

Flight Report: DC-8 flight 7, August 25, 2008

The NASA DC-8 aircraft completed the fifth and final dedicated data flight of the Arctic Mechanisms of Interaction between the Surface and Atmosphere (AMISA 2008) project on August 25, 2008, between 0851-1922 UTC. The DC-8 was in the vicinity of the R/V Oden between 1144-1632 UTC. The 10.6 hour flight out of Kiruna, Sweden was timed to sample low level Arctic stratus under non-frontal conditions and to map the surface sea ice state under post-freezeup conditions. The synoptic state was characterized by dry air advecting from the W-SW over the Oden, at which location a pressure ridge was beginning to form. An unexpected jet streak and an attendant frontal wave produced some high clouds and low-level frontal-like structures for the first two hours the DC-8 was in the vicinity of the Oden. A high altitude mapping grid and racetrack patterns at several fixed and varying altitudes were flown in the vicinity of the Oden.

In planning for this flight, forecast moisture and flow conditions were deemed optimal for low-level Arctic stratus formation, although in general it is exceedingly difficult to forecast this type of cover. Accordingly, the cloud conditions actually encountered were that of inhomogeneous low-level stratus modified by the influence of at least two air masses advecting from slightly differing directions. The inhomogeneous conditions were noted north of Svalbard, where long waves of stratus punctuated by clear air were observed. Inhomogeneities were further observed within the racetrack sampling patterns around the Oden where higher clouds and moisture were noted to the north and NE of the ship. Upon descent the stratus deck top at ~1.9 km (6,200') was clear above, and thus dominated by cloud top radiative cooling.

The high altitude mapping grid consisted of three flight lines and covered an area of 250 x 75 km. the grid was aligned with the AMSR-E product grid for use in satellite algorithm validation studies, and covered $20 \times 6 = 120$ pixels. While executing this pattern five sondes were dropped (one at each corner and one in the center over the Oden) to characterize the synoptic flow and inversion height field around the Oden. In addition, two each sondes were dropped enroute inbound toward and outbound from the Oden area. The sonde dropped at the southeastern corner of the high altitude grid showed an inversion top of 1.0 km and a cloud top of only 0.5 km, with a dry layer between 500 m and 2200 m. The western and northern area of the flight pattern were not covered by upper-level clouds and showed low-level stratus clouds with tops near 1200-1500 m and a sharp but shallow cloud-top inversion near 1500 m. This latter cloud structure was the one primarily sampled by the later racetracks.

The first low-altitude racetrack was flown using a sawtooth pattern to provide maximum information on the vertical distribution of cloud and condensation nuclei. During these sawtooths a strong correlation was noted between the occurrence or absence of large CN concentration and the presence or absence (respectively) of clouds and moderate amounts of cloud liquid water. These correlations were observed on sawtooth lines between ~600-900 m (~2,000'-3,000') altitude and for cloud liquid amounts of ~0.1-0.15 g/m³. Larger cloud liquid amounts (up to ~0.35 g/m³) were observed near the cloud tops. The measurements were mostly of volatile CN, and provided the strongest evidence to date of

the importance played by CN in Arctic cloud development. It was noted that an abundance of CN were observed at transit altitude (~9.7 km, or 32,000') enroute to the Oden over Svalbard, although this upper tropospheric CN did not play a role in the inversion layer cloud dynamics.

Upon completion of the sawtooth pattern, the altitudes of the two mid-cloud racetrack patterns were selected to be ~600 m (~2,000', or within the cloud at the top of the mixed layer) and ~1,000 m (3,300', or just above the cloud layer). First, a ~100 m (350') altitude racetrack pattern was flown during which significant volatile CN concentration and sea ice state was observed. The two successive racetracks at higher altitude produced Clarke probe icing that compromised the LARGE and VACC data, but not before registering significant CN concentrations at the top of the mixed layer (~600 m altitude). Attempts to take data at 1,000 m altitude led to strong probe icing, which was unable to be shed completely even upon ascent to above the clouds at 1,200 m. Accordingly, the 1,000 m altitude racetrack was called off. A final 1.7 km (5,500') altitude racetrack was flown to complete AMISA mapping requirements, followed by a 1.3 km (4000') leg where good VACC and LARGE data were acquired, and a final short sawtooth line oriented orthogonal to the previous lines so as to measure CN concentrations along the flow over the Oden. Again, CN spikes were observed at ~730 m (~2,400') altitude within clouds with liquid amounts of ~0.15 g/m³.

During the flight, post-freezeup conditions were predominant around the Oden. The surface was observed to be mostly frozen over by heavy grease ice on all but the largest leads. In some of these partly open cases the grease ice protruded from the lead edges by tens of meters. Surface reports at the Oden suggested ~5 cm thick ice cover over leads that required the use of swimmers to break up for in situ sampling. All meltponds were frozen over and covered with snow. Accordingly, aerosol production and heat and moisture transfer from the surface was largely precluded. As in the previous Oden flight (DF011) the surface albedo was noticeably higher than during the two Oden flights at the start of AMISA.

Although icing on the Clarke probe inlet prevented complete aerosol characterization by VACC and LARGE on the mid-level racetracks, good data was observed by these instruments during all other racetrack and sawtooth lines. The ice buildup was well documented with photos and believed to be resolvable upon outfitting the probe inlet with appropriate heaters. Also, one dropsonde failed upon release, but was immediately re-launched. Otherwise, all instruments exhibited normal operation during the flight. Remnant data from the sonde dropped over the Oden was received upon closest approach ~1.5 hours after release.

The DC-8 AMISA campaign is part of a NASA-sponsored International Polar Year (IPY) project with the goal of understanding the surface and atmospheric radiation and dynamical processes leading to Arctic sea ice freezeup. Research activities on the Oden are sponsored by the Swedish Polar Secretariat, with support from European funding agencies and the U.S. NSF, and NOAA. AMISA participants include personnel from the University of Colorado at Boulder, University of Leeds (UK), Georgia Institute of

Technology, and NASA DFRC, NASA GSFC, and NASA LARC.

The first of two AMISA transit flights back to the U.S. occurred on Thursday, August 28, with customs entry in Bangor, Maine. Final reports on this flight and the final return flight to Palmdale in Friday, August 29, are forthcoming. Also forthcoming is a post-mission synopsis covering the entire set of AMISA flights.

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