Flight Report: DC-8 flight 5, August 22, 2008

The NASA DC-8 aircraft completed the third dedicated data flight of the Arctic Mechanisms of Interaction between the Surface and Atmosphere (AMISA 2008) project on August 22, 2008, between 0357-1237 UTC. The 8.7 hour flight out of Kiruna, Sweden was planned to provide radiometric mapping of an area of strong sea ice concentration gradient under conditions of heavy and homogeneous cloud cover. The sea ice edge on the east side of the Fram Strait ice tongue was selected as the target area due to strongly varying ice concentration, open ocean location, and accessibility from Kiruna. The mapping grid was aligned with the pixel grid of the NASA AMSR-E sea ice product. The grid extended from open water east of the ice tongue in the Fram Strait to concentrated sea ice within the ice pack. A heavy stratus cloud layer over the entire grid provided near-ideal conditions within which to study the impact of clouds on AMSR-E sea ice retrievals. The homogeneity of the southerly flow of moisture was important for providing uniform cloud conditions over both the open water on the SE portion of the grid as well as the concentrated ice in the Fram Strait ice pack at the NW end of the grid.

Two complete mapping grids were flown during the sortie: a 3-line grid at 8800 m covering 250 x 75 km and a nine-line grid at 1700 m covering 125 x 40 km. These grids correspond to 20 x 6=120 and 10 x 3=30 AMSR-E pixels, respectively. In addition, three 125-km long subtracks of the high altitude grid lines were flown at 110 m altitude to measure the total cloud liquid and moisture burden from the surface upwards in the grids. The total column cloud liquid water and moisture will provide validation data for the atmospheric correction portion of the AMSR-E sea ice concentration algorithm. The total burden is also important for radiative transfer calculations used in satellite intercomparisons. The maximum sea ice fraction occurred on the west end of the high altitude grid, and was ~75-85%. Open water occurred on the east end. The meltpond coverage fraction relative to the lead area was visually estimated to be between ~5-25%, depending on location within the grid.

During the flight, cloud over the area was caused by southerly flow of moisture from a major low pressure system located southeast of Svalbard. The flow produced stratus extending from ~1600 m up to ~3600 m altitude. Thin higher clouds existed above the eastern side of the stratus deck; slightly greater cloud top liquid and probably radiative cooling existed on west end. Cloud extended to the surface on the west end. The cloud liquid water distribution was noted to be increasing with altitude from near zero at 1300 m - 1600 m and peaking at ~0.3-0.5 g/m^3 at the cloud top (~ 3600 m). This structure is consistent with Arctic cloud profiles in which production of liquid water occurs at the cloud top. The cloud liquid water profiles obtained during the flight are expected to be particularly valuable for radiative transfer calculations and associated retrieval algorithm improvement.

All of the DC-8 instruments operated well throughout the flight with the exception of the particle imaging and large-particle size distribution instrument on the CAPS probe. The CAPS imager suffered an optical misalignment that was corrected after flight. However, it is expected that measured cloud size spectra were compromised during the flight.

During the flight three dropsondes were released in order to assess cloud thermodynamic conditions and layering. Of these three sondes it was noted that two of them had apparently landed intact on the ice and transmitted remnant signals to the DC-8 for up to 4.5 hours after release.

As in previous AMISA flights, this flight was very well managed and accomplished both satellite algorithm validation objectives along with cloud microphysical observations useful for AMISA cloud radiation studies. The timing of the flight with respect to cloud evolution and grid coverage was excellent from the standpoint of mapping goals.

The mapping flight fulfilled a major goal of AMISA in providing data by which to improve AMSR-E sea ice retrieval algorithms by providing a better understanding of the effects of clouds and precipitation on the AMSR-E high frequency microwave channels. Although the best spatial resolution is available from the highest-frequency AMSR-E channels (37 and 89 GHz horizontal polarization), it is these same channels that are most affected by cloud cover. Development of improved means to compensate for cloud cover is expected to lead to more accurate retrievals in marginal zones and better spatial resolution for detecting leads over pack ice.

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. 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 occurred on Saturday, August 23, over the icebreaker R/V Oden. A report on this flight is forthcoming.

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