DEVELOPMENT OF AMSR-E THIN ICE ALGORITHM IN THE ARCTIC AND ANTARCTIC OCEANS, AND THE OKHOTSK SEA

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ABSTRACT:

The heat insulation effect of sea ice is greatly reduced in thin ice area. Turbulent heat flux to the atmosphere at the thin ice surface is possibly 2 orders of magnitude larger than that at the thicker ice surface. In coastal polynya, which is mostly covered with thin ice, sea ice is formed very actively because of the large amount of heat loss to the atmosphere. Further, dense shelf water (DSW) is formed due to large amount of brine rejection associated with the high ice production. Sinking of the DSW drives global thermohaline circulation. Therefore, quantitative estimates of ice and DSW production in coastal polynyas are quite important to understand the climate system and the changes. Since heat loss to the atmosphere is fairly sensitive to ice thickness, especially when it is very thin, an estimate of thin ice thickness including the polynya area detection is essential. In this study, we propose a thin ice thickness algorithm using Advanced Microwave Scanning Radiometer-EOS (AMSR-E) data in the Arctic and Antarctic Oceans, and the Okhotsk Sea. The algorithm is based on the AMSR-E polarization ratio of brightness temperature at 89- and 36-GHz channels (PR89 and PR36) through a comparison with ice thicknesses (hi) estimated from the MODerate resolution Imaging Spectroradiometer (MODIS) infrared data. We also propose fast ice detection using AMSR-E brightness temperature at 89 GHz channel. Because the spatial scale of coastal polynya is not so large (typically <100 km), an advantage of the AMSR-E data is the finer spatial resolution of ~6 km and ~12.5 km at 89 GHz and 36 GHz channels, respectively. A scatter plot of PR36 versus hi (PR36-hi plot) and a PR89-hi plot showed similar relationship; PR is negatively correlated with hi, and is not sensitive to hi when hi is >0.2 m. In the Arctic Ocean, the PR-hi plot showed an exponential-like relationship. On the other hand, in the Antarctic Ocean and the Okhotsk Sea, the PR-hi plots showed a linear relationship for hi <0.2 m. When the PR-hi relationship was approximated by a linear line, the lines in the Arctic and Antarctic Oceans were similar. By using these PR-hi relationships coastal polynyas are detected. In the case of the 89 GHz channel, data affected by atmospheric water vapor is excluded. Because of the finer spatial resolution, the AMSR-E algorithm can detect coastal polynya more in detail than the SSM/I thin ice algorithm which was developed previously.