Large Oyashio eddies drive interbasin exchange between the Sea of Okhotsk and the subpolar Pacific

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Abstract
The water exchange between the Sea of Okhotsk and subpolar Pacific governs the intermediate water ventilation. The mechanism of this exchange have not yet revealed. What determines the variations of this exchange flow to the subpolar Pacific have not yet shown. Most of the previous works suggested that the interbasin exchange occurs through the two deepest straits along the Kuril Islands, which are the Kruzenshtern Strait to the north of the Middle Island Chain, and the Boussole Strait to the south. Here we show the evidence that large anticyclonic eddies drive the interbasin exchange via the mid depth straits in the Middle Island Chain. Based on hydrographic, Argo and Argos data we estimate the flow from the Sea of Okhotsk to the subpolar Pacific through this Middle Island Chain. This mechanism explains significant differences between the structure of the Oyashio in extremely cold year in the subpolar Pacific.

Results. We present the longest ever observations under the Kamchatka Current and Oyashio. These observations started in the middle of the 20th century and continues to the recent years. The Kamchatka Current is the largest subarctic western boundary current, which flows up to 1200 km from the western Bering Sea to the northern Kuril Islands, where it joints the Oyashio Current. It originates near the Cape Olutorskiy in the western Bering Sea and flows along the coast of Kamchatka. The source region of the Kamchatka Current is located near the northwestern coast of the Bering Sea, when the Alaskan Stream waters inflow through the Near Strait.

We used historical CTD observations, Argo and Argos data to obtain the characteristics of the Kamchatka Current halocline and its anticyclonic eddies (Fig. 1). These data are available due to the Coriolis project and related projects (www.coriolis.eu.org). The CTD data were collected at the Pacific Oceanological Institute (POI). We also describe the features of the Bering Sea eddies during the record warming event in recent years using Argo data. Kamchatka and Oyashio eddies have a cold low salinity core (Fig. 2). The eddies have a diameter of ~ 120 km with a thick cold layer in a halocline. The temperature in their core increased by ~ 2.4°C from the beginning of observations, while salinity decreased. We found that 2012 was the extreme cold year in the Subpolar Pacific. Record breaking warming occurred in the Kamchatka Current in 2015-2018 (Rogachev and Shlyk, 2021). Temperature in halocline rose by ~3°C from 2012 to 2018 at 26.6 sigma-teta,, while in the western Bering Sea temperature rose by 2.3°C. It is plausible that the warming in the Kamchatka Current halocline in 2012-2018 is associated with the lowest sea-ice coverage in the Bering Sea. Similar warming occurred in the Oyashio Current. The largest Oyashio eddy observed in 2012 (Fig. 3).

It is possible to formulate the following questions: - are there strong changes in the water mass properties of the Kamchatka Current and Oyashio? -How do they compare to other oceanographic changes in the Subarctic Pacific? - What drives these changes? In the present work we study the characteristics of the halocline in the Oyashio. Our major goal is to reveal the changes in properties of the Kamchatka Current and Oyashio for the 70-years period from the middle of the previous century to 2021.

Rogachev, K., Shlyk, N. 2021. Record-breaking warming in the Kamchatka Current halocline. Ocean Dynamics, 71 (5), pp. 545-557.

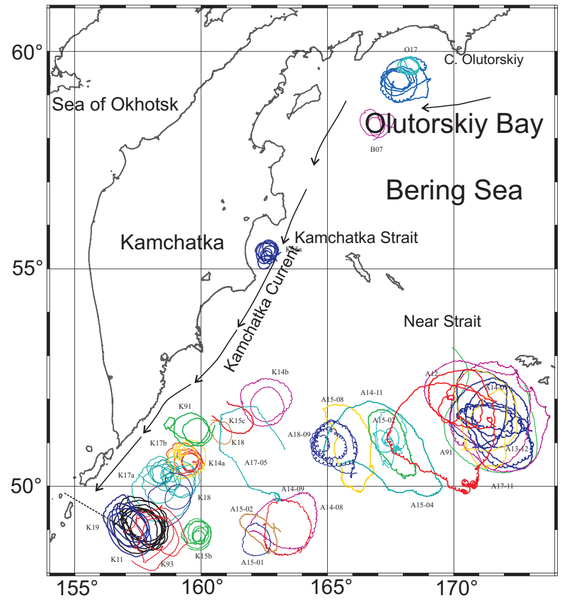

Fig. 1. Study region with drifter's tracks and position of the Aleutian (A) and Kamchatka Current eddies (K). Letters O and B mark Olutorskiy Bay and Bering Sea Kamchatka eddies. The map shows the distinct source regions for the Kamchatka and Aleutian eddies.

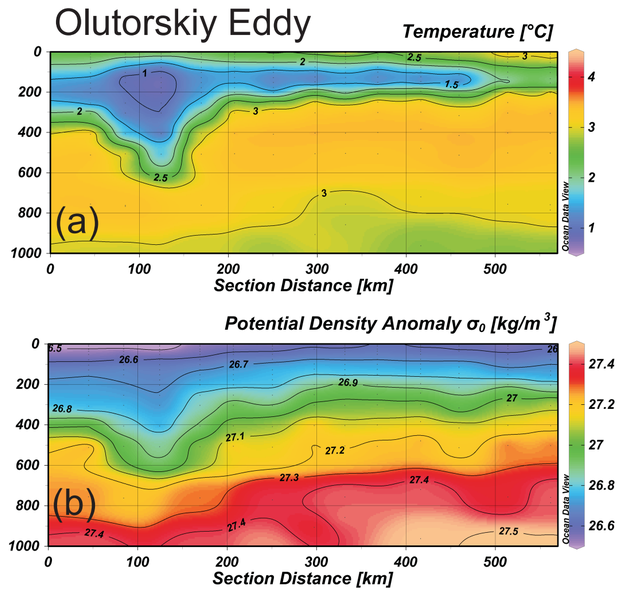

Fig. 2. Potential temperature (a) and density (b) sections across the oldest Olutorskiy eddy in the middle of the 20th century. Note a thick cold core of the eddy.

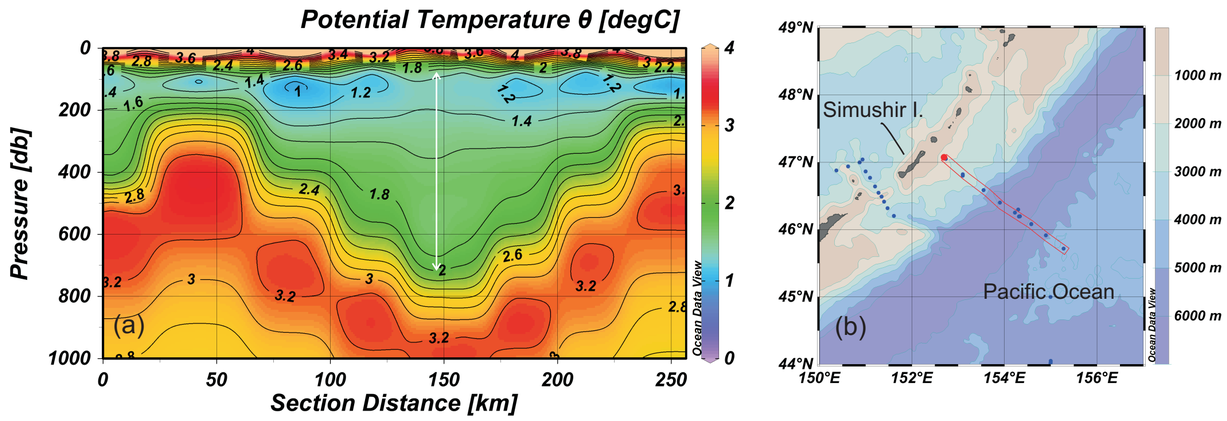

Fig. 3.Potential temperature in the Oyashio eddy off Simushir Island in 2012 (a) and stations map.