

Global Mapping of sea ice production and heat/salt flux in ice-covered regions, using satellite passive microwave data

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Ice-covered regions are the areas that the surface heat condition is most unknown. A coastal polynya is a hot spot at which intensive heat/salt exchange occurs. Most of the polynya area is covered with thin ice. During winter, heat loss over thin ice is one or two orders of magnitude larger than that over thick ice, causing the very high ice production there. Quantitative estimation of heat/salt flux and ice production in polynyas has been very limited due to the difficulty of direct in-situ measurements. General objective analysis dataset such as ECMWF and NCEP does not take account of the effects of coastal polynyas. Satellite passive microwave is a strong tool for detection of thin ice (polynya) area and estimation of thin ice thickness globally on a daily basis.

In this study, we have estimated heat flux over the ice-covered regions globally, using the thin ice thickness algorithm of SSM/I and AMSR-E we have developed. Heat loss is obtained assuming that the sum of radiative and turbulent fluxes at the ice surface is balanced by the conductive heat flux in the ice, whose thickness is derived from the thin ice algorithm. Heat loss in the ice-covered regions during the freezing period corresponds to sea ice production, on the assumption that all of the heat loss at the surface is used for ice formation. Thereby, global mapping of sea ice production has been done. This also gives the salt flux into the ocean, assuming that the salt rejection is proportional to the ice production.

From the mapping in the Southern Hemisphere, the Ross Ice Shelf Polynya has by far the highest ice production, which is consistent with the fact that AABW with the highest salinity is formed there. The Cape Darnley polynya in East Antarctica is found to be the second highest production area, which is suggested to be an unknown AABW formation area by the recent Japanese IPY observation. In the Northern Hemisphere, the highest ice production rate is shown in the North Water Polynya. The Okhotsk northwest shelf polynya is also found to be very high ice production area.

These global datasets of sea ice production and heat/salt flux will be archived on our website soon. These dataset will be also useful for validating and providing boundary conditions for coupled atmosphere-ice-ocean models. We are now making mooring observations of Ice Profiling Sonar and ADCP in the Antarctic and Arctic polynyas, which will provide very good validation data for the ice thickness and production algorithm.