

Flight Report: DC-8 flight 4, August 15, 2008

The NASA DC-8 aircraft completed the second dedicated data flight of the Arctic Mechanisms of Interaction between the Sea and Atmosphere (AMISA 2008) project on August 15, 2008. The 11.2 hour flight out of Kiruna, Sweden was designed to provide synoptic-scale post-frontal observations of a plume of cold, dry air that originated from Greenland and flowed northward along the Fram Strait towards the R/V Oden. Aerosol sampling was performed during three sets of stacked flight lines enroute to and over the Oden to determine the density and composition of biogenic and maritime aerosol flow into the near-polar Arctic inversion layer from the free troposphere. This aerosol is hypothesized to feed the development of Arctic clouds by providing condensation nuclei to seed the growth of liquid water droplets. The flight was performed during pre-freezeup conditions over most of the observed domain, as evidenced by the widespread presence of leads from the Fram Strait ice edge to the Oden. The presence of grease ice on most of the meltponds observed at low altitude at the Oden and the second stack suggested, however, that freezeup was incipient (see photo).

The aerosol sampling stacks were located at three points: 1) over open water in the northern Fram Strait, 2) over broken first-year pack ice midway from open water to the Oden, and 3) directly over the Oden. Bracketing each stack were dropsonde releases that were used along with aircraft meteorological data obtained during descent and ascent to estimate the height of the mixed layer and direction of flow. A total of four dropsondes were released. The flight lines within each of the stacks were aligned orthogonal to the prevailing flow to provide maximum averaging of cross-stream flow variations, and hence the best average representation of aerosol characteristics within the flow. Altitudes of the lines were determined to provide sampling of the boundary layer (350' altitude), the mixed layer (~2,500'-3,000'), and the air immediately above the low level clouds and inversion layer (5,500').

Evidence of maritime biogenic aerosols was observed within the boundary and mixed layers at each stack, with methylsulfonic acid (MSA) and possibly H₂SO₄ and biogenic carbon being detected. Despite strong maritime flow a decided lack of salt aerosols was observed. This observation was consistent with insufficient whitecapping in the Fram Strait. A complex aerosol composition was observed at 5,500' over the Oden, with a gradient increasing in concentration toward the western end of the line. Overall, the observations were suggestive of well-contained transport of maritime aerosols to the Oden by flow within the mixed layer. Although a change in cloud concentration confounded aerosol measurements during the lowest line over open water, good sampling was obtained by VACC and LARGE on all other lines.

In addition to aerosol sampling the DC-8 completed a seven-line sea ice imaging grid over the Oden at 5,500' for the purpose of mapping sea ice cover around the Oden during post-frontal conditions. The grid covered the same lines as flown during pre-frontal conditions on August 12, thus providing data necessary for intercomparing ice concentration before and after the frontal passage on the 12th. The clear and consistent nadir video imagery of leads and meltponds during low-altitude lines is expected to be valuable for determining lead and meltpond fraction for retrieval algorithm development.

The low-altitude stack lines also facilitated observations of the structure of the Fram Strait ice tongue through which much Arctic ice ultimately flows as a result of transpolar drift (see photo).

During overflight the Oden was moored to an ice floe at (87.40N, 5.77W) and had a number of instruments operating, including the millimeter-wave cloud radar, 449-MHz wind profiling radar, S-band precipitation radar, sodar, and 60-GHz profiling radiometer. Setup of the remaining ASCOS instruments was proceeding but hampered by the presence of two polar bears.

As in the previous (pre-frontal) flight, this flight was very well managed and accomplished multiple science objectives over the Oden and within the stacks enroute. The timing of the flight was (again) excellent from the standpoint of AMISA science goals, with sampling of the mixed layer flow being performed along a long band of well-defined southerly flow.

Most of the DC-8 instruments operated well throughout the flight. A dropout of the PSR/A computers occurred enroute back to Kiruna but resulted in no science data loss. Although the C-band radiometer did not operate during the flight it was diagnosed and repaired afterwards in preparation for later flights. During one Oden overpass at 2,800' the VACC and LARGE instruments were largely inoperative due to ~75% probe icing, but recovered upon ascent out above the low level cloud layer. At this level the cloud liquid was supercooled and the water content was noted to be ~ 0.05 g/m³ at the western end and 0.25 g/m³ at the eastern end, as measured by the CAPS probe. This gradient appeared to be associated with longwave radiative effects from an upper-level cloud layer over the western half of the leg.

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, University of Leeds (UK), Georgia Institute of Technology, and NASA DFRC, NASA GSFC, and NASA LARC.

The next AMISA science flight is being planned for Tuesday afternoon, August 19, to map the sea ice edge in the northern Fram Strait under conditions of heavy clouds. The mapping activity will serve to improve NASA satellite imaging of sea ice concentration by providing a better understanding of the impact of clouds and precipitation on the AMSR-E high frequency microwave channels.

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