

Flight Report: DC-8 flight 6, August 23, 2008

The NASA DC-8 aircraft completed the fourth dedicated data flight of the Arctic Mechanisms of Interaction between the Surface and Atmosphere (AMISA 2008) project on August 23, 2008, between 1204-2045 UTC. The DC-8 was in the vicinity of the R/V Oden between 1438-1807 UTC. The 8.7 hour flight out of Kiruna, Sweden was timed to observe clouds over the Oden associated with the moist air mass observed in the Fram Strait the previous day (on flight DF010) during the ice edge mapping mission. This moist air mass had advected north to the Oden, which was located near the western boundary of the air mass. The flight was designed to study Arctic air mass divergence profiles, Arctic cloud microphysical properties and radiation profiles within clouds, and aerosol transport trajectories and their impact on liquid water production in Arctic clouds. The surface around the Oden was experiencing freezeup, thus fulfilling an important AMISA observation condition. This was also the first AMISA overflight of the Oden during which all ship instruments were in operation.

The sampling domain around the Oden was located near a frontal boundary with a complex vertical structure that varied from west to east across the sampling domain. In the eastern portion of the flight pattern near the Oden, the cloud tops extended to nearly 4000 m with uniform SSW flow throughout and near moist neutral static stability. The air mass on the western side of the flight pattern had slightly colder near-surface temperatures, and had a shallow moist layer near the surface and only one cloud layer near 3500-4000 m above. The air mass on the western side also had winds from the SE and greater static stability. Over the Oden, a cloud layer near 1500 m was present. Moist static neutrality was present above this layer and moist static stability existed below. The inversion layer altitude as measured at the Oden was at ~250-300 m. The eastern side and levels from 1500 m and above over the Oden had characteristics of the moist air mass sampled the day before while the western side was different. Oddly enough, the winds obtained from the dropsondes suggested diffluence near this front throughout the 4 km depth of the clouds.

Surface observations showed virtually all meltponds completely frozen over, with leads showing significant coverage by grease ice. Lead surface conditions indicated freezeup in progress, with limited moisture, heat, and aerosol transfer taking place. To the NW of the Oden the grease ice coverage was ~80-100%. Ice floes were covered with fresh snow, and exhibited a noticeably higher albedo than during Oden overflights over one week earlier.

Three patterns were flown over the Oden: A high-altitude Z-box survey pattern, and low-altitude sawtooth box centered around the Oden for cloud microphysical, low-level divergence, and aerosol condensation nuclei (CN) sampling, and a stacked set of straight and level and sawtooth lines over the Oden for cloud radar validation purposes. A total of 11 sondes were released during the flight, including five during the Z-box survey pattern used for synoptic assessment. During the Z-box the PSR was performing wide area mapping using the AMSR-E imaging channels. Observations during this pattern showed enhanced cloud water and (likely) precipitation due southwest of the Oden.

During the sawtooth box pattern distinct repetitive layers of CN at 1300-2000 m altitude were observed, but only on the two southeastern sides of the box. The advection and falloff of CN is hypothesized to have been a cause of significant liquid water over the box, observed to be as high as 0.1 to 0.2 g/m³ on the east end. Upon ascent the cloud liquid water was noted to increase from 0 to ~0.2 g/m³, consistent with Arctic cloud models that place the liquid thermodynamic engine of the inversion layer at the cloud top.

During low altitude (110 m altitude) lines large CN concentrations were also observed, and determined to be mostly volatile in composition. Interesting dropouts in CN concentration were also noted in this line. These dropouts are conjectured to be caused by subsidence which would suppress aerosol production from any open leads. Careful analysis of the meteorological structure will be required to understand the observed aerosol variability in the vicinity of this layered interface between two air masses.

All instruments exhibited normal operation during the flight, with the exception of one failed dropsonde that needed to be repeated. The failure was traced to an antenna connection problem known to be present on a few sondes. No LARGE/VACC probe icing was reported during flight. Pre-flight repairs of the CAPS particle size imager were successful, resulting in good cloud size spectra measurements.

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 last AMISA science flight occurred on Monday, August 25, over the Oden. The report on this flight is forthcoming.

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