

## ORACLES P3 Ground Scientist Report

Date: 15 October 2018

Flight number: PRF09Y18

Routine flight or target of opportunity? Routine to 14S

If target of opportunity, what is the goal?     

Flight scientist: Jens Redemann

Assistant flight scientist: n/a

Ground scientist: Michael Diamond

Asst. Ground scientist:     

Take-off: 06:58:46UT (from TMS)

Landing: 14:26:14UT (at TMS)

### Quick summary:

Representative ACAOD or ACAOD range for flight: 0.2-0.3;      

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

Yes/No/Unclear

Notes:

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

Yes/No/Unclear

Notes: Several areas of significantly thicker and more productive clouds were encountered

Did the flight cross a gradient in aerosol loading?

Yes/No/Unclear

Notes: Models predicted increased loading S of 5S and relative gap above cloud at 14S

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

Yes/No/Unclear

Notes: Most notably at 8.5S

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

Ramps 0

Sawtooth legs 2

Square spirals 1

Plume legs 4

MBL legs 2

Above plume legs outbound transit to 14S

Cloud legs 1

Above cloud legs 2

**Instrument status:**

<b>Instrument</b>	<b>Comments</b>
<b>P3</b>	No issues reported.
<b>4STAR</b>	Pretty good day; ACAOD less than 0.3 most of the day.
<b>HiGEAR</b>	All instruments working; interesting saw-tooth measurements.
<b>HiGEAR-AMS</b>	Great; no issues.
<b>PTI/SP2</b>	Both PTI and SP2 performed well; SSA of 0.85 measured (to be verified).
<b>HSRL-2</b>	No problems; interesting structure.
<b>RSP</b>	Performed well all day.
<b>APR3</b>	Worked fine in all channels.
<b>Cloud probes</b>	Good data, all working except CAS; observed strong gradients in mixing and drizzle/no-drizzle areas.
<b>CCN</b>	Worked well, CVI runs very interesting.
<b>PDI</b>	-
<b>Vertical winds</b>	-
<b>WISPR/CVI</b>	Worked as expected.
<b>COMA</b>	Worked well; interesting results at all altitudes.
<b>SSFR</b>	Good day, running the leveling platform on aircraft INS worked well, but is more work in square spirals.
<b>data</b>	All good.

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

*flight scientist: Jens Redemann*

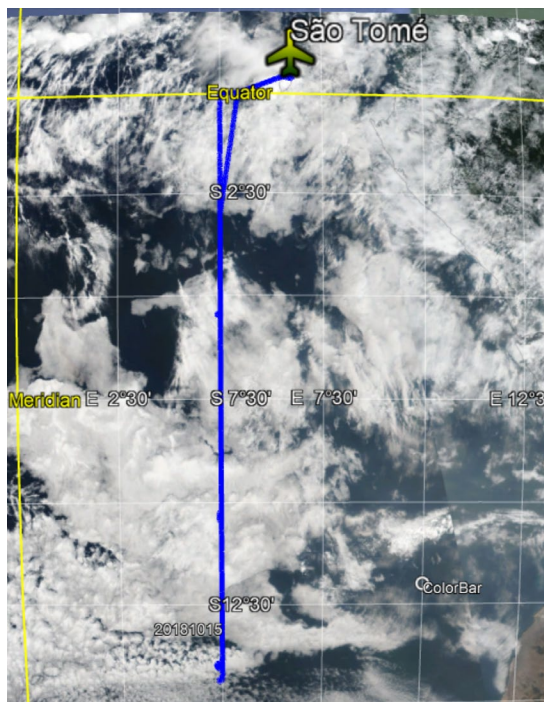
*ground scientist: Michael Diamond*

### flight plan and objectives:

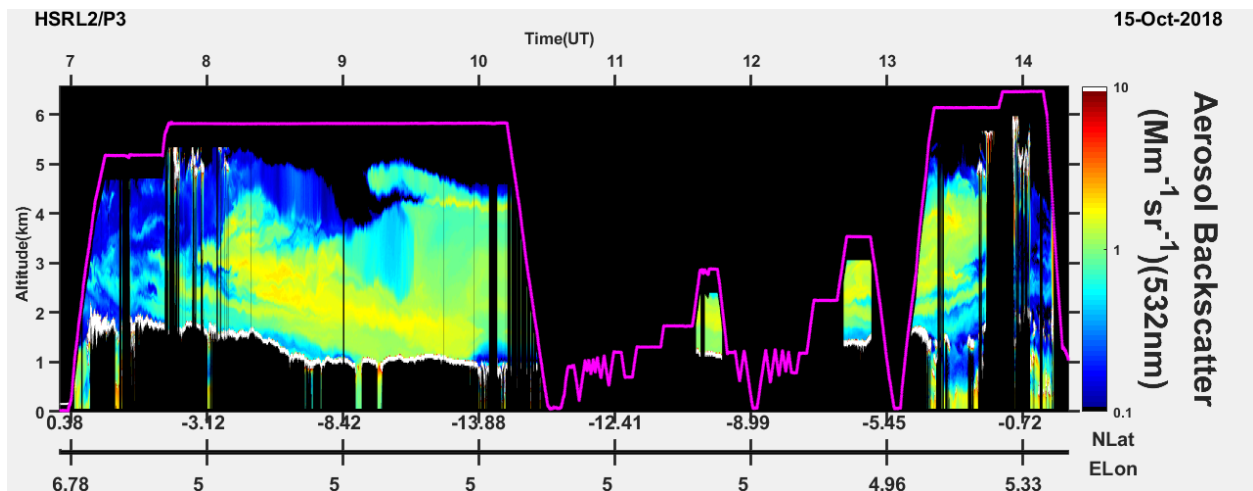
- Routine flight to 14S
- Verify model predictions of dry air/low scattering intrusion between 1-2km alt at 14S
- Look for areas of obvious mixing and gap in close spatial proximity during S-bound leg for BL work during N-bound leg in second half of flight
- High clouds forecast to stay to the East of the flight track (verified)
- Low cloud situation at South end was complex in forecasts

### Flight Summary:

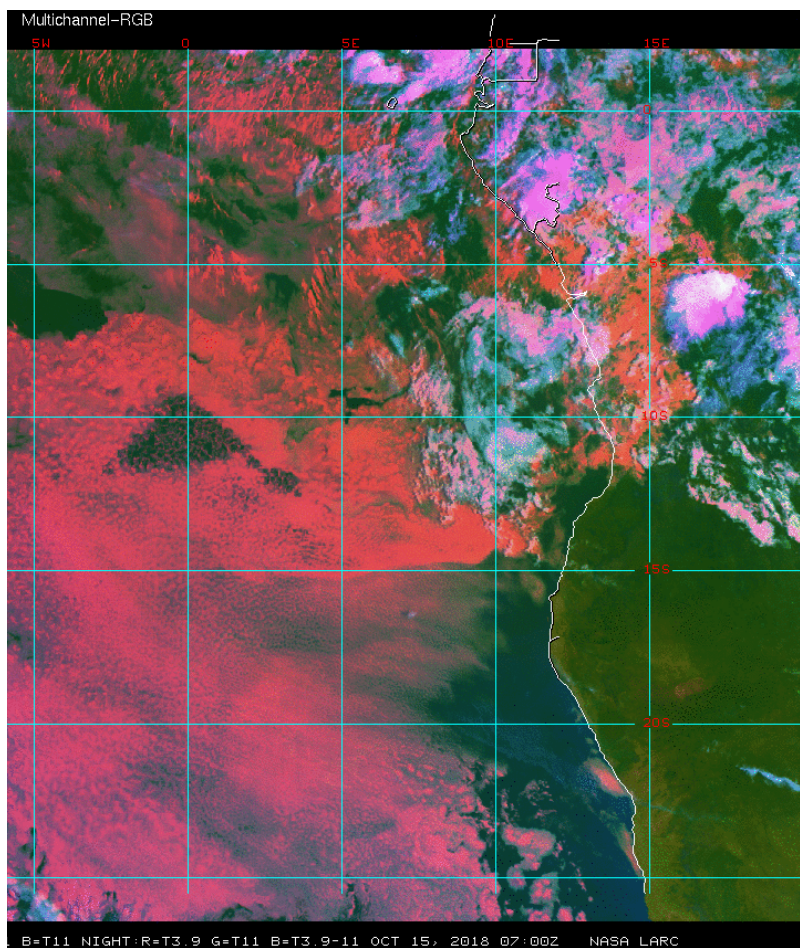
Take –off at 06:58:46UT. During Southbound transit at 18kft, we saw similar situation to Oct 7, i.e. minimal direct contact between smoke and Sc from 3-9S. APR detects heavily precipitating Sc clouds at 5S, in all 3 channels; consistently, SEVIRI shows LWP of > 300 g/m<sup>2</sup>. We identified two regions that showed gap (8.5S) and no gap (9.5S) in relative close proximity. Significant drizzle (3-channel APR return) between 11 and 13S. Square spiral at 14S, geometrically thin high smoke loading layer at 13kft, broken Sc. **Very clean BL**, low cloud bases 500ft; 77ppb CO, BC 30ng, 7Mm-1 scat, 0.23 ACAOD. During sawtooth N-bound, clouds thickening, found peak above-cloud smoke at 12.4S (1.5ug/m<sup>3</sup> BC), dropping as we head N. Level legs at 5.5kft yield 220ppb CO, 1.3ug/m<sup>3</sup> BC and at 8kft 120-135 ppb CO, 20Mm-1 scat, 300ng/m<sup>3</sup> BC. Second set of sawtooth patterns contrasting 9.5 and 8.5S – found smoke near cloud top at 9.5 and gap at 8.5S, as indicated by lidar during S-bound leg. Regular spiral (because of Ci around) at 5.5 S, because lack of data in routine flight coverage at that latitude and drizzle in APR during S-bound leg, measured 0.8g/m<sup>3</sup> LWC. Landed at 14:26:14



**Figure 1.** Flight track as flown, overlaid onto NPP-VIIRS image.



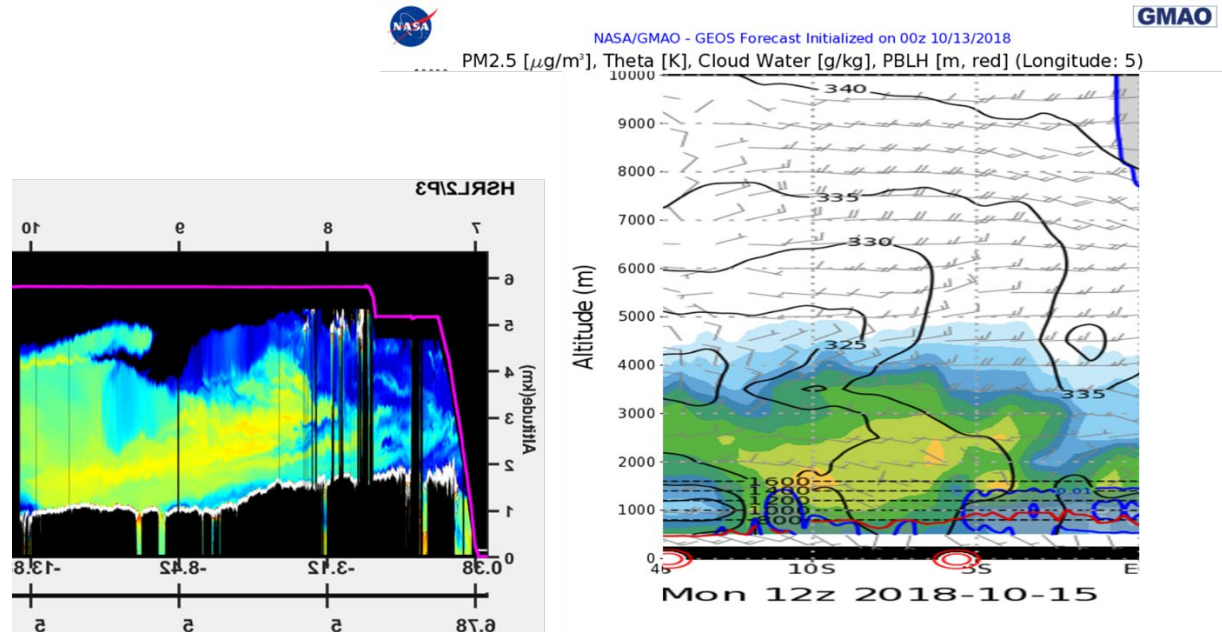
**Figure 2.** HSRL lidar curtain (532nm backscatter) for entire flight.



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

### Forecast Verification:


Complex low-cloud structure well represented by models. Aerosol structure generally represented well. Aerosol tops possibly underestimated by ~500m relative to lidar curtain. Boundary layer height poorly represented.





**Figure 4.** Lidar curtain during S-bound leg (left) and 48hr forecast of BC/OC curtain along routine flight track from GEOS-5 (right).



## Run Table [UTC]


description	beginning time	end time	altitude	notes
	07:09			Very little pollution on the climb out, minor bump in scat at 4kft
	07:14			Lots of Ci in the forward camera
High altitude leg	<div> <div>Time: 288 07:14:11 Latitude: +00 10.5 Longitude: +005 53.6</div> <div>2018-10-15 07:14:10</div>  </div>			
	07:15	10:11		<p>Drizzle seen in all three APR-3 bands around 5 S — SEVIRI shows LWP &gt; 300 g/m<sup>2</sup> there. Drizzle and perhaps light rain seen south of 11 S, where SEVIRI LWP &gt; 150 g/m<sup>2</sup></p> <p>Pretty solid/steady plume, sloping downward toward the south. Gap with clouds (also shallowing to the south) gives way to contact around 9.5 S</p> <p>Clear smoke-cloud contact from 9.5 to 13.5 S. Elevated plume from 9 S southward, interesting wave-like band where elevated plume</p>

description	beginning time	end time	altitude	notes
	07:18			intersects main plume from 11.5 S southward
	07:23			Moderate depol layer in lidar at 9kft
	7:46			Scattered Ci in all directions
				Mid-level clouds 500ft below flight alt (19kft)
	8:03			Mid-level clouds in the forward direction are geometrically thin, but noticeable. Satellite imagery does not show these
	<div> <div>Time: 288 08:03:11 Latitude: -03 24.0 Longitude: +004 60.0</div> <div>2018-10-15 08:03:11</div>  </div>			
	8:10			At 4S, lidar shows layers at 12kft and 9.5kft
	8:20			APR sees heavily precipitating Sc clouds, at 5S, in all 3 channels;

description	beginning time	end time	altitude	notes
				SEVIRI shows LWP of > 300 g/m2 (!! ) there, so makes sense.
	8:49			Patchy Ci, low clouds breaking up and cloud tops decreasing in altitude at 7.5S
	9:03			High alt smoke layer visible in the forward direction, very scattered Ci, pic
				
	9:21			Upper layer starting to come in at 15kft
	9:46			Low clouds thickest between 11 and 13S
	10:02			Low clouds looks interesting, cells of precipitation, plan is to saw-tooth through clouds starting at 14S, pic



description	beginning time	end time	altitude	notes
				
Square spiral	10:11	10:36		Setting up for square spiral, no Ci Peak aerosol layer: 13.5Kft, CO max of 220 ppb, rBC $\sim 0.8 \mu\text{g}/\text{m}^3$ Some drizzle observed during square spiral
Mix of sharp and dull saw tooth	10:36	11:11		Very clean BL, low cloud bases 500ft; 77ppb CO, BC 30ng, 7Mm-1 scat, 0.23ACAOD cloud Nd $\sim 150$ increasing to 250 Low, but not ultra-clean low, CCN ACAOD $\sim 0.23$
	10:43			During saw-tooth, found 2 <sup>nd</sup> cloud layer 500-1,100ft pic

description	beginning time	end time	altitude	notes
				
	10:46			In cloud BC 30ng, 70ng above cloud
	10:59			Clouds getting geometrically thicker, more pollution at cloud top 1.5ug/m3 near 12.4S
Above-cloud leg	11:10	11:20		Slightly cleaner above cloud 1ug/m3, 45Mm-1 scat, 0.3 ACAOD, Aerosol layer now about 25% less concentration (in OA, BC, scattering) than last above cloud leg, Rosons observed, APR-3: clouds have been ~1.2 km thick & frequently precipitating
Plume leg	11:21	11:34	5.5kft pressure	After ascent, started 12min leg at 5.5kft pressure alt, 1.3ug/m3 BC, CO at 220 ppbv, same as in plume at 13.5 kft APR-3: clouds have been ~1.2 km thick & frequently precipitating Excited Andrew: "might be the juiciest clouds this far south we've

description	beginning time	end time	altitude	notes
				seen yet, save for the 600m isolated cells we saw on 10/02"
Plume leg (relative clear slot)	11:37	11:45		9kft; ~140 ppb CO, 1.4-1.5 BCOC, 20Mm-1 scat, 300ng/m3
Sawtooth	11:50	12:24		9.5 S – 7 S <ul style="list-style-type: none"> <li>• ACAOD 0.25</li> <li>• Nd &gt; 300/cc, LWC &gt; 1 g/m3</li> <li>• No gap at start of sawtooth (~9.5 S), gap by ~8.5 S</li> <li>• Cloud Nd ~100-200</li> <li>• Some drizzle under where there is gap between cloud+aerosol</li> <li>• Going through very wispy grey cloud</li> </ul>
MD thoughts on sawtooth: Very interesting case, as "above-cloud" view would see plume-cloud contact and Nd of ~300/cc transition to gap with Nd of 100-200/cc — clear mixing story. Yet, below cloud, CO is steady around 100-110 ppbv, or perhaps slightly decreasing to the north. But big difference is drizzle, which can also account for the Nd/aerosol differences. Shows how hard it is to disentangle multiple processes. Although timescale and MBL CO suggest precipitation scavenging is the real story behind the cloud differences here.				
	11:53			Start of saw-tooth, no gap detected, LWC >1g/m3, Nd>300/cc
	12:00			Descending to 200ft in clear slot, AOD ~0.3, 20 Mm-1 , 275ng BC, CO ~100ppb, CCN 200 (@0.5SS)
	12:01			Almost all fine mode scattering
	12:02			Resumed saw-tooth, very clean above cloud, as observed by lidar Southbound
	12:21			Above cloud 3min leg, 9Mm-1, <100ng/m3 BC, ACAOD 0.29
Plume leg	12:28	12:37		7S – 6S, 7.5 kft; Large Roseon's, 60Mm-1 scat, 10min leg

description	beginning time	end time	altitude	notes
Plume leg	12:42	12:52		Leg at 11kft pressure alt, 6S – 5S
Circle spiral	12:52	13:05		Round spiral to minimum safe altitude at 5.5S
	13:07			Ascending to 10kft and RTB, because ground is warning of local convection becoming an issue and recommends RTB by 14:30UT, 0.8g/m3 LWC
	13:25			Transit at 19kft pressure
	13:29			Low and mid-level clouds embedded in smoke
	14:26:14			Landing; Coffee machine spill near HSRL, checking for instrument issues (but probably fine)