Flight report: 18 August 2016, PRF10

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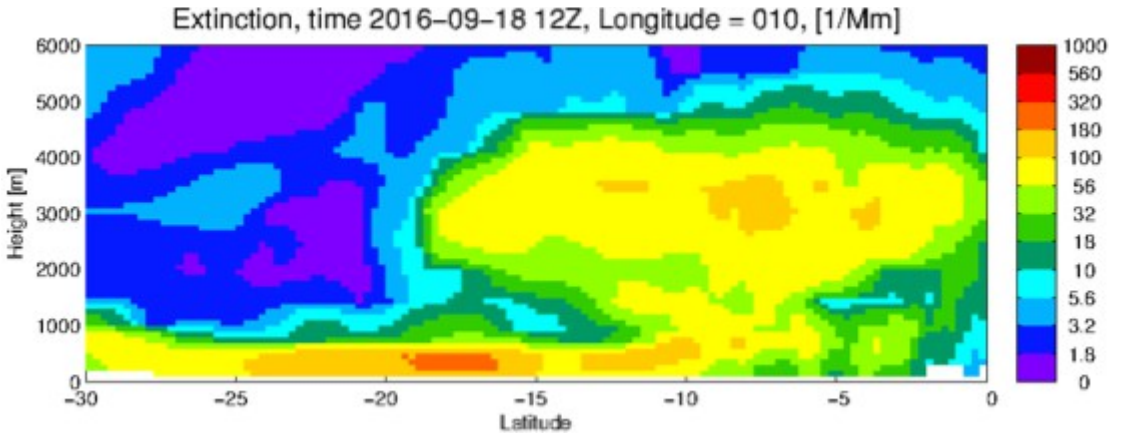
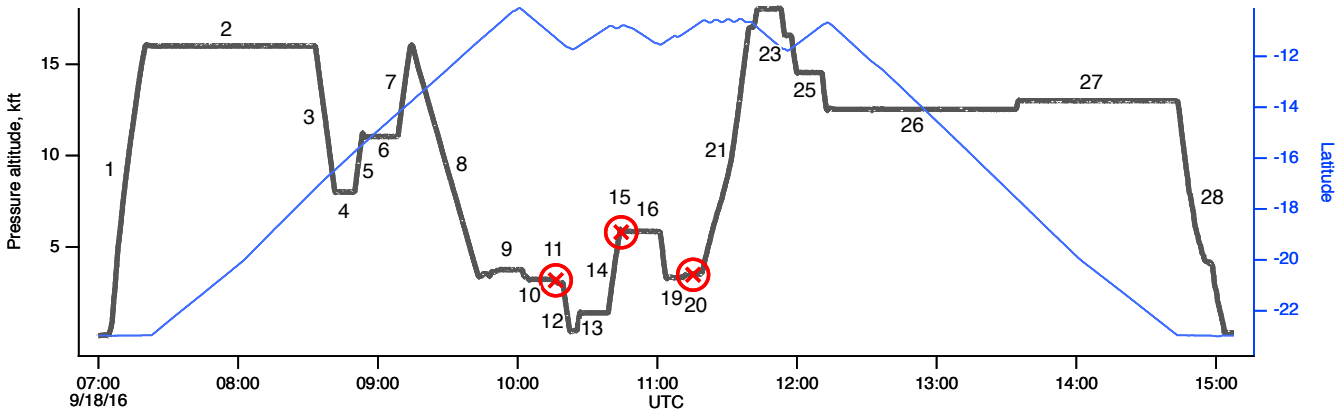
Walvis Bay local flight

Overview:

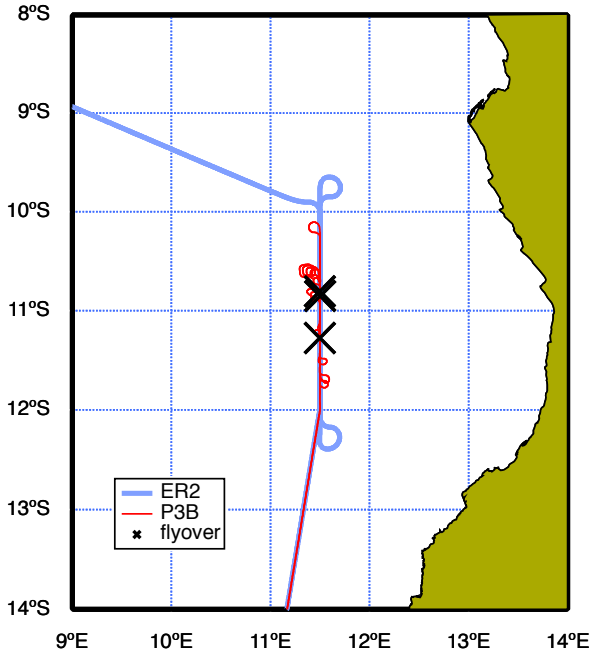
In this flight we wanted to find the youngest, densest plume we could by flying up the coast. That increases the likelihood of cirrus, so this pattern had been avoided in previous flights. We were chasing a predicted plume at about 4 km and just a few days old. The lower parts of the plume were predicted to be older. The goals of the flight were:

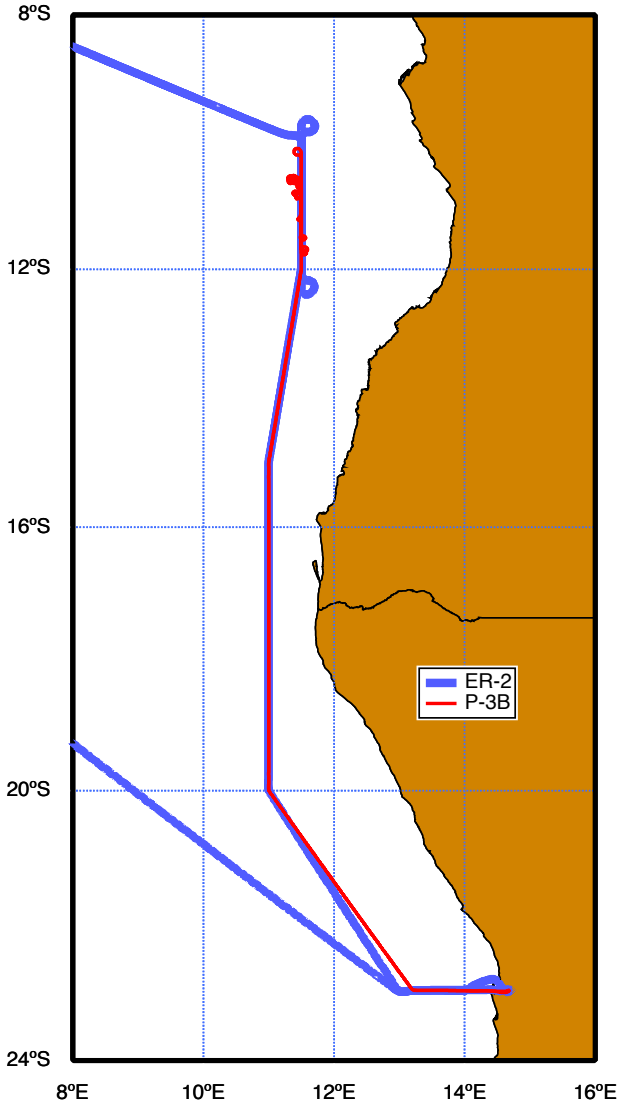
- Sample freshest substantial plume possible, in this case a predicted tongue at 12ºS to 14ºS, 11.5ºE
- Full radiation wall near the coast
- Coordinate with 3 ER-2 crossings
- Address odd finding that aged plumes seem to have little brown carbon





Event	Start	End	Alt	Description
1	07:04:25	07:20	16,000'	Takeoff, ascend to transit altitude through point α
2	07:20	08:33	16,000'	Transit
3	08:33	08:41	8000'	Slant profile down through much of the plume (exploring plume, also slowing down for the ER-2)
4	08:41	08:50	8000'	Level leg
5	08:50	08:53	11,250'	Up to thicker region of plume. Overshot a bit
6	08:54	09:08	11,000'	In-plume leg
7	09:08	09:14	16,000'	Up to above plume
8	09:14	09:43	3400'	Profile down to just above cloud, entering study region
9	09:43	10:02	~3500'	Above cloud run
10	10:04	10:19	3300' to 3100'	In-cloud run. Thin clouds, adjusted altitude to stay in.
11	10:16:24		3100'	ER-2 overpass. P-3B near top of cloud, occasionally breaking through. Should be good for ER-2 cloud property validation.
12	10:19	10:22	400'	Profile through MBL. No scud, apparently not decoupled. Calm seas, no whitecaps.
13	10:27	10:38	1500'	MBL leg. Processed pollution, enough that AMS high-precision mode worked.
14	10:38	10:44	6000'	Square spiral up to 6000'.
15	10:44:31		6000'	ER-2 overpass. P-3B in lower pollution layer. Not really ideal for anything. Maybe HSRL comparison.
16	10:49	10:58	6000'	Radar overpass of southern half of cloud leg.
17	11:01	11:04	3000'	Profile down to just above cloud.
18	11:06	11:11	3000'	Circling to wait for ER-2
19	11:11	11:19	3500'	Above cloud run
20	11:15:26		3500'	ER-2 overpass. Very nice this time! Just above cloud
21	11:19	11:39	17,000'	Square spiral up through plume
22	11:39	11:42	18,000'	17kft wasn't completely out of plume, up to 18kft
23	11:42	11:53	18,000'	Radiation leg (almost?) entirely above plume
24	11:54	11:57	16,000'	Heading N at plume level. But it's not here!
25	11:59	12:10	14,500'	Found the plume at 14.5kft. In-plume level leg
26	12:14	13:33	12,500'	Exit the study region heading south in the plume
27	13:34	14:43	13,000'	Adjust up a bit during transit back,
28	14:43	15:03:30	0	Descent to WBV, landing



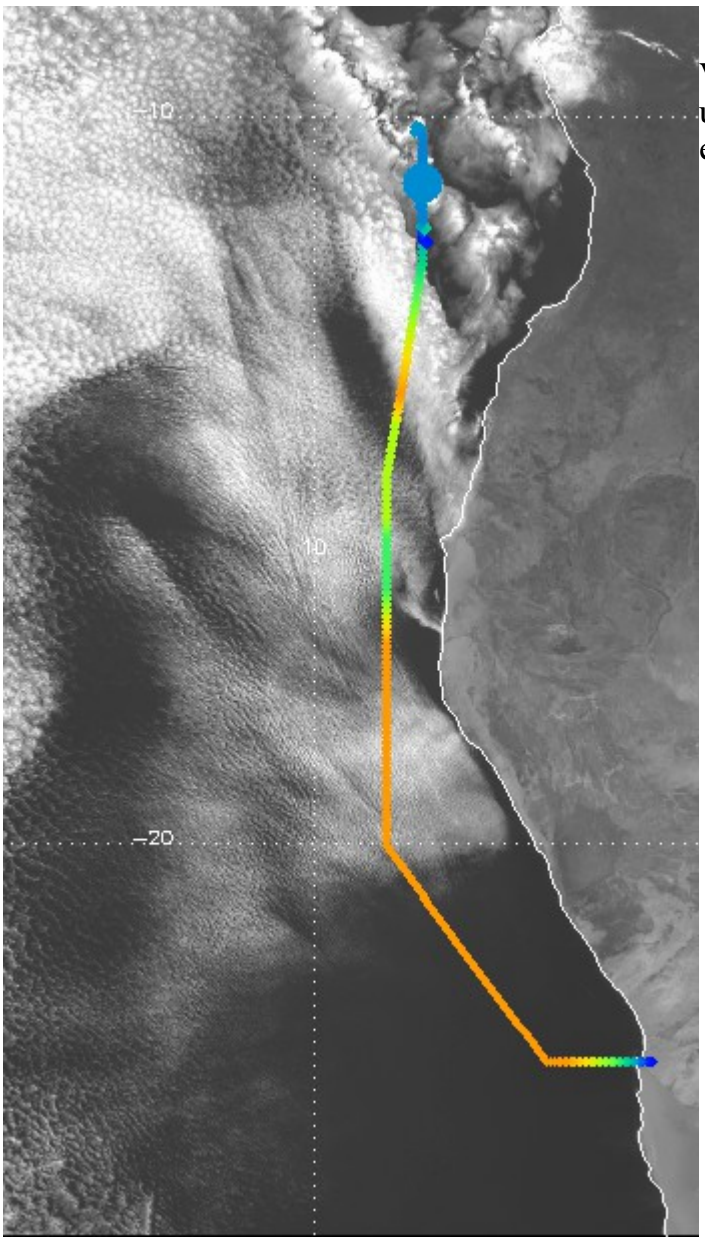


Highlights:

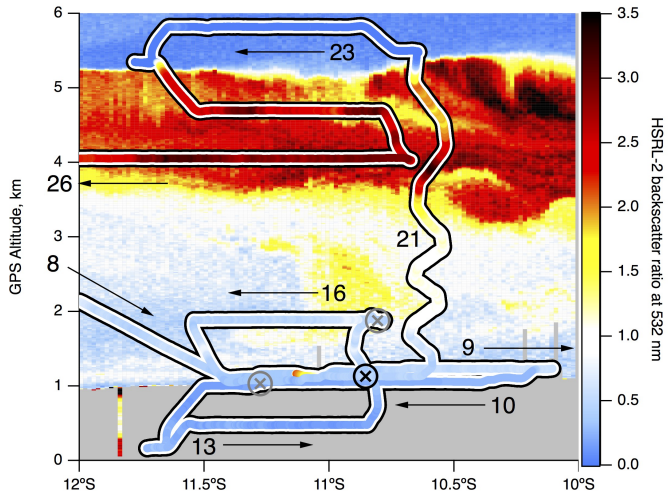
- We did find a big, high plume as predicted
- Used HSRL data to identify layers to fly in
- Fairly uniform cloud cover, variety of drizzle rates.
- Polluted, but not decoupled MBL
- The radar data were apparently great!
- ACAOD fairly steady ~0.35, perhaps to 0.4.
- 2 pollution layers found, at 10 to 13 kft and 14 to 17 kft
- The long transit restricted time on station, so there was just one radiation wall, but it was pretty extensive, with 3 in-plume legs, 2 legs just above cloud, an extended cloud leg, an MBL leg, and one deep profile.
- Cirrus didn't seem to be a big problem, so even though we had anticipated a primarily in-situ flight, the radiation data may be of high quality.
- 3 ER-2 overpasses, two of which were really nice (one just above cloud top, the other just below)

Lowlights:

- Making all 3 ER-2 overpasses useful was too difficult. Might have worked better with more planning and more practice.
- HIGEAR nephelometer failed to turn on, so less scattering data than usual.
- I failed to get a complete vertical profile from sea surface to above the plume in a single location. After the 3rd ER-2 overpass, I should have descended to 100' and done the big square spiral profile from there. (My rationale was to get the profile in as soon as possible after the overflight.) A difficult-to-time option would have been to profile from low altitude, reaching cloud top just before the overpass.



Visible imagery makes the clouds look less uniform than the seemed from the plane. Might explain the changes in drizzle.



Latitude vs altitude in the study region. HSRL backscatter ratio at 532 nm from near the 3rd overpass is superimposed on the P-3B flight path. The P-3B path is colored by scattering from the dry Radiance Research nephelometer. It's kind of cheating; while backscatter ratio and total scattering are related, they are not strictly comparable quantities. The agreement in color is very pretty, though! The black ⊗ is the P3-B position at the 3rd ER-2 overpass; the grey ones are the earlier overpasses. Numbers are those in the event table.

View through the forward camera at the 3rd ER-2 overpass.

Instrument status:

P3	All good
4STAR	Worked well; max AODs slightly above 0.4, but will have to confirm no cirrus in the post-processing
HiGEAR	Everything worked well… total nephelometer didn't come on today, so using submicron as the total neph, didn't have submicron scattering today. AMS worked; w-band worked
AMPR	worked.
RSP	Worked, good data when air speed is slow
APR3	Good flight, implemented new trick to get data closer to the surface.
Cloud probes	Worked well except the 2ds which worked fine eventually (software issue; worked the second-half of in-cloud leg, and after); got good data in the 20-min in-cloud leg.
CCN	Worked well, saw lower activation ratios in fresher plume, overall some of the highest CCN concentrations seen even though lower fraction compared with CN counts. Depleted supersaturation in the column.

PTI	Worked, comparison between PSAP and PTI showed PSAP high by ~50%; saw AAE values in this plume higher than what was seen further west; consistent with Art's theory of bleaching
PDI	Worked well
Vertical winds	Apparently fine (personnel not on flight)
WISPR	Worked (personnel not on flight)
COMA	Worked well
SSFR	Had good flight, liked those square spirals. Want below-cloud to above the plume in all one go in future flights if possible
data	Worked well; maybe will have new plots next time??

Progress towards Science Objectives:
green-success likely red-success uncertain
Direct Forcing
SO1-1 evolution of BBA properties with transport: ~ 3 hours in study region, ~2 hours in FT BB plume both younger than other flights up high and of various ages
SO1-2 spectral radiative fluxes ~2 hours
SO1-3 factors that control seasonal variation of aerosol
Semi-Direct Effect
SO2-1 relative aerosol-cloud vertical structure Total about 90 minutes near FT/MBL boundary
SO2-2 constrain aerosol heating rates Good flight pattern, but apparent gap in SP2 data
SO2-3 cloud microphysics 20 minute cloud leg
Indirect Effects
SO3-1 aerosol-BL mixing No gap between aerosol and less polluted MBL; Total about 90 minutes near FT/MBL boundary
SO3-2 aerosol-BLcloud microphysics 20 minutes in mildly polluted MBL, 20 minutes in MBL clouds
SO3-3 precipitation susceptibility 20 minute cloud leg, 10 minute radar leg