Flight Report: DC-8 flight 3, August 13, 2008

The NASA DC-8 aircraft completed the first dedicated data flight of the Arctic Mechanisms of Interaction between the Sea and Atmosphere (AMISA 2008) project on August 13, 2008. The 9.8 hour flight out of Kiruna, Sweden was timed to coincide with passage of a major warm moist air plume originating from Siberia over the R/V Oden. The mid-tropospheric plume produced significant clouds and precipitation over the DC-8's observation grid, centered over the Oden. The flight served a number of science objectives, including observations of prefrontal and frontal conditions, air sampling in and above the Arctic inversion layer at several altitudes, wide-area mapping of sea ice cover, clouds, and moisture, and profiling of the Arctic inversion layer across a strong frontal gradient. Sampling of the atmosphere and surface imaging across the area of frontal flow enroute to the Oden was also performed. The area enroute was characterized by significant sea ice divergence and associated developing lead structure. The flight was exceptionally well managed, especially given the complexity of the sampling plan, multiple science objectives, and timing of the flight with regard to the evolving weather. A total on-station time of ~3.5 hours around the Oden was achieved.

The frontal band around which the flight was planned was typical of major polar storm activity known to disrupt the radiation balance within the inversion layer and lead to freeze-up. The flight occurred during pre-freeze, as was evidenced by a preponderance of leads and meltponds in the vicinity around the Oden. However, evidence of incipient freeze-up was observed as a ubiquitous presence of grease ice on meltponds and leads. Accordingly, the timing of this flight was excellent from the standpoint of AMISA science goals being that observations were carried out during critical sea ice and inversion layer transition conditions.

A total of seven dropsondes were released during the flight: three enroute to the grid within the frontal band, two over the Oden as the front passed the sampling grid, and two enroute to back to Kiruna within the pre-frontal wrap-around flow. Two well defined inversion layers within the front over the Oden (see sounding file) were clearly seen in the soundings. Within the inversion layer icing conditions were present, but mostly on west (prefrontal) end of grid, whereas warmer air was observed on the east (frontal) end. Moderate amounts of total cloud liquid water (up to ~0.5 g/m3) were observed at 5,500'.

Alignment of the DC-8 sampling grid was chosen to provide atmospheric cloud and aerosol sampling along tracks orthogonal to the low-level flow around the Oden. As such the sampling strategy provided good signal-to-noise conditions along tracks for aerosol measurement (i.e., long sampling time along an aerosol contour) and precluded contamination of atmospheric chemistry sensors operating on the Oden. Both sea salt and biogenic sulfate aerosols were observed within the upper part of the inversion layer, providing evidence of trapped long-range transport of natural cloud-producing aerosols. The source may have been the Kara and Laptev Seas, ice-free along the Siberian coastline, as the high wind-speed low-level prefrontal flow traversed it along its trajectory to the Oden site. This low-level prefrontal flow ended up in the warm layer at the top of the inversion over the Oden.

The Oden overpass occurred at 2100Z, and was coordinated using both aircraft-to-ship Iridium and VHF radio communications. In-flight updates on the ship's position and operations were essential to achieve an overflight that passed within ~5 nmi of the ship and a coordinated release of a rawinsonde from the Oden.

From the time the Oden had moored to an ice floe (~12Z) until the DC-8 overpass time (~00Z) the ship drifted southeast with the ice pack a distance of ~5 nmi. The low altitude (400') line was accordingly shifted south during flight to accommodate this drift, resulting in a closest overpass occurring ~200 m downwind of the Oden and at ~350' altitude (see photo).

Most DC-8 instruments operated exceptionally well throughout the flight. Among problems being diagnosed are data acquisition failures on the C-band radiometer. The LARGE and VACC sensors were unable to operate at 2,500 feet altitude due to icing of the Clarke inlet probe, although this problem was resolved upon ascent to warmer air above the inversion layer. The utility of in-flight data network in downloading updated MODIS satellite maps was again clearly demonstrated. Also useful was an in-flight spreadsheet program to lay out and overlay the evolving Oden grid pattern on the Google Earth in-flight position display.

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, 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, LARC, and GFSC.

The next AMISA science flight is being planned for Friday morning, August 15, to observe what is forecast to be drier and colder air flowing from the Fram Strait to over the Oden. This flow is expected to originate from over Greenland, and should be particularly free of aerosols.

Al Gasiewski
Ola Persson


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