Development of a thin ice thickness algorithm of AMSR2 for Antarctic coastal polynyas

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A coastal polynya is newly-forming thin sea-ice areas formed by divergent ice motion driven by prevailing winds and/or ocean currents. In coastal polynyas, huge amounts of heat flux from the ocean to the atmosphere occur because the heat insulation effect of sea-ice is greatly reduced in the case of thin ice, and accordingly sea ice is formed actively. Dense water formed in Antarctic coastal polynyas with the intense sea-ice production is a major source of Antarctic Bottom Water, which is a key player in the global climate system.

In Antarctic coastal polynya areas, algorithms that detect the polynya areas and estimate the thin ice thickness from passive microwave satellite (SSM/I or AMSR-E) data have been developed to estimate the ice and dense water production. The spatial (grid) resolution of AMSR-E, which was launched in May 2002 onboard NASA's Aqua satellite, is four times higher than that of SSM/I in the pixel density. This advantage of AMSR-E is critical for the monitoring of the coastal polynyas because of their fairly small areal extent (i.e., from 10 to 100km at most). Although AMSR-E failed in October 2011, AMSR2 (Advanced Microwave Scanning Radiometer 2), the successor to AMSR-E, was launched in May 2012 onboard the GCOM-W (Shizuku) satellite. The spatial resolution of AMSR2 is improved about 17% from AMSR-E (about 5 km at 89 GHz). In this study, we present a thin ice thickness algorithm for AMSR2 data.

The thin ice algorithm has been developed based on a relationship between polarization ratios (PR) of AMSR2 brightness temperatures (TBs) and thermal ice thickness, as in previous algorithms of AMSR-E. We used AMSR2 TBs at 89 GHz and 36.5 GHz. The thermal ice thickness is based on heat flux calculation using sea-ice surface temperatures derived from satellite thermal infrared images. As the first step of the AMSR2 algorithm development, we used 14 clear-sky MODIS images acquired in the Ross Ice Shelf polynya area. The AMSR2 PR is negatively correlated with the thermal ice thickness. The AMSR2 PR vs. ice thickness relationship is similar to that of AMSR-E. We plan to develop the AMSR2 algorithm also using clear-sky MODIS images acquired in other Antarctic coastal polynya areas, such as the Ronne Ice Shelf and Cape Darnley polynyas.

Keywords: Antarctic Ocean, Coastal polynya, AMSR2

