DICE Flight Report: May 29, 2003

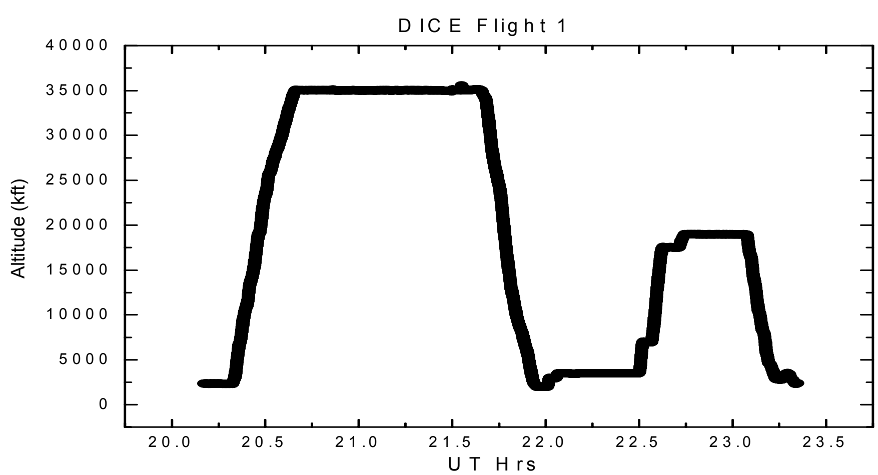
Flight Type: Test flight over the ocean with LRR that included both low and high altitude sampling.

Flight Objectives:

1. Check out instruments, plumbing, software, communications
2. Evaluate ability of venturi pumps to maintain isokinetic flow in inlets
3. Check out flow through small filter samplers
4. Develop sampling procedures
5. Make initial tower flyby

Flight Plan (UT)

20:11 Taxi
20:19 Take off and climb
20:41 Level at 35 kft
21:39 Begin descent
21:58 2.4 kft
22:04 Level at 3.5 kft and 250 IAS
22:17 Speed up to 300 IAS
22:29 Climb
22:45 19 kft
23:04 Descend into Edwards
23:14 3 kft and level
23:16 Pass Tower
23:20 Land



Participating DICE Groups: Langley, PILS, Hawaii, UNH

Report

All groups were successful in powering up their instruments after takeoff. Hawaii was unable to tune the laser in the OPC unit on their rack, but all other equipment operational. Langley lost flow signals on PCASP, but otherwise in good shape. PILS forgot to turn on dilution flow and system exhaust port froze at 35 kft; it thawed on descent and system worked OK afterward.

Software to record the APS and Neph data from each rack worked well and transmission through inlets could be monitored in real time. The nephs were not previously calibrated and showed significant (orders of magnitude) and unrealistic deviations between inlets. The APS units were carefully calibrated before installation and were hence more trustworthy. However, their pumps began to oscillate above 30 kft and, to avoid burning them out, we cut them off. They cranked back up and performed well after we descended into the marine boundary layer.

A particular concern was whether we could draw enough flow through the 25 mm filters on the sample manifolds to make them worthwhile. We designed the plumbing to be isokinetic with 46 lpm volumetric flow through the filters. At 3.5 kft and with the bypass valves switched into place, Hawaii was able to draw >41 lpm, UNH ~27 lpm and Langley <7.5 lpm; with flow passing through the Teflon filters, Hawaii drew 20 lpm, UNH 20 lpm and Langley 1.5 lpm. Based on these results, we decided to install a large vacuum pump on the DC-8 to draw air through the filters.

Another concern was whether the venturis would supply enough pumping to maintain isokinetic flow in our inlets. At 35 kft and 250 IAS, UNH and Hawaii were able achieve isokinetic flow within a few percent; and Langley could go super-isokinetic by 30%. In the boundary layer at 250 IAS, UNH was 6% below isokinetic, Hawaii was dead-on, and Langley could go super-isokinetic by 25%. UNH's exhaust line was somewhat collapsed and Jack thinks he can get higher exhaust flows by installing hose clamps on the line to keep it from pinching in.

Maintaining the proper flows in each inlet was a challenge. Since Hawaii and PILS draw air from the UNH test inlet, it was particularly difficult to gather the necessary information and determine the proper bypass flow to achieve isokinetic flow it that inlet. Langley was also confused about the plumbing for the filter system and mistakenly set their excess flow about 30% too high for most of the flight. We hope to have a table of flow settings displayed on the aircraft video system before the next flight.

APS data recorded during the 500' tower flyby is shown in Figure 2 and suggest that our approach to evaluating the inlet passing efficiency has promise. Although highly preliminary, both graphs indicate that the Hawaii and UNH inlets transmit large particles more efficiently than the Langley inlet.

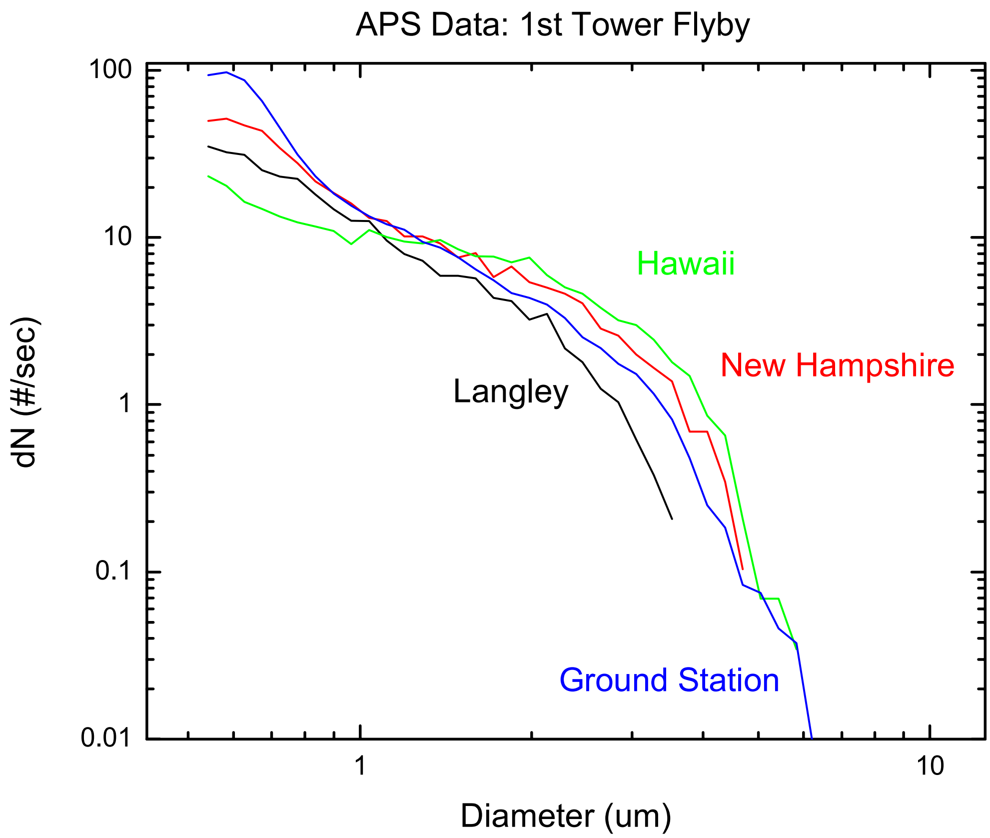


Figure 2. A comparison of aerosol size distributions recorded on the aircraft with that measured on the ground station during the DC-8 pass by the Edwards tower. The Langley inlet was operating ~30% super-isokinetically while the UNH inlet was ~6% subisokinetic; flow velocity through the Hawaii probe was also probably subisokinetic. The aircraft data represent 150 second averages while the ground station data are the average of 20 minutes of data centered on the time of the aircraft passing.

Etc.

The Lightweight Rainfall Radiometer that is installed on the DC-8 started rumbling at high airspeeds and became a concern to the pilot. In the post-flight briefing Gordon Fullerton recommended that, to prevent damage to the airframe, a new speed limit be imposed on the aircraft when the LRR antenna is deployed.