud layers during initial climb out
	07:16			Pollution layer at 12-13kft

description	beginning time	end time	altitude	notes
	07:28			Red PTI absorption cannot be trusted right now
	07:41			Auto-pilot nav setting "LNAV" causes only 0.1deg roll
	08:04			Interesting linear cloud organization below
	08:15			Low clouds breaking up a bit
	08:37			Low cloud edge at 5.95S



description	beginning time	end time	altitude	notes
	840			Clear spot starting at 6.7 S was noted as possibility for clear-sky radiative wall (but still some Cu)
				
	09:15			Mid-level clouds visible to the East of flight track

description	beginning time	end time	altitude	notes
	09:21			HSRL ACAOD estimate of 0.35-0.38
	09:28			Lidar imagery aerosol layer seems to be 10-11 kft for most prominent and seeing a couple of higher level clouds beneath aircraft
	09:42			Gas pollution tracers were increasing, climbed to 20kft, refractory CN dropping but recovering Southward
	10:15			plan: go beyond 15 S, 90-270, ramped descent at 1kft/min to 14kft GPS for level leg there
	 <p>The figure is a 532nm Aerosol Scattering Ratio plot. The vertical axis represents altitude in kilometers (km) and feet (kft), ranging from 0.00 to 7.00 km (0.00 to 22.96 kft). The horizontal axis represents time, with labels for 09:30:12, 09:36:52, 09:43:32, 09:50:12, 09:56:53, 10:03:33, and 10:10:14. A color scale on the right indicates the scattering ratio, ranging from 0.00 (dark blue) to 6.00 (dark red). The plot shows a prominent aerosol layer between 10 and 15 kft, with a sharp increase in scattering ratio (red/orange) between 09:43 and 09:56. There are also several vertical streaks of high scattering ratio extending from the surface up to 15 kft, likely representing ground-based emissions or local aerosols.</p>			
	10:33			Started descent to 13kft pressure
	10:34			Mid-level cloud tops very smooth

description	beginning time	end time	altitude	notes
				
	10:27			Polluted mid-level cloud rBC=1ug/m3
	10:29			Level at 13kft, scat 80 Mm-1, 230ppb CO; mid-level clouds embedded in plume
				

description	beginning time	end time	altitude	notes
	10:41			Start of descent at 13.5S to 7.5kft
	10:47			Start of level leg at 8kft GPS, scat 40-60, rBC= 0.9ug/m3, 199ppbCO total for 12 min
	11:04			Starting sawtooth pattern here for fear of outrunning low clouds
	11:10			Clouds getting thinner geometrically in saw-tooth
	11:13			Skimming cloud tops with fluctuations in temperature seen (at 2. 8ft)
	11:14			3 min leg above cloud for nephs and 4STAR
	11:15			1.5 down to 1ug/m3, above cloud getting lower, AOD 0.45
	11:16			At 3.1 kft, entrainment into cloud top. Above inversion, temperature has increased
	11:17			Below cloud, there appears to be a decoupled BL below
	11:22			Descending Min safe alt run, 2 mins
	11:24			CO: 115ppb
	11:27			Ascending for in cloud run, going above cloud shortly, then 5min in cloud
	11:29			Cloud top at 2.5kft

description	beginning time	end time	altitude	notes
	11:34			Pollution at cloud top, AOD 0.42
	11:36			Climb to 8kft GPS, scat / BC dropping off at 5kft
	11:42			Start of straight and level at 8kft, scat 75Mm
	11:57			Reversing course heading back to 9S for square spiral
	12:36			During square spiral a few low clouds to the S and W, 1.3ug/m3
	12:43			One more square all around, 0.4 AOD, highest CO at 200ft, normally 70-80, now 125-130ppb, no sea salt, sub-micron is 95% of total scat
	12:50			3 min run for 4STAR, calm sea
	13:02			8kft run, BC 1ug/m3, CO 230ppb, variable
	13:53			Climb to cruise altitude, RTB,
	2:57			Convection near the island
	3:08:16			landed 15:08:16