

## **RF08 12 September 2016    Mission Report**

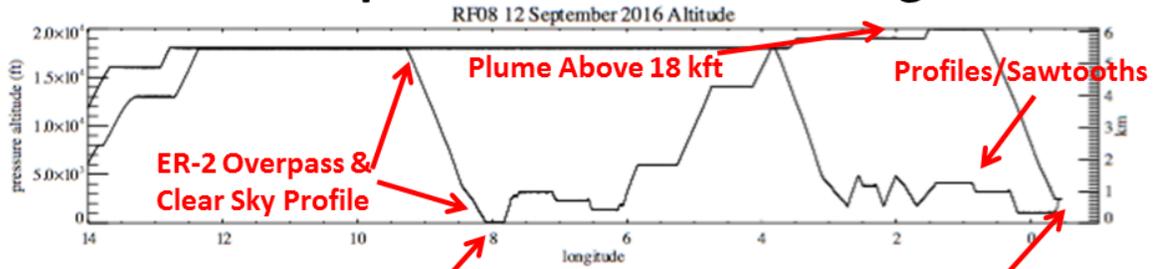
*flight scientist: Greg McFarquhar*

*mission scientist: Sarah Doherty*

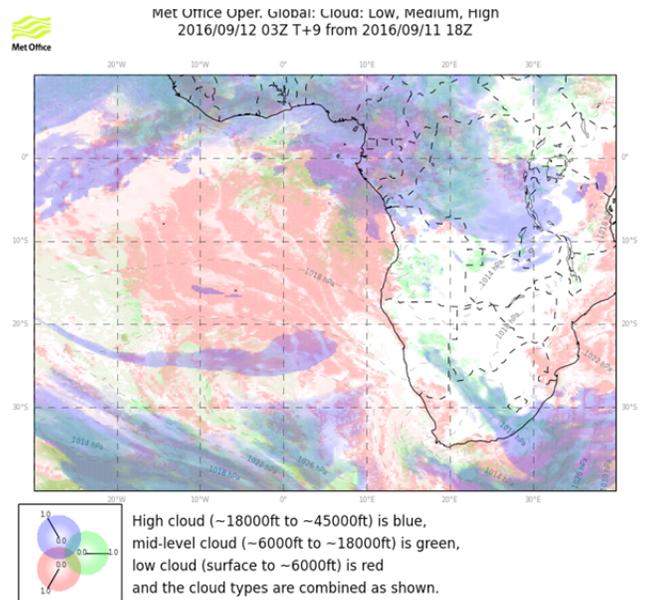
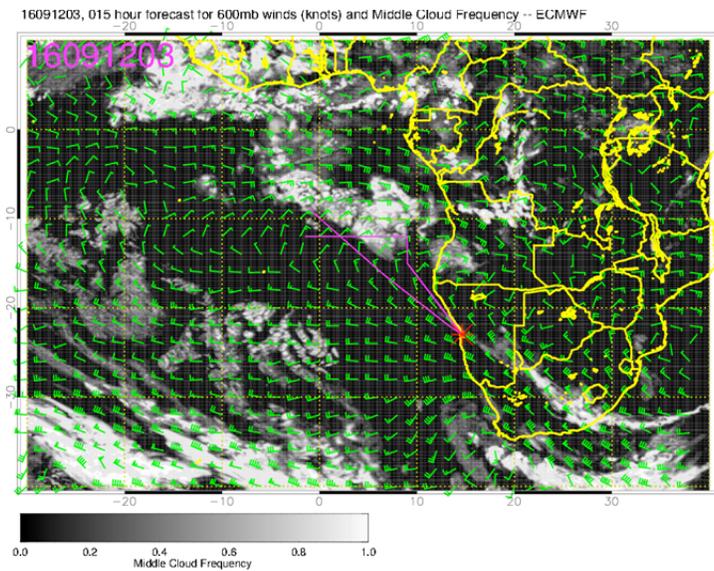
Flight plan and objective: The goal of the mission was to transit to as far north and west on the routine NW-SE line as possible at high altitude, and then to conduct a routine flight on the inbound NW-SE line running from 23°S13°E to 10°S0°E by conducting as many full profiles (legs below, within, above cloud, sawtooths through cloud and profiles/constant altitude legs of free tropospheric aerosols) Loose, but not exact coordination with the ER-2 on the inbound leg was envisioned.

**Flight Summary:** We flew the outbound leg above the altitude of the aerosols, but raised altitude from 18 kft to 19 kft, and then subsequently to 20 kft to keep out of the aerosol layer before starting the profile runs in order to keep the probes clean. Along this path, one speed run was performed where the air speed was reduced to 200 knots indicated in order to help with RSP acquisition of data. At the end of the northbound leg before descend, the APR reported seeing drizzle At 10.75°S the P-3 started to descend towards the boundary layer at 1000 feet per minute. On the descent, another plume was encountered just north of 10°S; the plane turned and started heading south about 40 miles north of 10°S. While travelling just north of 10°S cloud base was 3000 feet, top 3500 feet and the P-3 started to turn at this altitude. But, after turning, the cloud bases encountered were lower so the P-3 descended for the leg below cloud base. A leg through cloud and a leg above cloud were then flown before executing some sawtooth maneuvers. The first saw tooth was executed at 500 feet minute, and the subsequent ones at 1000 feet minute. The second saw tooth included a 3-minute run above cloud, and ascended to 1000 feet above cloud rather than 500 feet above cloud. On these sawtooths, the cloud probes reported some of the largest particles they had seen thus far in the project. After the sawtooth legs the P-3 ascended to 18 kft (500 feet per minute until above inversion, then 1000 feet per minute above), and did two constant altitude legs at 14 and 6 kft, including a 200 knot 5-minute section as 14 kft.). The P-3 then descended to 500 feet below cloud for a 10-minute below cloud leg, 10 minutes above cloud and 10 minutes above cloud (including a 5-minute section at 200 knots). Thereafter the P-3 stayed at cloud level for a few minutes awaiting the arrival of the ER-2 above a target point at 18°S/8°E because the flight scientists were notified that an unplanned overpass was possible. However, the P-3 arrived 7 to 8 minutes ahead of the ER-2 at the indicated point, and there was not sufficient time remaining in the mission to loiter at this location until the ER-2 arrived. Because the clouds had thinned considerably and were very sparse at this location (18°S/8°E), the P-3 executed a full profile to sample the aerosols from 200 feet above the ocean surface (including flying for 5 to 7 minutes at 200 feet of which 5 minutes was at 200 knots indicated) and then ascended to 18 kft (500 feet per minute to 4kft, then 1000 feet per minute thereafter) to transit to Walvis Bay.

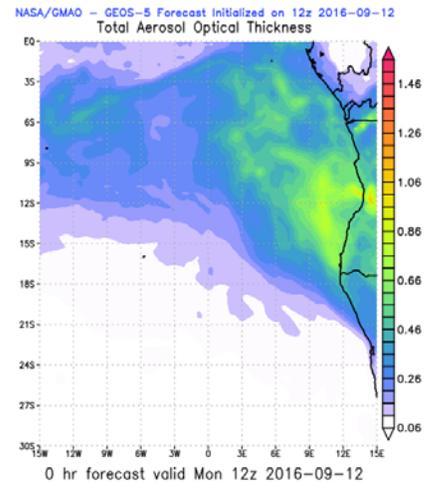
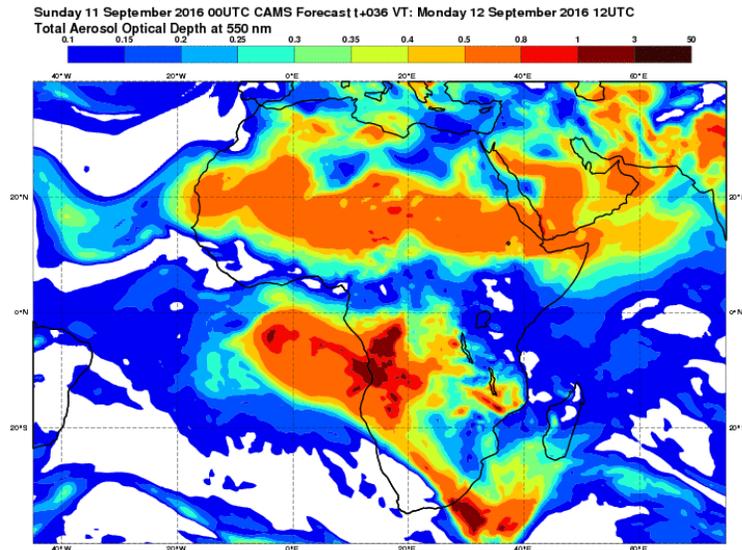
# RF08: 12 Sept. 2016 "Routinish" Flight



**Forecast:** The middle level cloud forecast was very similar to that of 10 September with more on north and east end of the domain, and a waning during the course of the day. Low cloud was expected at the northern and western parts of the ORACLES routine line, with a stable forecast and agreement between the EC and UK models. None of the models were forecasting exceptionally high aerosol optical depths, with no clear trend on how the optical depths varied along the track



Forecast Cloud Coverage.



## Forecast Aerosol Coverage

### Notes from flight:

#### Manifest (full flight)

Crew (5): Michael Singer [chief pilot]/Mark Russell [co-pilot]/Brian Yates/Todd Brophy/Mike Terrell  
 Science (19): Greg McFarquhar [flight scientist]; Greg Sadowy, Ousmane Sy (APR); Brian Cairns (RSP); Steven Howell, Amie Dobracki, Amie Dobracki (HIGEAR, HIGEAR-AMS); Art Sedlacek (PTI); David Noone (WISPER); Jim Podolske (COMA); Joe O'Brien (cloud Probes); Ashley Heikkila (PDI); Sabrina Cochrane (SSFR); Eric Stith (Data); Eric Cantrell (AMPR); Michal Segal Rozenhaimer (4STAR); Herb Sims, Ismail K. Kristina Pistone (Extra)

Ground mission scientist: Sarah Doherty

**General Observations:** In this flight, two boundary layer profiles and two free troposphere profiles were completed including one through an aerosol layer immediately before the ER-2 overflew the same AirMSPI point. Two legs were conducted through the aerosol plume, with the aerosol plume being more intense further south. The boundary layer profiles were quite clean, and clouds and precipitation were observed to reach the ground from the APR towards the northern end of the track. The biomass burning plume was not being entrained into the cloud. There were few mid and high level clouds noted. In general, the top of the aerosol layer was very high, extending to 19kft and then 20kft at the northern end of the routine leg. When descending into cloud layers, the AOD increased up to 0.2-0.25, which was relatively lower compared to previous days. Images showed that a thick BB layer was underneath the P-3 at  $\sim 12^{\circ}\text{S}/2^{\circ}\text{E}$  and when continuing further northwest. When going towards  $-10^{\circ}\text{S}/0^{\circ}\text{E}$ , the brown haze seemed to be mainly to the east. In summary, AOD values were lower than in former days, 0.2-0.3 versus 0.5-0.6 on other days. Over the cloud tops, towards the crossover with ER-2, the AOD was about 0.3. In general, AOD at altitude 19kft was higher on the inbound routine leg at about 0.02 relative to 0 ( $\sim 0.005$ ) on the outbound leg.

#### Instrument Status:

4STAR: good flight, AOD comparable to Saturday's flight when were very high (0, and max of 0.4), some zenith mode for retrievals and some sky scans

HIGEAR: good flight, everything worked well, interesting MBL data, mostly clean and some good data above cloud that was very clean

HIGEAR-AMS: AMS ran well, weren't in plume layer too much, but got some really good data when ascending and saw 2 layers and difference in nitrate concentrations

AMPR: 37 GHz was disrupted by radar, post-processing will take care of it.

RSP: instrument worked well on nice slow legs, geometry coming back for remote sensing for comparing with ER-2, low-level leg nice lots of nice caps

APR: worked perfectly, on transit observed nice clouds and precipitation reaching ground, some looked like convective precipitation but need post-processing

Cloud probes: everything operational except 2DSV, have CIP/2DSH, sawtooths during first profile saw number distribution broaden to lower sizes as went thru cloud

CCN: functioned, report #s, couple periods looked like 100% activation

PTI: functioned, bit noisier than would like, absorption in green at minimum of 25; absorption Angstrom exponents of 1.2

PDI: worked really well, mean distribution #s similar to previous flights

WISPER: performed well, great data in up and down profiles, base data great from low water vapor concentrations

COMA: worked well; some of cleanest air that has been sampled thus far

SSFR: worked well whole flight, no radiation walls, but good to look at SSFR on ER-2 with this plane

Data: performed well with couple of exceptions

**Run Table [UTC; times are approximate]**

Run #	Start time	End time	Altitude	Notes	SOs attempted
1	7:27	7:58		Takeoff; going west and then diagonal northwest	
2	7:58	10:16	18 kft	Transit above plume	SO1-2
3	10:18	10:47	19 kft	Transit above elevated plume	SO1-2
4	10:49	11:00	20 kft	Transit above even more elevated plume	SO1-2
5	11:00	11:22		Descending to boundary layer	SO1-1; SO1-3; SO2-1; SO2-3; SO3-1; SO3-2
6	11:22	11:32	1 kft	10-minute leg ~500 feet below cloud base	SO2-1; SO2-2; SO2-3; SO3-1; SO3-2; SO3-3
7	11:34	11:44	3.2 kft	10-minute leg within cloud	SO2-1; SO2-3; SO3-1; SO3-2; SO3-3

8	11:46	11:55	4.2 kft	10-minute leg above cloud	SO2-2; SO2-1; SO1-2
9	11:55	12:21		Saw tooth profiles through cloud	SO2-1; SO2-3; SO3-1; SO3-2; SO3-3
10	12:21	12:42		Ascent to 18 kft through free troposphere	SO1-1; SO1-2; SO1-3; SO2-1; SO2-2
11	12:42	12:58	14 kft	Descend to 14 kft for constant altitude run through aerosol plume.	SO1-1; SO1-2; SO1-3; SO2-1; SO2-2
12	12:58	13:17	6 kft	Descent to 6 kft for constant altitude run through aerosol plume	SO1-1; SO1-2; SO1-3; SO2-1; SO2-2
13	13:17	13:23		Descent to 500 feet below cloud	SO1-1; SO1-3; SO2-1; SO2-3; SO3-1; SO3-2
14	13:23	13:32	1.3 kft	10-minute run ~500 ft under boundary layer cloud base	SO2-1; SO2-2; SO2-3; SO3-1; SO3-2; SO3-3
15	13:34	13:43	2.3 kft	10-minute run through cloud	SO2-1; SO2-3; SO3-1; SO3-2; SO3-3
16	13:44	13:56	3.2 kft	10-minute run ~500 ft above cloud	SO2-2; SO2-1; SO1-2
17	13:56	14:01		Descent to 200 ft above ocean surface	SO1-1; SO1-2; SO1-3; SO2-1; SO2-2
18	14:01	14:09	0.1 kft	Run at 200 ft above ocean surface	SO1-1; SO1-2; SO1-3; SO2-1; SO2-2
19	14:09	14:30		Profile through boundary layer and free troposphere (to 18 kft) in cloud free conditions	SO1-1; SO1-2; SO1-3; SO2-1; SO2-2
20	14:30	15:14	18 kft	Constant altitude run at 18 kft	SO1-1; SO1-2; SO1-3; SO2-1; SO2-2

20	15:14			Return to Walvis Bay	
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**Progress towards Science Objectives: expectation-based estimates need further analysis  
green-success likely red-success uncertain**

*Direct Forcing*

SO1-1 evolution of BBA properties with transport:

SO1-2 spectral radiative fluxes

SO1-3 factors that control seasonal variation of aerosol

*Semi-Direct Effect*

SO2-1 relative aerosol-cloud vertical structure

SO2-2 constrain aerosol heating rates

SO2-3 cloud microphysics

*Indirect Effects*

SO3-1 aerosol-BL mixing

SO3-2 aerosol-BLcloud microphysics

SO3-3 precipitation susceptibility

Additional Notes and pictures available from Kristina Pistone (her notes contributed to this report)