DICE Flight Report: June 7, 2003

Flight Type: Dryden local with tower flybys

Flight Objectives:

1. Continue instrument characterization studies
2. Provide opportunities for instrument intercomparison
3. Examine the impact of subisokinetic flow upon inlet transmissions characteristics
4. Perform multiple tower flybys

Flight Plan (UT)

18:49 Taxi
18:58 Takeoff
19:04 Level at 18 kft
19:26:20 – 19:42:00 Spiral sounding over EAFB
19:42:00 – 19:45:20 200’ pass by tower (#1); all isokinetic
19:46:20 – 19:51:00 500’ downwind (#1); all isokinetic
19:56:40 – 19:59:30 200’ pass by tower (#2); all isokinetic
20:01:30 – 20:06:30 500’ downwind (#2);all isokinetic
20:13:00 – 20:15:20 200’ pass by tower (#3); LaRC=50%; UNH=70%
20:17:20 – 20:19:20 500’ downwind (#3);LaRC=50%; UNH=70%
20:28:00 – 20:30:00 200’ pass by tower (#4); LaRC=50%; UNH=70%; UH=70%
20:32:30 – 20:34:00 500’ downwind (#4); LaRC=70%; UNH=70%; UH=70%
20:42:50 – 20:45:40 200’ pass by tower (#5); LaRC=50%; UNH=50%; UH=50%
20:47:50 – 20:49:40 500’ downwind (#5); LaRC=50%; UNH=50%; UH=50%
20:58:00 – 21:00:40 200’ pass by tower (#6); LaRC=50%; UNH=50%; UH=50%
21:00:40 Climb to 10 kft
21:04:00 Level at 10 kft
21:17:30 Begin descent
21:30:00 Land

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

Report

The skies over Edwards were clear and cloudless and the temperature ~97 F at takeoff. Winds were light and variable; no evidence of dust devils. Haze was evident throughout the valley and some of the suspended particulates may have come from a fire that was burning near Lancaster the previous day. Lee and Eric went to the tower early to raise the filter collector higher above the roof to prevent contamination from blowing dust and debris. Filter collection at the tower began at takeoff and continued at 30 minute integrals until one half hour after landing.

We took off at ~12 pm local and climbed to 18 kft to warm-up instruments and collect lidar aerosol profiles of the area around Edwards. Lidar images indicated a rather deep, boundary layer with enhanced aerosol scattering in the vicinity of the Borax mine near Boron. In situ measurements recorded during the spiral descent indicated the top of the PBL was near 5 kft and that there were slight gradients in aerosol parameters with height and position along the loop encompassing Eddy Tower (see Figure 1).

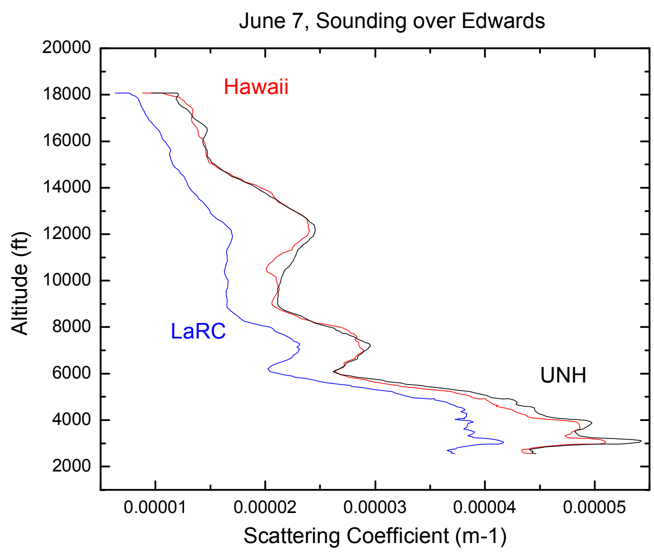

Figure 1. Aerosol scattering profiles recorded over Edwards just prior to the tower passes. Isokinetic flow was maintained in all inlets throughout the descent.

During the descent and first two passes by the tower, we maintained all inlets at isokinetic flow velocity by carefully adjusting our bypass flows in response to changes in airspeed and static pressure. Figure 1 indicates that under these conditions, aerosol scattering coefficients are almost identical behind the Hawaii and UNH inlets but significantly lower downstream of the LaRC inlet. Pressures were also very similar (and roughly equivalent to the total pressure measured on the aircraft pitot-static system) inside the UNH and Hawaii inlets, but almost 100 mb lower inside the LaRC inlet (see Figure 2). In separate tests (see report from June 5 flight) we found that the pressure inside the LaRC inlet was essentially the same as that in the other inlets up to 50% isokinetic flow, but dropped precipitously for flows approaching 100% isokinetic, almost like the inlet was behaving like a critical flow orifice. This caused us to speculate that a thin turbulent region exists around the circumference of the inlet tip that reduces the effective diameter of the opening. The Langley probe has the smallest inlet diameter (0.125” as opposed to 0.21 for Hawaii and 0.31 for UNH) so it is one most effected.

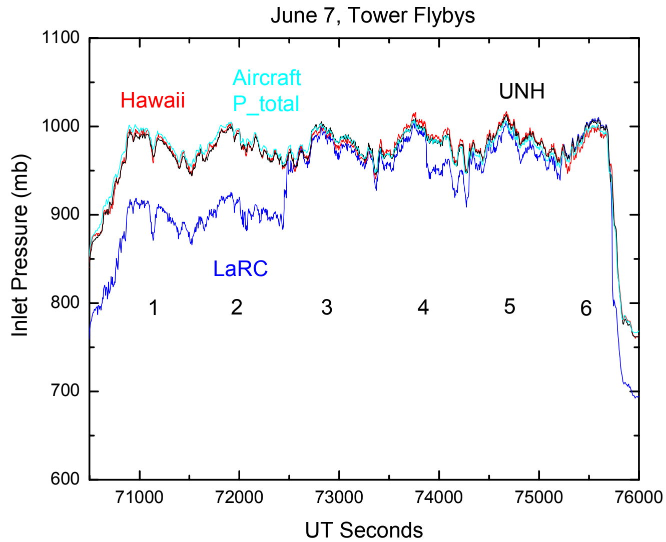

Figure 2. Pressure measurements recorded during the six tower flyby passes. During the first two passes all inlets were operated at isokinetic flow. On lap 3, only Hawaii was isokinetic whereas LaRC was at 50% and UNH was 70%. On passes 4, 5 and 6, all inlets were subisokinetic to some extent. Note that during lap 4, LaRC briefly increased their bypass flow to 70% of isokinetic which resulted in a corresponding drop in inlet pressure.

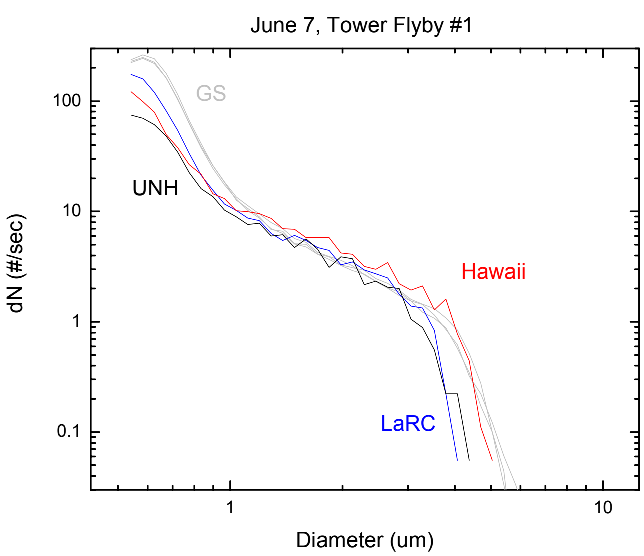

Figure 3. Aerosol size distributions measured during the first tower flyby when all inlets were isokinetic. The ground station (GS) data are 15 minute averages recorded during the time periods before, during and after the aircraft passed.

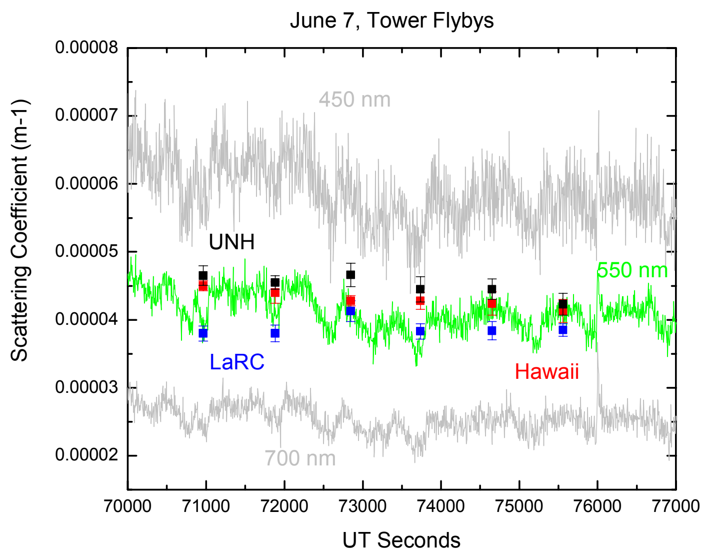

Figure 4. Average aerosol scattering coefficients recorded by Radiance Research Nephelometers on the aircraft during the 200' flybys compared to the continuous record of data from the TSI three-wavelength nephelometer on Eddy Tower.

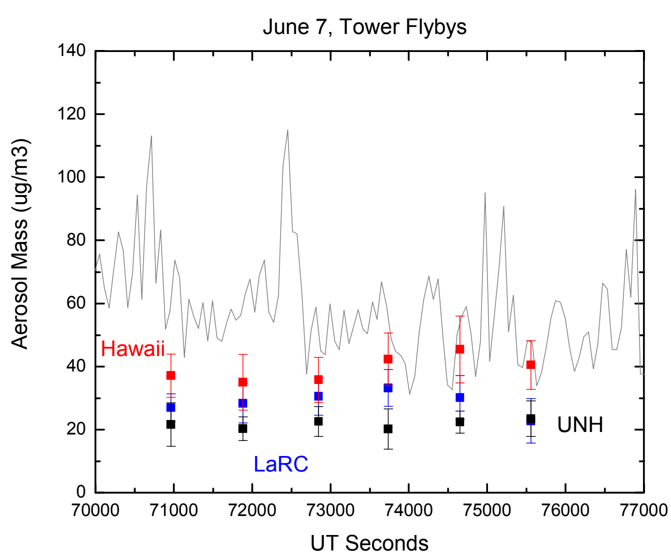

Figure 5. Average aerosol mass calculated from DC-8 APS data recorded during the 200' flybys compared to the continuous record of similar data from Eddy Tower.

Aerosol size distributions from the APS units on each inlet suggest the primary impact of the turbulent flow inside the LaRC inlet tip is to remove particles greater than about 2 um in diameter (Figure 3). Our data also suggests the UNH inlet scrubs such particles, but this is not borne out by the simultaneous scattering measurements, thus we suspect the APS unit on that rack is less sensitive to large particles. Plumbing has subsequently been installed that will allow air from the UNH inlet to be sampled by the complement of instruments on the UH rack (and visa versa), which should remove differences in instrument performance as a source of uncertaintly.

Figures 4 and 5 compare the aircraft scattering coefficients and integrated aerosol mass with similar measurements from the tower. Although the scattering data generally agrees to within 10% for the two platforms, the aircraft aerosols masses are in some cases substantially lower than the tower observations, particularly for the UNH and LaRC inlets. The Hawaii masses are lower on the first 3 passes when that inlet was operating isokinetically, but comparable on the last three runs when the inlet was at 70, 50, and 50% of isokinetic flow, respectively. As mentioned above, we suspect that the APS used on the UNH rack may be slightly less sensitive to large particles which would bias their calculated aerosol masses low.