IMPACT OF CLOUD COVER ON ARCTIC SEA ICE SURFACE MELT

S. V. Nghiem[1], R. Kwok[1], D. K. Perovich[2], and D. G. Barber[3]

[1]Jet Propulsion Laboratory, California Institute of Technology
4800 Oak Grove Drive, MS 300-235, Pasadena, CA 91109, USA

[2]Cold Regions Research and Engineering Laboratory
72 Lyme Road, Hanover, NH 03755, USA

[3]Department of Geography, University of Manitoba
Winnipeg, MB, R3T 2N2, Canada

The objective is to investigate effects of cloud cover on large-scale surface melt over Arctic sea ice. We use satellite data acquired by the RADARSAT Synthetic Aperture Radar (SAR), by the QuikSCAT/SeaWinds scatterometer (QSCAT), and by the Advanced Very High Resolution Radiometer (AVHRR). The cloud-ice-albedo feedback mechanism plays a key role in the heat and mass balance of the ice and upper ocean in the Arctic that affects the global climate system. Albedo of snow-covered sea ice has significant changes between phases of freezing and melting during seasonal transition periods. Low values of albedo results in increasing heat absorption and melting over sea ice surface from melt onset to fall freeze-up. Cloud cover interferes with both short-wave and long-wave radiation and strongly modifies the net surface heat flux. Especially in summer when sea ice surface is close to the isothermal condition with surface temperatures fluctuating around the freezing point, energy absorption or release associated with net positive or negative heat flux most effectively results in thermodynamic phase changes over sea ice due to melting or refreezing, respectively. We use RADARSAT-1 data from the Arctic Snapshot program and sea ice products from the RADARSAT Geophysical Processor System (RGPS) to isolate thermal effects on sea ice from effects due to ice dynamics and ice deformations. Together with results from the Surface Heat Budget of the Arctic Ocean (SHEBA), we show that SHEBA results can be extended to aggregation scale, and thus coarse-resolution satellite data with a frequent coverage are applicable to study sea ice surface thermodynamics. We apply QSCAT data to determine the timing of albedo change and verify the results with in-situ measurements from the Collaborative Interdisciplinary Cryospheric Experiment (C-ICE). Then, we determine melt zones associated with net energy absorption or release over the entire Arctic sea ice during summer when surface heat and ice mass variabilities are important. We show the pattern of melt zones derived from QSCAT data together with AVHRR to illustrate effects of cloud cover on surface melt over Arctic sea ice. QSCAT results reveal a large-scale cyclonic pattern of sea ice surface melt with zones of positive, neutral, and negative energy associated with a cyclonic cloud cover pattern around a low pressure system over the Arctic Ocean.