Development of heat and salt flux dataset associated with sea-ice processes in the Antarctic Ocean

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Antarctic coastal polynyas are very high sea ice production areas. The resultant large amount of brine rejection leads to the formation of dense water, which is a major source of Antarctic Bottom Water (AABW). The sinking of the dense water plays a significant role in the global climate system by driving thermohaline (overturning) circulation and biogeochemical cycles such as the carbon dioxide exchange between the atmosphere and deep ocean. Sea-ice melting supplies freshwater, nutrients, and iron into the upper ocean, leading to biological hotspots through phytoplankton brooming. The air–ocean heat flux in the sea-ice zone, a cause for the freezing and melting, is provided as a component in some global meteorological datasets. However, the treatment of sea ice is not appropriate in their heat flux calculation. Further, because the coastal polynya's typical width from the coast to the offshore is at most 100 km, the heat flux dataset with the spatial resolution of 10–100 km cannot sufficiently resolve the coastal polynyas. This study developed a heat and salt flux dataset associated with sea-ice processes in the Antarctic Ocean using AMSR2 sea-ice data.

Daily heat and salt fluxes were estimated on the polar stereographic grid at a spatial resolution of about 6.25 km. We considered sea-ice concentration as well as thin ice thickness and type for the heat flux calculation. These sea-ice parameters are derived from AMSR2. Heat fluxes were calculated using formulas that are suitable for the Antarctic sea-ice zone: the longwave radiation is calculated by an empirical formula and the turbulent heat fluxes are calculated from bulk formulas. As atmospheric input data, we used near-surface atmospheric data from ERA5 dataset. Data of air temperature at 2 m, dewpoint temperature at 2 m, wind at 10 m, and surface sea level pressure were used. The salt flux of this study consists of salt supply due to brine rejection associated with freezing and freshwater supply associated with melting. The effect of ice advection is taken into account using ice drift derived from AMSR2. The resultant dataset will be used to investigate biogeochemical cycles caused by sea-ice freezing, advection, and melting from comparisons with in-situ observations accompanied by the GRAntarctic project.

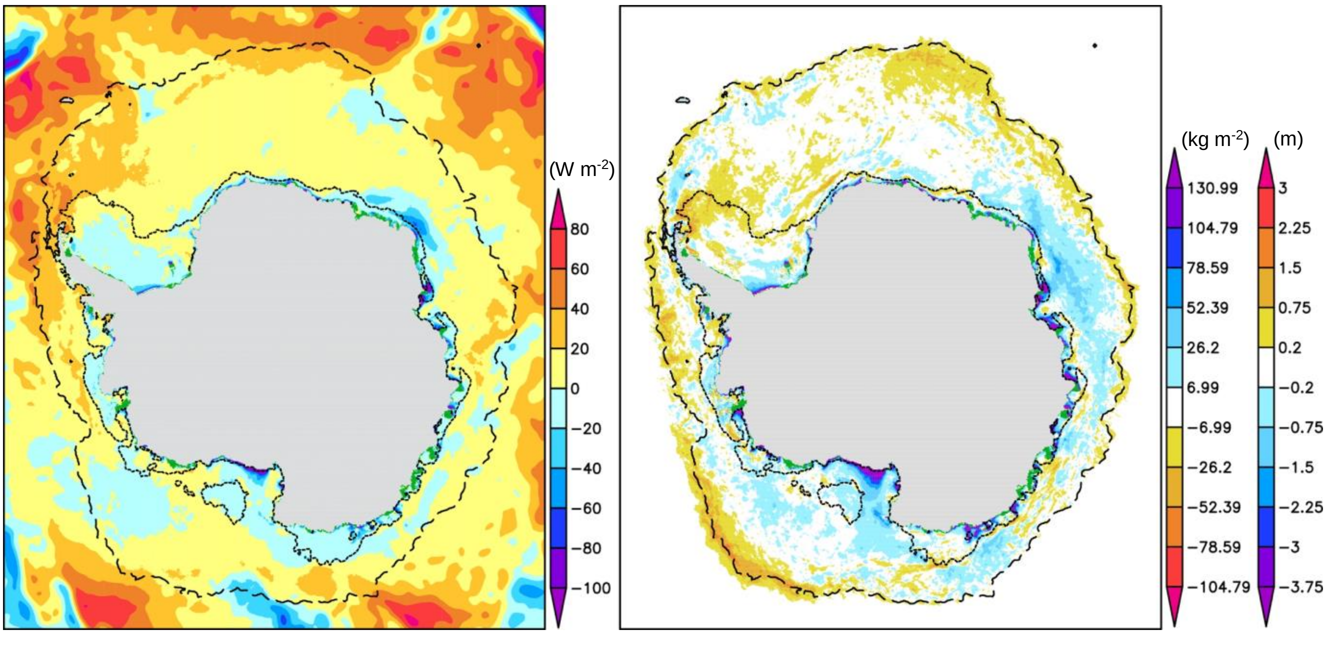

Figure 1. Annual heat (left) and salt/freshwater (right) flux in the 2019/2020 season. Dashed and dotted lines indicate maximum (September) and minimum (February) sea-ice extent.