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Helicopter-borne observation with portable microwave radiometer in the Southern Ocean and the Sea of Okhotsk

TAMURA, Takeshi[1*] ; OHSHIMA, Keiichiro[2] ; LIESER, Jan[3] ; TOYOTA, Takenobu[2] ; TATEYAMA, Kazutaka[4] ; NOMURA, Daiki[2] ; NAKATA, Kazuki[2] ; FRASER, Alex[2] ; JANSEN, Peter[3] ; NEWBERY, Kym[3] ; MASSOM, Robert[3] ; USHIO, Shuki[1]

[1]National Institute of Polar Research, [2]Institute of Low Temperature Science, [3]ACE CRC, [4]Kitami Institute of Technology

It has been recently recognized that sea ice production in the polar regions is controlled by the thin sea ice area with thickness of less than 0.2 m. Spatial distribution of thin ice area and its variability are important information to better understand the reduction of the sea ice covered region in a changing climate environment. We have developed a thin ice thickness algorithm for satellite passive microwave data of the Advanced Microwave Scanning Radiometer-EOS (AMSR-E) and Special Sensor Microwave Imager (SSM/I). Although the microwave skin depth of bare sea ice is about several cm at most, microwave brightness temperatures correlate with the surface salinity (brine volume fraction), which is sensitive to thin ice thickness. Here, we present in-situ observations using a helicopter-borne portable passive microwave radiometer that has the same specifications as the satellite AMSR-E and AMSR-II sensors (36 GHz-vertical and -horizontal channels), to validate and improve our thin ice thickness algorithm. This study estimates the relationship between the microwave brightness temperatures (both satellite and helicopter-borne portable sensors) and in-situ observations of sea ice thickness.

We present data from two airborne missions, one in early austral spring 2012 during the Sea Ice Physics and Ecosystem eXperiment (SIPEX-2) of the Australian Antarctic Program in East Antarctica, and one from the Sea of Okhotsk in mid-winter 2009. These microwave data are compared with the satellite AMSR-E and AMSR-II data and ice thickness estimated from Moderate-Resolution Imaging Spectroradiometer (MODIS) data, helicopter-borne IR sensor data, and ship-borne downward looking camera data. High-resolution airborne microwave brightness temperatures show good agreement with low AMSR-E and AMSR-II brightness temperatures, despite the significant resolution mismatch. In the thin ice region, the polarization ratio of 36 GHz vertical and horizontal temperatures (PR-36) is found to be well correlated with ice thickness, supporting the validity of the AMSR-E thin ice algorithm which was developed previously by our group. We also discuss the microwave characteristics of fast versus pack ice, with a view to improving a satellite fast ice detection algorithm.

Keywords: passive microwave, heli-borne portable radiometer, thin ice region, in-situ validation, Southern Ocean, Sea of Okhotsk