DICE Flight Report: June 13, 2003

Flight Type: LRR piggyback with Trinidad Head (TH) Flybys and Central Valley Sampling

Flight Objectives:

1. Continue instrument characterization studies
2. Examine sensitivity of APS and RR neph units by cross-sampling between racks
3. Perform constant level legs in polluted air masses for instrument/technique inter-comparisons
4. Perform multiple flybys of Trinidad Head

Flight Plan (UT)

16:15:00	Taxi
16:21:47	Takeoff
16:31:47 – 16:57:30	level at 18 kft in haze layer; good instrument IC leg
17:25:20 – 22:50:20	level at 35 kft doing LRR maneuvers; very low aerosols
22:50:20 – 23:27:00	Down-sounding from 35 kft over TH; all isokinetic
23:27:10 – 23:33:40	level at 500' MSL passing TH; all isokinetic
23:36:40 – 23:45:00	level at 500' MSL; UH and UNH inlets switched; all iso; pass TH
23:46:00 – 23:50:20	level at 500' MSL; sampling own inlets; all iso
23:59:30 – 24:20:00	level at 13 kft; UNH 70%; LaRC 70%; UH iso
24:26:00 – 24:35:00	level at 8 kft; UNH 70%; LaRC 70%; UH iso
24:36:00 – 24:43:00	level at 8 kft; UH and LaRC inlets switched
24:51:40 – 25:01:00	level at 1 kft; all 70% of iso
25:02:00 – 25:10:00	level at 1 kft; UH and UNH inlets switched
25:20:30 – 25:41:00	level in haze layer at 16 kft

Participating DICE Groups: Langley In Situ, Langley Lidar, PILS, Hawaii, UNH, Cal Tech

Report

As usual, the weather was dry and cloudless at Edwards California, in the heart of the Mohave Desert. At takeoff time, the temperature was ~70^{o}F and winds were light and variable but generally coming from the southwest. Haze was prevalent throughout the valley and striated dark features apparent on the horizon that gave us an indication that elevated layers of pollution might be encountered on the ascent out of Edwards.

We took off at ~9:15 am local and climbed to 18 kft for a 20 minute sampling leg prior to turning the aircraft over to LRR for their extensive surveying of snow- and cloud fields over the Cascades and North Pacific, respectively. Fortuitously, this altitude coincided with that of an intense pollution layer that was persistent in both space and time (Figure 1). Scattering coefficients in the layer peaked at > 50 Mm, which was higher than values

recorded in the boundary layer on takeoff. Dave Westberg's trajectory forecasts show the layer originated from frontal lifting that occurred a few day previously over the Western Pacific near Japan and indicated the air mass should contain biomass burning emissions from central Asia as well as urban emission from Pacific Rim.

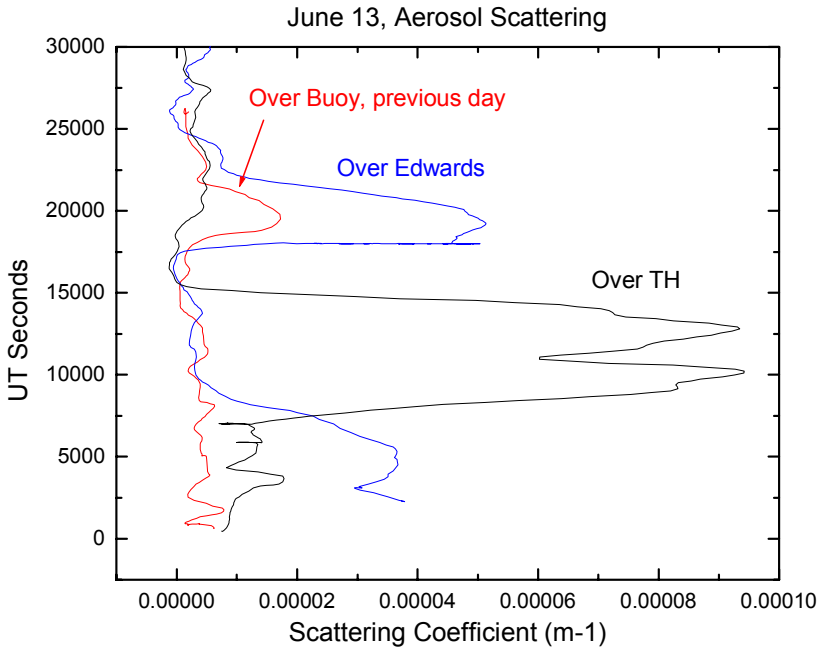

Figure 1. Aerosol scattering profiles recorded during the ascent from Edwards (blue), the descent into Trinidad Head (black), and the downsounding over an ocean bouy located 200 km west of Monterrey on June 11, all showing evidence of a pollution layer between 17 and 25 kft altitude.

At the end of the 18 kft leg, we climbed to 35 kft, flew north over Lake Tahoe then headed northwest, crossing an cold-front, to a fly over group of low-level rain clouds several hundred km offshore, west of British Columbia. After crossing the front into the cold side of the low, we noted the presence of thin cirrus at altitudes below our flight level; CIMS reported measuring high HNO3 concentrations indicative of stratospheric air.

When LRR finished mapping the oceanic rain showers (5 hours into the flight), we headed southeast, re-crossed the cold-front and entered a region of high humidity and widespread cirrus. We crossed several contrails, as evidenced by their high concentrations of ultrafine particles, and obtained several minutes of cirrus particles observations with our wing-tip mounted precipitation particle imaging probe.

During the descent into TH, we noted slight enhancements in scattering at ~20 kft (see above discussion), but penetrated a layer with significantly enhanced aerosol loading below 15 kft (Figure 1). CIMS reported that the layer contained high concentrations of

organic acids, but PILS noted no enhancement in potassium suggesting an urban rather than biomass burning source for the pollution.

Aerosol parameters dropped like a rock as we neared the top of a thick stratus deck at 7.5 kft, possibly due to precipitation scavenging. Below the deck (~2 kft base) and in the vicinity of TH, humidity levels were high and CN values were relatively low; patchy scud clouds were evident over the forest near the Arcata airport and intermittently over the ocean west of TH. The cloud cover will preclude a closure experiment between the aircraft optical aerosol measurements and the ground station sunphotometer, but winds were from the northwest, with a long ocean fetch and spatially uniform concentrations, so the comparisons between in situ measurements should be meaningful.

After completing an approach to Arcata Airport, we headed northwest and passed ~200 meters west of the NOAA ground site at ~500' MSL. We then went into a 10^{o} banked turn and completed a left base back to the airport, remaining at 500' over the water for ~5 minutes. After the second approach to the Arcata Airport, we again passed TH at 500'and went into a broad 10^{o} left banked turn that resulted in ~10 minutes low level sampling time over the water.

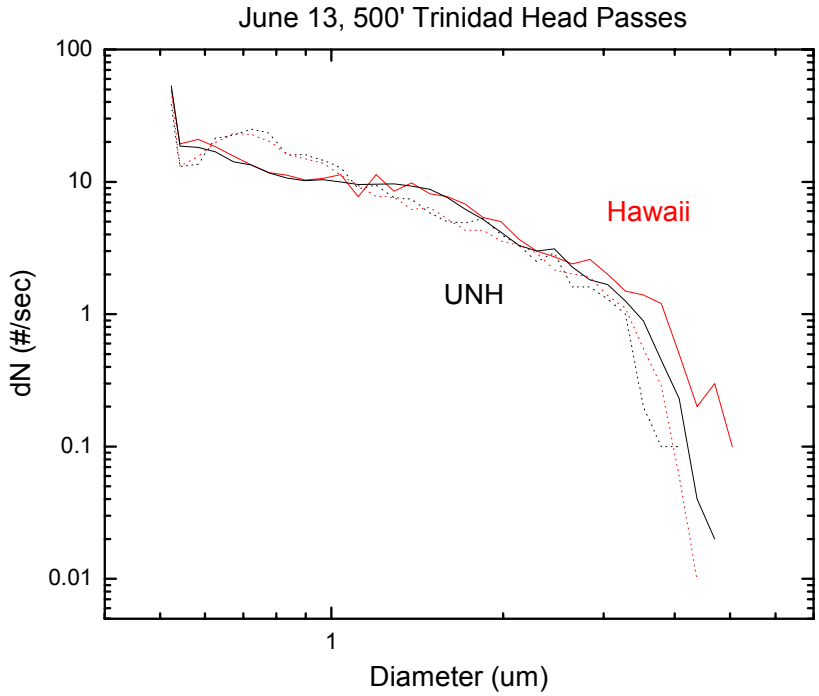

Figure 2. MBL aerosol size distributions from behind the Hawaii and UNH inlets when sampled by the APS unit on the Hawaii (solid curves) and UNH (dashed) racks.

For the first TH flyby, all inlets were isokinetic and sampled by the instruments on the respective group's rack. For the second pass, the UH inlet was sampled by the UNH instruments and visa versa. Figure 2 shows aerosol size distributions recorded on these passes and indicates that the APS unit on the UH rack is slightly more sensitive to large particles than its UNH counterpart. However, taking the differences into account, it appears that the UH inlet may be slightly more efficient at transmitting coarse mode particles. This was supported by additional inlet cross-over sampling data obtained during the1 kft run over the Central Valley later in the mission (Figure 3).

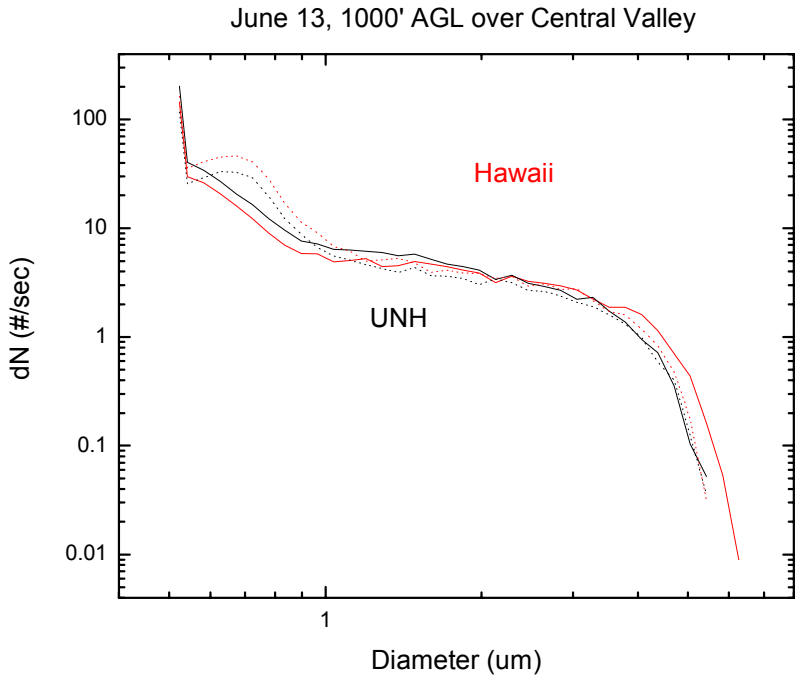

Figure 3. Aerosol size distributions from behind the Hawaii and UNH inlets when sampled by the APS unit on the Hawaii (solid curves) and UNH (dashed) racks. Data are from the 1 kft leg over the Central Valley.

When we completed the second loop pass TH, we climbed to 13 kft and headed back to Edwards via the Central Valley of California, re-entering the heavily polluted layer sampled during the downward spiral into TH. During the 20-minute leg at this level, we again measured large scattering coefficients (Figure 4) and CIMS reported enhance HNO3 and organic acid concentrations and an interference signal associated with high levels of O3. Single scattering albedo was ~0.86 in the layer, indicating high concentrations of absorbing aerosols (black carbon). The layer was still evident when we dropped down to 8 kft (Figure 4), but began to thin out as we approached the downwind side of the San Francisco Bay area; indeed, scattering coefficients dropped two orders of magnitude between the beginning and end of the 20-minute leg.

When we descended to 1 kft AGL, skies were relatively clear and the air somewhat clean over the Central Valley, though dust billows were evident in the wake of trucks and farm

vehicles traveling the roads and plying the field of the land below. These particles were clearly evident in the APS size distributions recorded during the leg (Figure 3).

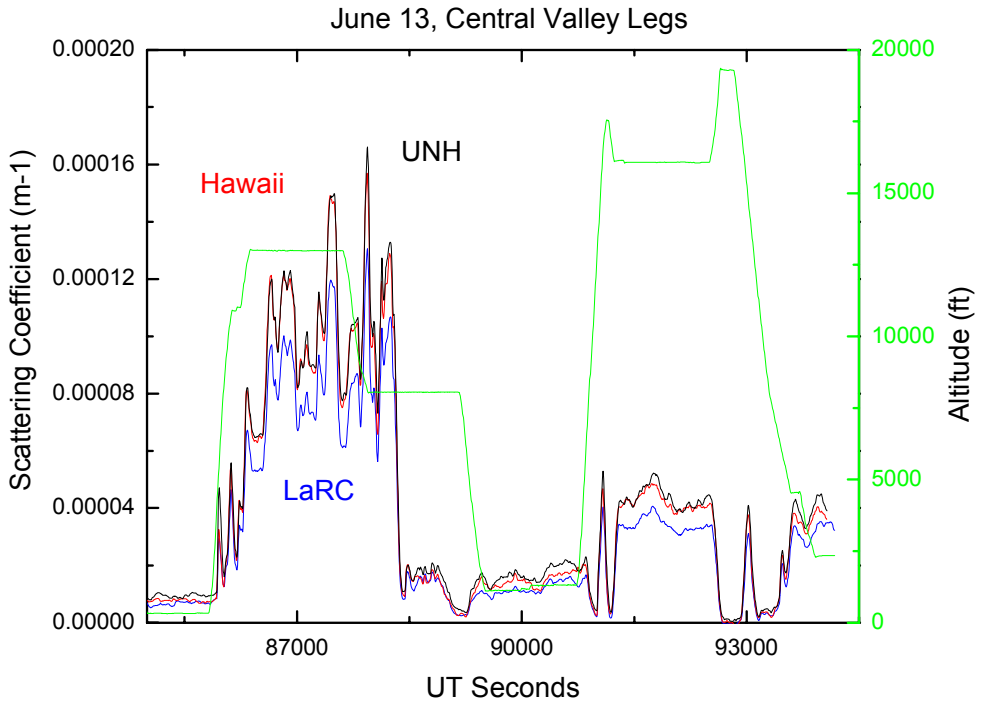

Figure 4. Scattering coefficients measured behind the three inlets during the transit back from Trinidad Head to Edwards. Note that the Hawaii and UNH signals are typically superimposed whereas those from the LaRC instrument is usually 10 to 20% lower, indicating a loss of particles in the inlet.

Scattering coefficients increased steadily as we traveled further south on the 1 kft leg and encountered air more aged since its influx from the MBL in the Bay area. When we climbed to18 kft, we encountered clean air between 8 and 13 kft, but encountered the pervasive pollution layer that peaked at 16.5 kft altitude; readjusting the aircraft altitude to that height, we obtained 20-minutes of aerosol characterization measurements that again showed the layer to have high acid concentrations and an absence of biomass burning tracers.

We ended the flight by recording a spiral profile in clear skies over Edwards, where the temperature had risen to 80^{o}F and winds had increased to 10 m/s, gusting to 15 m/s from the southwest, strong enough to suspend dust particles from the dry lake beds that surround the airfield.