DICE Flight Report: June 17, 2003

Flight Type: Dedicated DICE mission with six Eddy Tower Flybys, four Trinidad Head (TH) Flybys and multiple constant altitude sampling legs in the Central Valley

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 and Eddy Tower

Flight Plan (UT)

15:47:00	Taxi
16:04:00	Takeoff
16:15:30 – 16:17:40	1st 200' pass by Eddy Tower; all iso; all sampling own inlets
16:28:30 – 16:31:00	2nd 200' pass by Eddy Tower; all iso; UNH and UH inlets switched
16:31:00 – 16:47:00	spiral climb to 18 kft over Dryden; all iso
16:52:00 – 17:12:00	level run up Central Valley; all isokinetic
17:17:00 – 17:38:00	level run at 13 kft over Central Valley; all isokinetic
17:41:00 – 18:03:00	level run at 16 kft NE of Red Bluff; all isokinetic
18:03:00 – 18:19:20	sounding over TH; all iso
18:19:20 – 18:27:00	1st loop by TH at 500'; all iso sampling own inlets
18:28:00 – 18:35:00	2nd loop by TH at 500'; all iso; UNH and UH switched
18:36:00 – 18:43:00	3rd loop by TH at 500'; all iso sampling own inlets
18:44:00 – 18:51:30	4th loop by TH at 500'; all iso; UNH and UH switched
18:51:30 – 18:55:00	Climb to 11 kft; all iso
18:55:00 – 19:15:00	level at 11 kft; enroute to Red Bluff; all iso; sampling own inlets
19:18:00 – 19:38:00	level at 8 kft; all iso; sampling own inlets
19:43:00 – 20:03:20	level at 1 kft over Central Valley; all iso; sampling own inlets
20:03:20 – 20:11:30	Climb to 17 kft; all iso
20:11:30 – 20:25:40	level at 17 kft; performing inlet pressure tests
20:29:10 – 20:52:30	Spiral descent over Dryden; all iso
20:52:30 – 20:55:05	3rd 200' pass by Eddy Tower; all iso; samling own inlets
21:05:30 – 21:08:05	4rd 200' pass by Eddy Tower; all iso; UNH and UH inlets switched
21:17:40 – 21:20:25	5th 200' pass by Eddy Tower; all iso;UH and LaRC inlets switched
21:30:50 – 21:33:00	6th 200' pass by Eddy Tower; all iso; all sampling own inlets
21:40:05	Landed

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

Report

At takeoff time, the temperature was ~85°F and winds were reported to be light and variable at the control tower. Haze was prevalent throughout the valley and dust devils had been spotted over the lakebed the afternoon before. Dave Westberg went to the tower 1 hr before takeoff and began taking filter samples at 30 minute intervals for the first and last two hours of our flight, i.e., the time periods when we were making passes by Eddy Tower.

After letting the aircraft get good and heat soaked on the tarmac during refueling, we took off at ~9:04 am local and climbed to 3 kft before turning a broad left base to set up for a 200' pass by the tower. During this time, all inlet characterization instruments were brought online and appeared to be working normally. We made the usual approach over Boron, completed the first pass by Eddy Tower and were forced to take a right turn at the end of the run to avoid aircraft that were working over the bombing range. Though the pilots tried to maintain a constant 500' AGL altitude on this downwind run, the right-base flight track passed over uneven terrain where aerosol loadings were highly variable, making comparisons between the inlets somewhat more difficult. Regardless, we switched sampling inlets between the UH and UNH racks about halfway through the downwind and completed a second pass by Eddy Tower, with all inlets operating at isokinetic velocities. Aerosol size distributions recorded during the two passes are displayed in Figure 1 and reinforce our earlier observation that the UH inlet is slightly more efficient than the UHN inlet at passing large dust particles. The LaRC inlet in contrast, is clearly less efficient than either of the other inlets, even after its tip diameter had been increased to reduce the effects of turbulence occurring near the inlet walls.

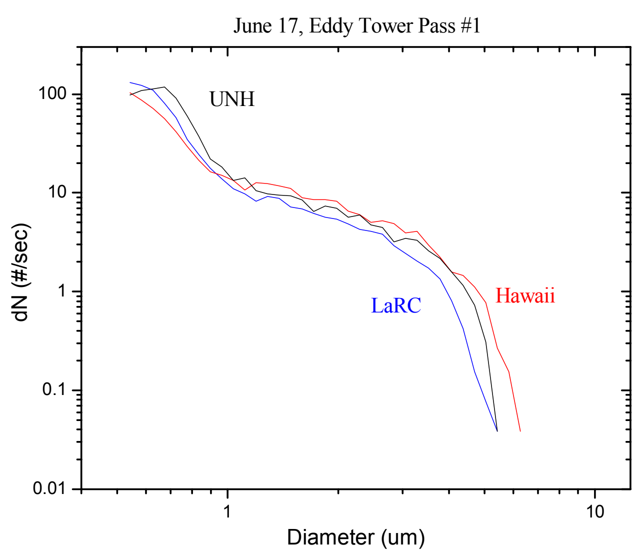

Figure 1a. APS size distributions from first pass by Eddy Tower. All inlets were isokinetic and being sampled by instruments in each respective group's racks.

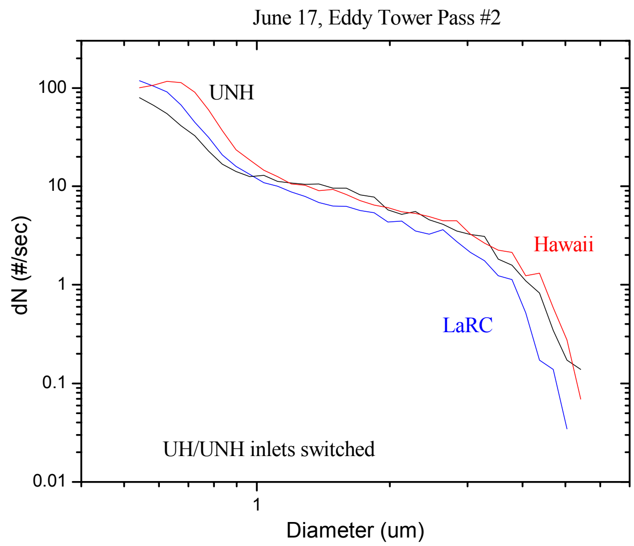

Figure 1b. APS size distributions from second pass by Eddy Tower. All inlets were isokinetic; the UH and UNH inlets were sampled by instruments in the other group's rack.

To further investigate performance differences between inlets, we recorded pressure profiles behind each inlet as a function of sampling velocity during the high altitude legs over the Central Valley. Figure 2 shows plots of the UNH and LaRC data (UH data not available at this time) and suggests that the flow within the LaRC sampling system is much more restricted than that in the UNH sampling train. The source of this difference is not readily apparent, since the calculated Reynolds Number for the two systems are approximately the same.

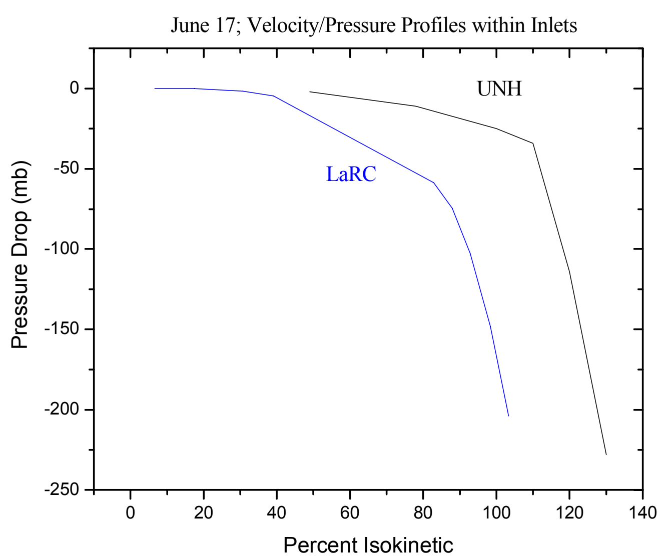

Figure 2. Pressure drop as a function of inlet velocity for the UNH and LaRC inlets.

During the flight north to Trinidad Head, we performed three, 20 minute-long constant altitude legs to acquire data for instrument intercomparisons purposes. Because the LRR radiometer and deflection fence had been removed from the DC-8 prior to flight, the aircraft indicated airspeed was maintained at ~300 nm/hr for these and the rest of the flight legs during the mission. This higher airspeed improved the performance of the venturi pumps, allowing UNH to maintain isokinetic flow on its filter collection inlet, thus providing an opportunity to compare the filter and PILS measurements under more realistic conditions. Because aerosol loadings were relatively high throughout the Central Valley, UHN was able, in most cases, to collect samples at 5-minute intervals on each of the constant altitude legs.

As we approached Trinidad Head, it became evident that low-level stratus clouds completely blanketed the coast, masking the ground-based sunphotometer and eliminating the opportunity for an optical closure experiment. We thus performed an enroute descent into the Arcata airport and extended our approach to pass just west of TH at 500' altitude. After passing TH, we flew north into the wind for two minutes , turned left to reverse course, flew a parallel track back to a point along the coast a minute or two south of TH, then turned left to intercept the original track past TH, all the while maintaining 500' altitude. This racecourse was positioned entirely over water and beneath a broken deck of stratus clouds. The relative humidity in the MBL approached 100% and thin scud clouds were encountered intermittently along the flight track and were clearly sensed by the wingtip-mounted optical particle probes.

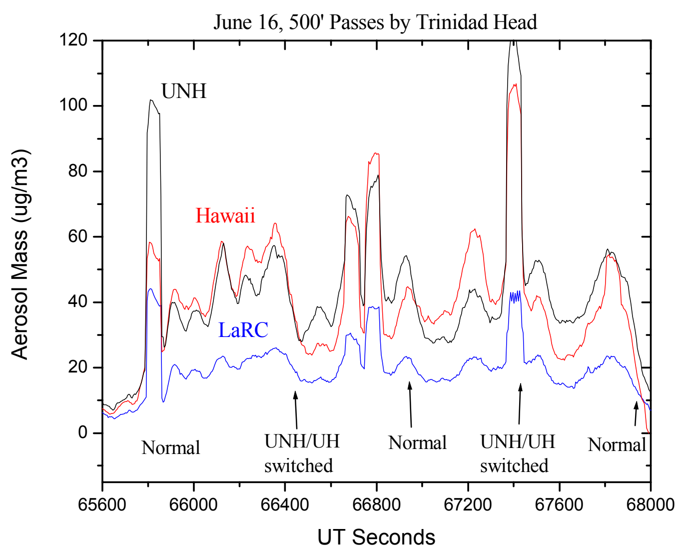

Figure 3. Calculated aerosol mass from APS measurements on the LaRC, UNH, and UH racks. At the indicated times, flow from the UH and UNH inlets were cross-sampled by instruments on the other groups racks. The large square-wave peaks are associated with cloud penetrations and suggest the UNH inlet transmits cloud particles more readily than the other inlets.

During the TH passes, all inlets were operated isokinetically and the inlet flow was cross-sampled on the UH and UNH racks on the 2nd and 4th passes by the NOAA aerosol monitoring station. Figure 3 shows data recorded during the runs and provides additional evidence that, in cloud-free conditions, the UH inlet is slightly more efficient at transmitting large particles than the UH inlet.

After completing four circuits around Trinidad Head, the pilots poked the aircraft through a small opening in the stratus deck and we climbed to 11 kft to pass over the coastal mountain range enroute to Red Bluff, a small town at the northern edge of California's Central Valley. A gradient in air quality was observed on this 20 minute leg as we passed from relatively clean maritime air into a continentally influenced air mass with relatively high aerosol scattering. Pollution effects were even more evident on the subsequent 20 minute sampling leg conducted at 8 kft which was still ~5 kft above the mixed layer top as indicated by the LaRC Lidar. CIMS reported high concentrations of nitric acid and PILS measured enhanced levels of both sulfate and nitrate aerosols. Large particles were enhanced during the 1 kft leg over the Central Valley which provided an additional opportunity to evaluate the relative passing efficiencies of the aerosol inlets (Figure 4).

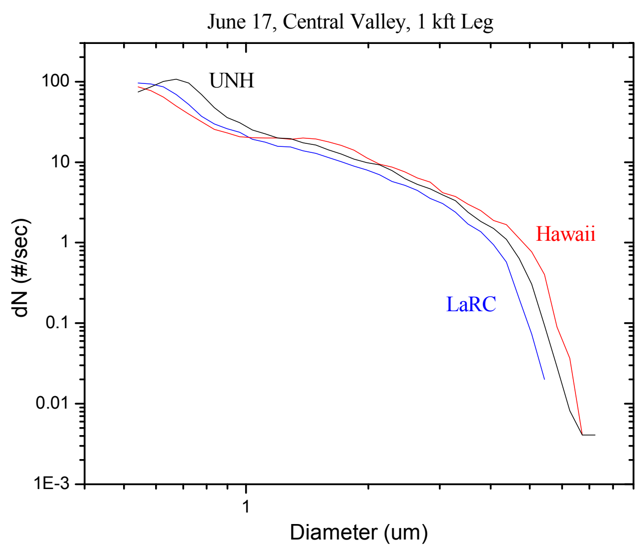

Figure 4. Aerosol size distributions from 1 kft leg over the Central Valley.

After completing the Central Valley constant altitude legs enroute back to Edwards we climbed to 17 kft, conducted additional inlet velocity/pressure tests, then popped up to 20 kft before performing a spiral profile on descent into the air field to set up a series of four tower flybys.

Conditions at the field by this time (2 pm, local) were still cloud-free, hot, and winds were relatively calm. A huge dust devil was observed over a dry lake-bed to the east and particulate concentrations were highly variable along the track by the tower and the east side of Rodgers Dry Lake.

Aerosol mass concentrations measured on the final set of tower flybys are shown in Figure 5, and again suggest the UH inlet is slight more efficient than the UNH probe, and that both are significantly better at transmitting large particles than the LaRC inlet.

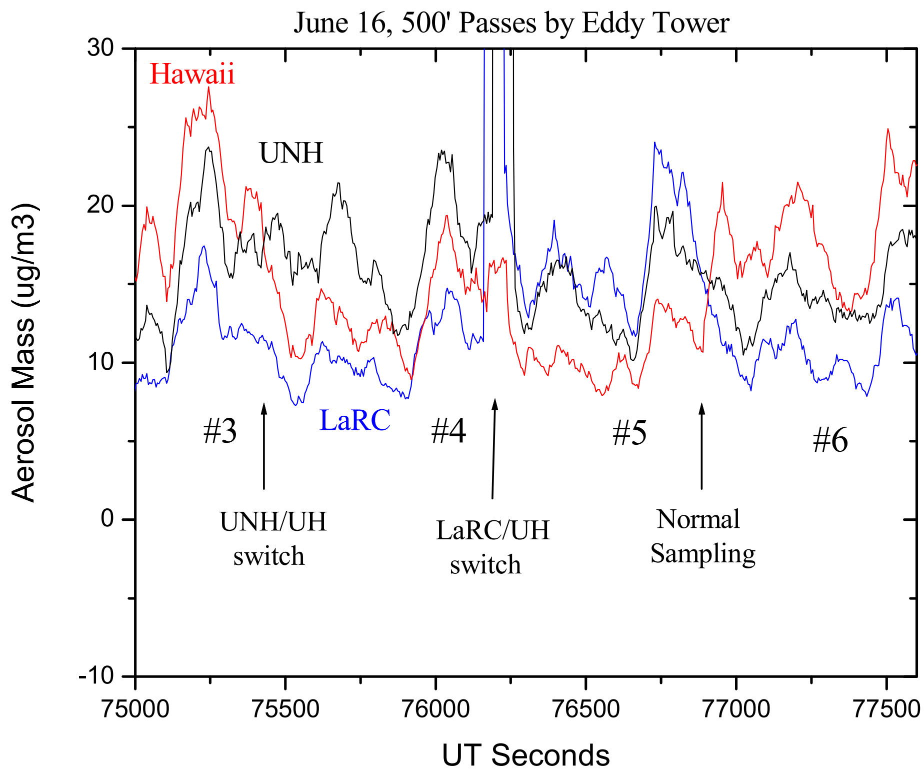

Figure 5. Calculated aerosol mass from APS measurements on the LaRC, UNH, and UH racks as recorded during the final four passes by Eddy Tower when all inlets were being operated isokinetically. At the indicated times, inlet flow was cross-sampled by instruments on the other groups racks. Note that regardless of which set of instruments was used, mass concentrations were always higher in flow coming from the UH inlet.