Monitoring of Sea Ice Thickness around Yamal Peninsula using AMSR2

Yurika Watanabe [1], Kazutaka Tayeyama[1], Koh Izumiyama[2], Seita Hoshino[3]
[1] *Kitami Institute of Technology*
[2]*Arctic Research Center, Hokkaido University*
[3]*Japan Aerospace Exploration Agency*

Survey of sea ice thickness using satellite sensors have become increasingly important for monitoring global environmental change and using the Northern Sea Route (NSR). It is hard to observe for ship in the vast area such as the Arctic Ocean every day. Therefore, satellite remote sensing using a passive microwave radiometer (PMR) is desirable for the monitoring daily sea ice thickness along the NSR. Recently, estimation of sea ice thickness using PMR has been attempted experimentally. However, First-year sea ice (FYI) thickness estimated in the study which few FYI data used are more inaccurate than estimated Multi-year sea ice (MYI) thickness. In this study, the brightness temperature (*TB*) measured by Advanced Microwave Scanning Radiometer 2 (AMSR2) of the Global Change Observation Mission-W (GCOM-W) was compared with the sea ice thickness measured by Synthetic interferometric radar altimeter (SIRAL) of CryoSat-2, and improved the algorithm for estimating sea ice thickness for FYI in the Arctic.

Observed SIRAL data and AMSR2 data from November 2019 to January 2020 at 60-65° N and 70-74° E were used in this study. The AMSR2 data during night time were used to avoid the effects of melting on the sea ice surface during day time. SIRAL measures the ice freeboard and snow thickness. Therefore, freeboard F_{ice} (m) were converted to total ice thickness T_{T} (m) using the following equation.

$$T_{\mathrm{T}} = F_{\mathrm{ice}} \cdot \frac{\rho_{\mathrm{w}}}{\rho_{\mathrm{w}} - \rho_{\mathrm{I}}} + Z_{\mathrm{snow}} \cdot \frac{\rho_{\mathrm{s}}}{\rho_{\mathrm{w}} - \rho_{\mathrm{I}}} \qquad (1)$$

Here, ρ_{w} (g/m^3), ρ_{I} (g/m^3), and ρ_{s} (g/m^3) are densities of sea water, snow, and sea ice, respectively. Z_{snow} (m) is snow depth. The T_{T} (m) in this equation used as correct value for sea ice thickness. AMSR2's *TB* with sea ice concentration of less than 90% and melting rate of more than 30% were excluded from the analysis, because those *TB* are considered to be affected on investigation of sea ice thickness parameters. Figure1 shows ice thickness distribution derived from SIRAL during December 2019.

Although spatial resolution of SIRAL is 250m, that of AMSR2 is 10km. Therefore, individual grid data of AMSR2 includes multiple grid data of SIRAL. To keep data representativeness, averaged value (T'_{T}) of multiple SIRAL data were compared with AMSR2's *TB* as shown in Figure 2.

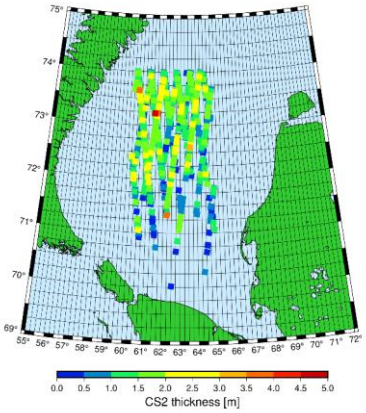

Figure 1. Ice thickness distribution map drawn by using SIRAL data

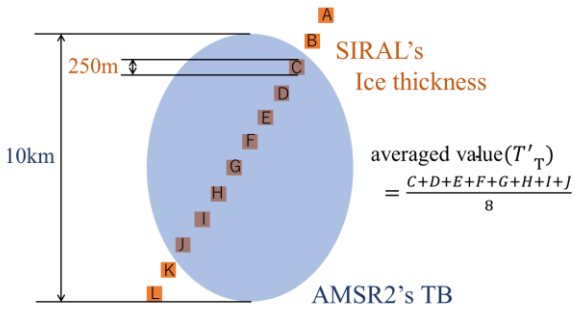

Figure 2. Schematic image of comparison with AMSR2's *TB* and averaged value (T'_{T}) image

References

Krishfield, R. A., A. Proshutinsky, K. Tateyama, W. J. Williams, E. C. Carmack, F. A. McLaughlin, M.-L. Timmermans, 2014 : Deterioration of perennial sea ice in the Beaufort Gyre from 2003 to 2012 and its impact on the oceanic freshwater cycle, Journal of Geophysical Research, 101, 1297-1303.

Hoshino, S., K. Tateyama, T. Yasuhiro, 2018 : Validation of sea-ice thickness derived satellite altimeter Cryosat-2 SIRAL in the Arctic, and application to Southern Ocean, Seppyo, 80(4), 304 (in Japanese).