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Modelling of ballast water discharge in the Arctic Ocean

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Sea-ice concentration in the Arctic Ocean decreased 9% per decade since 1978. With the decline of the sea-ice in the Arctic Ocean, more vessels are navigating through, enlarging the risk of alien species to enter the Arctic Ocean through ballast water. Vessels depend on ballast water for stability and to maintain structural integrity. However, it contains unintended aquatic species that are carried in the tanks. It is possible that the transferred species survive to establish a reproductive population in the host environment. I implemented a ballast water tracer (BW-tracer) into a high-resolution version of NAOSIM (North Atlantic/Arctic Ocean-Sea Ice Model). The focus of my work is to identify the flow of the BW discharged in the Arctic and areas of accumulation with potential for invasive species to survive. In 2013, 17.407 vessels navigated the Arctic waters, of those, 202 vessels were of Destination Traffic making 731 port calls in 37 different Arctic ports. The estimated amount of discharged BW by these vessels is about 13 million cubic meters. In the model, the BW-tracer is released in those areas where we know ships have been in 2013. My results show that the seasonal cycle of the ocean mixing affects the BW-tracer distribution. In winter, the tracer reach depths of around 35 m deep in the Barents Sea, where the maximum depth is about 80 m, and 750 m deep near the west coast of Spitsbergen where the maximum depth is about 3000 m. In spring, the sea ice starts to melt creating stratification in the upper level of the ocean, and the BW-tracer remains within the first 15 m deep in both regions. Moreover, strong surface velocities spread the BW-tracer during spring and summer, and the availability of sun and nutrients lead to more favorable living conditions for non-indigenous species. The analysis of both regions shows BW-tracer accumulation south of Novaya Zemlya, in the Barents Sea, and on the east side of the Kara Gate in the Kara Sea. Another area with tracer accumulation is located south of Spitsbergen. Model experiments show that in the Barents Sea, the BW-tracer remains for almost three months with 10% of its concentration.