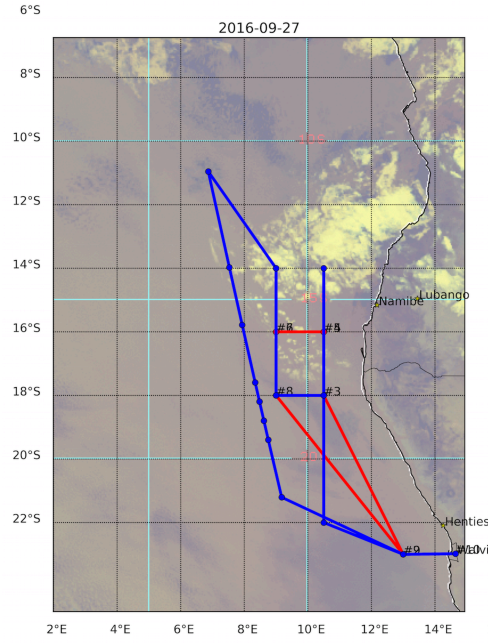
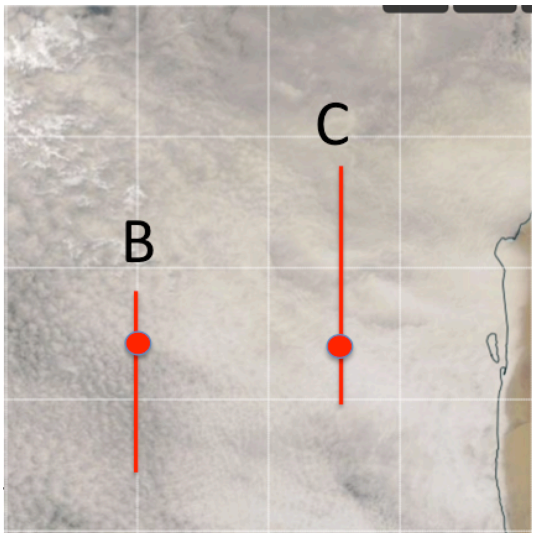
**PRF11 September 20 Tuesday**
**Mission Report**
*flight scientists: Sebastian Schmidt, Sarah Doherty*
*mission scientists: Greg McFarquhar, Rob Wood*

**Primary flight objective:**
Sample aerosol radiative effect, microphysical/optical aerosol and cloud properties for two different types of cloud fields (in terms of albedo and/or cloud fraction) in coordination with the ER-2.



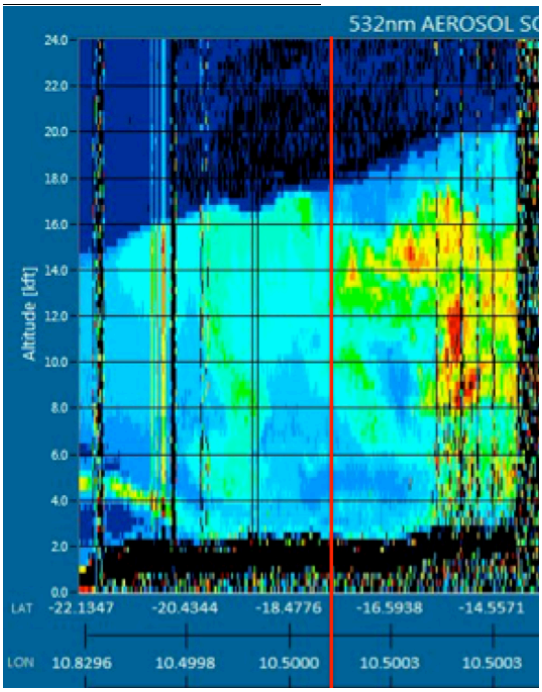




**Flight Summary:**

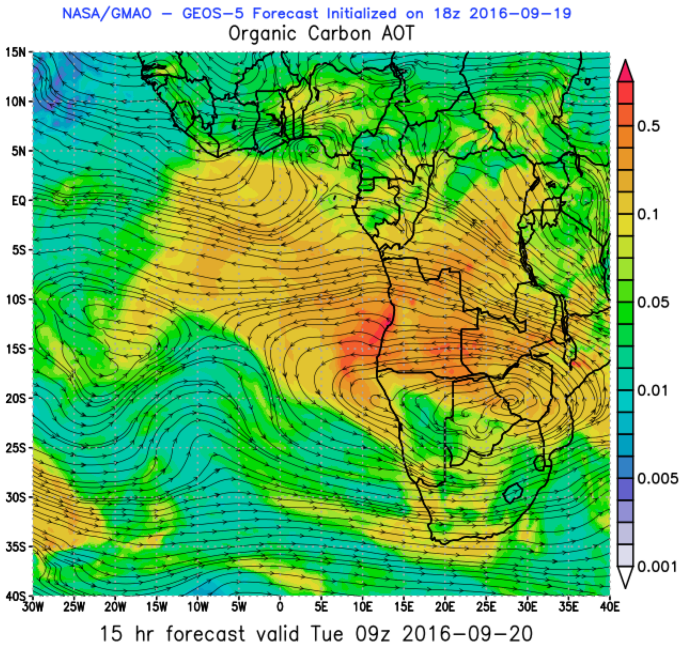
- flew two almost complete radiation/microphysics walls at 10.5E (“C”) and 9E (“B”)
- approximate latitudes for ER-2 coordination above; 2 at “C”, 3 at “B”
- ran into mid-level on “B”; decided to avoid them and move wall further South
- biomass burning plume reached highest altitudes so far (21kft) and largest AOD (~0.8)
- apparently fresh aerosol, absorption Ångström exponent higher than on other flights
- plume more stratified than on other days, vertical mixing did not set in yet
- patches of drizzle found in radar and cloud probes
- all instruments worked, although there was a temporary problem with the cabin temperature which affected AMS

**Manifest** Michael Singer, Mark Russell, Brian Yates,Todd Brophy, Mike Terrell (crew) Sebastian Schmidt, Sarah Doherty, Simone Tanelli/ Elin McIlhattan (APR), Kirk Knobelspiesse (RSP), Steffen Freitag (HIGEAR-1), Nikolai Smirnow (HIGEAR-2), Amie Dobracki (AMS), Mary Kacarab (CCN/WISPER), Art Sedlacek (PTI), Jim Podolske (COMA), Siddhant Gupta (Cloud probes/PDI), Sabrina Cochrane (SSFR), Mike Delaney (data), Herb Sims (data), Connor Flynn (4STAR), Michael Diamond (flight scientist training), Senior Shimhanda, Benjamin Nathanael (shadow students)

## Cloud/aerosol situation



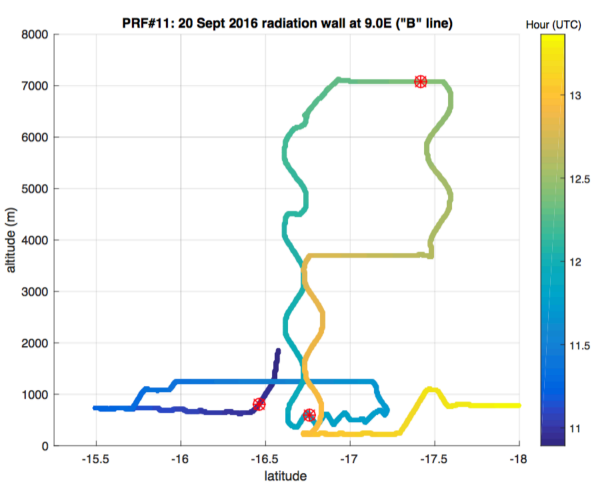

HSRL curtain along NS axis

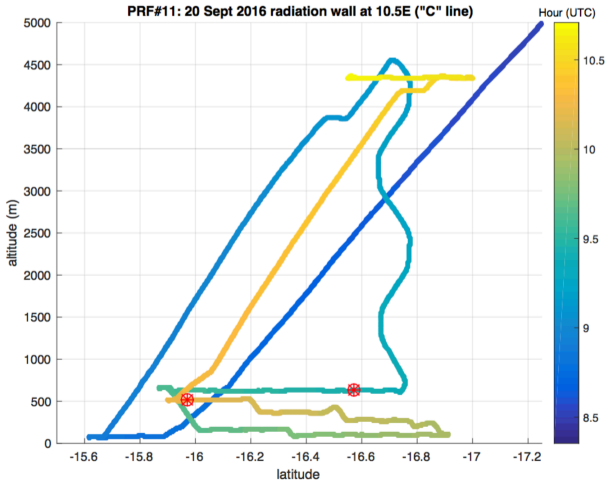



Forecast of OC AOT

Cloud situation in the target area: No high-level clouds, some mid-level clouds north of 15S, and a band of mid-level clouds at 17S (IR imagery), overcast low-level clouds which are thinning out on western (B) leg (partially breaking up, geometrically and optically thinner than in East (C))

## Wall setup and P-3/ER-2 coordination




HSRL curtains available for both walls; ER-2 overpasses marked by red circle

Description of walls:

*Wall C at 10.5E*

- full profile down (northbound)
- cloud profile (8:43), cloud base at 700'
- full profile up (southbound) further north than first profile, while waiting for ER-2
- radiation spiral down (with 200kn indicated airspeed for RSP)
- below-aerosol/above-cloud leg (northbound)

- 1st ER-2 overpass above solid cloud deck
- below-cloud leg (southbound)
- in-cloud in-situ sampling, stepping up gradually from base to top
- 2nd ER-2 overpass while we are in upper third of cloud (still solid cloud deck)
- climb up (southbound) for in-situ/radiation leg (northbound), then break off to west and continue in-situ sampling in transit to next wall, then descend to above-cloud level

*Wall B at 9E*

- lower albedo and cloud cover wall
- start with above-cloud/below-aerosol run and
- 1st ER-2 overpass above cloud; on this leg, we are running into mid-level clouds and reverse course;
- while working our way back south (out of mid-level clouds), we sample 1st in-situ layer at 3,500ft as recommended by HIGEAR
- in-cloud leg (northbound); since cloud is so thin, we do shallow porpoise as recommended by probes
- 2nd ER-2 overpass while in upper part of cloud porpoise
- radiation/in-situ spiral up, far enough south from mid-level clouds
- above-aerosol southbound run (clean); had to climb all the way up to 21 kft
- spiral down to 2nd in-situ leg (this time at higher level) northbound
- spiral down to below-cloud southbound
- profile up through cloud, short above-cloud leg, and return home

**individual instrument/science reports**

- APR: good flight, first leg (C) was a good dry-run for second module, second leg (B) was excellent sampling of a very thin, inactive, non-precipitating cloud, rest of the day was surveying
- RSP: descent cloud legs, 2 scenes with aerosol above cloud; slowed down sufficiently for the first
- HIGEAR: interesting day for aerosol data, capture almost everything from completely clean to polluted. Mostly fresh aerosol, interesting to see the high altitudes of the plume; cleaner clouds were encountered on western leg (B)
- AMS: Worked well, but concerned about temperatures (ADC, not pumps). Interesting to samples fresher vs. older parts of the plume
- CCN: Mary mentions that today was different case compared to the other days in terms of stratification (less vertical mixing had occurred in aerosol layer); data "funky" (sudden spikes), i.e., inhomogeneous aerosol layer
- PTI: Ran well, but fighting some heat-related issues (again cabin temperature). Able to get some good aerosol absorption measurements (PTI: 20-25 1/Mm; PSAP 50 1/Mm uncorrected); PTI single scattering albedo 0.86, vs. 0.75 from PSAP/Neph (uncorrected); values will become more consistent once scattering correction for PSAP applied. This will contribute to the absorption Ångström story, where here we are looking at a more "normal" case of fresher aerosol that is has not grayed through aging yet
- COMA: worked well, both main and ozone instrument. Lost Ozone for 20 minutes while going through drizzling cloud. A lot of variability in horizontal structure; not a lot of vertical mixing
- Cloud Probes/PDI: Worked well, got good data. New sampling approach for geometrically thin clouds: saw tooth (shallow porpoise) patterns. Thinner clouds in the west (B)
- 4STAR: worked very well. Best flight so far on the P-3 (in terms of AOD: 0.8); did sky scans, cloud scans, zenith mode obs
- SSFR: worked well; two walls, several spirals; should see contrast in terms of aerosol properties and cloud albedo (perhaps also CF)

**Metrics for achieved science objectives [green for full, red for partial]**

*Direct Forcing*

SO1-1 evolution of BBA properties with transport:

2 full characterizations of ambient/behind-inlet properties of *young* plume

[The metric here could be age of plume and/or distance from shore. Distinguish partial characterization (routine flight profiles with mainly in-situ measurements) vs. full radiation/in-situ characterization, which allow in-situ + radiation/remote sensing together]

SO1-2 aerosol radiative effect as function of cloud/aerosol properties:

2 cases. AOD~0.8. CF~100, but different COD on B vs. C

[The metric here could be (1) aerosol properties, (2) cloud properties, e.g., (1a) AOD500, (1b) SSA500, (1c) AAE, (1d) hygroscopicity, (2a) cloud fraction, (2b) COD, (2c) Reff; other cloud parameters such as Nd, precip are important for other objectives.]

SO1-3 factors that control seasonal variation of aerosol

5 collocations with ER-2 tie P3 measurements to remote sensing observations; two cases (walls B and C) to provide detailed information for Meyer retrieval of AOD above cloud [two data points for aerosol properties; two data points for cloud properties]

[Currently, routine flights are proposed as only way to achieve this via model validation. However, we should consider a second category: frequent links to satellite observations in distinctly different locations. This link can, however, only be established by full characterization of the aerosol properties above cloud, along with cloud properties. After the ER2 is gone (next deployment), this can only be done through satellite overpasses.]

*Semi-Direct Effect*

SO2-1 relative aerosol-cloud vertical distribution:

2 cross sections at 9.5E and 10E / both at 16.5±1S (1.5 hours each)

SO2-2 constrain aerosol heating rates:

2 full heating rate profiles for young plume (1.5 hours each)

[The metric here could be # of cases of full walls.]

SO2-3 cloud micro/macrophysics:

2 different cloud fields, probably not sufficient statistics for semi-direct?

*Indirect Effects*

SO3-1 aerosol-BL mixing:

2 cases with beginning aerosol-BL mixing for young, stratified plume

SO3-2 cloud changes as function of mixing

2 cases in terms of mixing and cloud microphysics: “dirtier cloud” on C leg, but shallow/thin on B,

SO3-3 precipitation susceptibility

2 contrasting cases (some drizzle on leg C → may not be function of mixing, but advection/meteorology in this case)

Note: While we sampled a latitudinal cross section of the atmosphere at only two longitudes, we actually saw gradients in mixing, vertical structure, and precipitation as a function of latitude. We certainly have more than just two profiles at each of the two longitudes.