Why does the sea ice, in the western area of the Sea of Okhotsk, always survive?

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The sea ice extent in the sea of Okhotsk has a clear interannual variation on record. The maximal sea ice concentration, ever recorded, covered almost the whole sea, and usually it covers more than half of the area. Conversely, the minimal sea ice concentration was just along the narrow western boundary lying over the continental shelf and partial slope where it seems to be warrantable and secure for the existence of drift ice. In other words, the cold water was conserved there in each year historically.

Why is this structure so robust? The key point is the water temperature, and whether it can reach the freezing point or not determine the existence of sea ice. What should be taken into account in changing the water temperature? The water exchange comes to mind first. The inflow from the North Pacific Ocean could determine if the drift ice located in the central area is melted or not, as whose temperature has a high consistency with the maximal sea ice concentration *(Nakanowatari et al 2010)*. The formation mechanism of current varying with topography might somewhat stop this inflow into the shallow area, and further block the heat exchange. For the coastal current, it is identified as the Arrested Topographic Wave *(Nakanowatari, Ohshima et al 2014)* whose volume transport is mainly influenced by the alongshore wind stress. While a stable circulation explained by Sverdrup Balance persists in the central area, deeper than 500m precisely *(Ohshima,2004)*, and the geostrophic transport takes an important role in this circulation. Besides, a sharp temperature gradient is in the low latitude, the north of the Hokkaido, and a cold core holds close to the coast, according to the observation *(Mizuta et al 2004)*. The same situation might also happen in the higher latitude.

For clarifying the current pattern inside of the Sea of Okhotsk, we reproduced the circulation of steady state with an Ocean General Circulation Model including stratification and coupling sea ice model set up first by *Matsuda et al (2015)*, and the ERA-interim dataset 1980.01.01-2018.12.31 was used as the atmospheric forcing. The simulation depicted the average sea ice concentration well, including thermohaline circulation inside of the Sea of Okhotsk. Analyzing the model output, the cross-isobath current in the section along 52N presents an inverse direction in the shallow mixed layer even in the sea surface. With the TRACMASS, an out-line particle tracking toolbox, we processed a further verification of the water movement in the surface layer. In the forward tracking experiment(January-April), most of the particles put in the central area lower than 54N do circulation along isobath deeper 500m. A handful of the particles put in the central area higher than 54N and in the northwestern area can enter the shelf region of East Sakhalin. The former one considered with warmer water might give a positive effect on sea ice melting, while the number of it is limited. In the backtracking experiment (April-January), most of the particles put in the shelf region of East Sakhalin do local movement restricted in 49-52N, which is a symptom of the cold water mass there is easier to be conserved.

Keywords: drift ice, heat transfer, water exchange, particle tracking

