Consideration of Diurnal Effects in Spaceborne Remote Sensing Data for Sea Ice Parameter Retrieval

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Abstract

To monitor polar sea ice, spaceborne active and passive sensors such as radars and radiometers are carried by satellites on sun-synchronous orbits. Thus, remote sensing data are acquired over a sea ice area along ascending and descending orbit paths during daytimes and nighttimes. In the Arctic, the amplitude of diurnal cycles of solar radiation in late winter to early spring is as strong as the radiation condition in a typical midlatitude winter. In this view, we investigate effects of diurnal thermal cycles on remote sensing signatures of sea ice to determine whether it is necessary to consider diurnal effects in spaceborne radar and radiometer data for sea ice parameter retrieval. For this purpose, we carried out a winter experiment at the outdoor Geophysical Research Facility in the Cold Regions Research and Engineering Laboratory. The ice sheet grew from open sea water to a thickness of 10 cm in 2.5 days, during which we took C-band polarimetric backscatter data in conjunction with meteorological, sea ice characterization, and millimeter-wave emission measurements. The initial ice growth in the late morning was slow due to high insolation. As the air temperature dropped during the night, the growth rate increased significantly. Air temperature changed drastically from about - 12°C to - 36°C between day and night. The diurnal thermal cycle repeated itself the next day and the growth rate varied in the same manner. Ice temperature profiles clearly show the diurnal response in the ice sheet with a lag of 2.5 hours behind the time of the maximum short-wave incident solar radiation. The diurnal cycles are also evident in the brightness temperature data. Measured sea ice backscatter revealed substantial diurnal variations up to 6 dB with repeatable cycles in synchronization with the temperature cycles and with the emission modulations of up to 10 K in brightness temperature. This work shows that diurnal effects are important for inversion algorithms to retrieve sea ice geophysical parameters from remote sensing data acquired with a satellite sensor on sun-synchronous orbits. Thus, separating the data into daytime and nighttime data provides more consistent data sets for the parameter retrieval.