# Estimation of the hydrodynamic regime of water in the spring transitional season for half a century in the Kamchatka Strait (the Aleutian island system)

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Map of the Aleut Archipelago. The line shows the area of research.

## Research task

To calculate integral current functions on the surface were calculated, from the surface to a depth of 200 m and from the surface to the bottom.

results discussion

There are used a hydrodynamic model adapted to the ODV software with uniform grid of 5'x5'. There are taken into account temperature and salinity at sea surface, spatial distribution of water density, atmospheric influence, bottom relief, coast orography and water exchange through straits.

## Input data

- monthly temperature and salinity on 0 m, WOD13 ; (www.nodc.noaa.gov);
- monthly mean sea level pressure from the NCEP Reanalysis;
- density vertical distribution in the deepest part of the research region, WOD13 (www.nodc.noaa.gov);
- bottom depths (GEBKO).

The straits of the Aleutian island system providing their water exchange are especially important for formation of many natural processes of the Bering Sea and the Pacific Ocean. And many factors complicates the study this region.

The geographical position and elongation of the Aleutian archipelago determine the main features of its climate and belong to the zone of temperate latitudes. Throughout the year this region is influenced by the permanent centers of action of the atmosphere: Polar and Hawaiian maximum. And also under the influence of seasonal large-scale baric formations: the Aleutian minimum, the Siberian maximum, the Asian depression. In winter, northeast, north and northeast winds prevail; in summer - southwest, south and southeast.

Through the Aleutian Straits as come very large amounts of surface and deep waters from the Pacific ocean, and flow Bering sea water.

The bottom relief is very complex. The deepwater zone is located in the southwestern (≈4420 m) and central (≈2000 m) parts of the Aleutian island system, shallow water - with depths mostly up to 100 m.

There are 47 straits in the Aleutian-Commander Ridge with a total cross-sectional area of approximately 735 km$^2$, but most of them are shallow (with depths up to 100 m). The Kamchatka Strait is located in its southwestern part and is the deepest strait of the Bering Sea. It divides the Commander Islands and Cape Africa on the east coast of Kamchatka. The width of the Kamchatka Strait is 103 miles, the maximum depth is ≈ 4420 m, the cross-sectional area is 335.34 km$^2$ (45.9%). The four most significant straits (the Middle, Buldyr, Amchitka, Amukhta) divide the Commander-Aleutian arc into five main groups of islands: the Commander, the Near, the Rat, the Andreyanov, and the Fox.

The continental shelf along the coast of Kamchatka and nearby Islands is narrow.

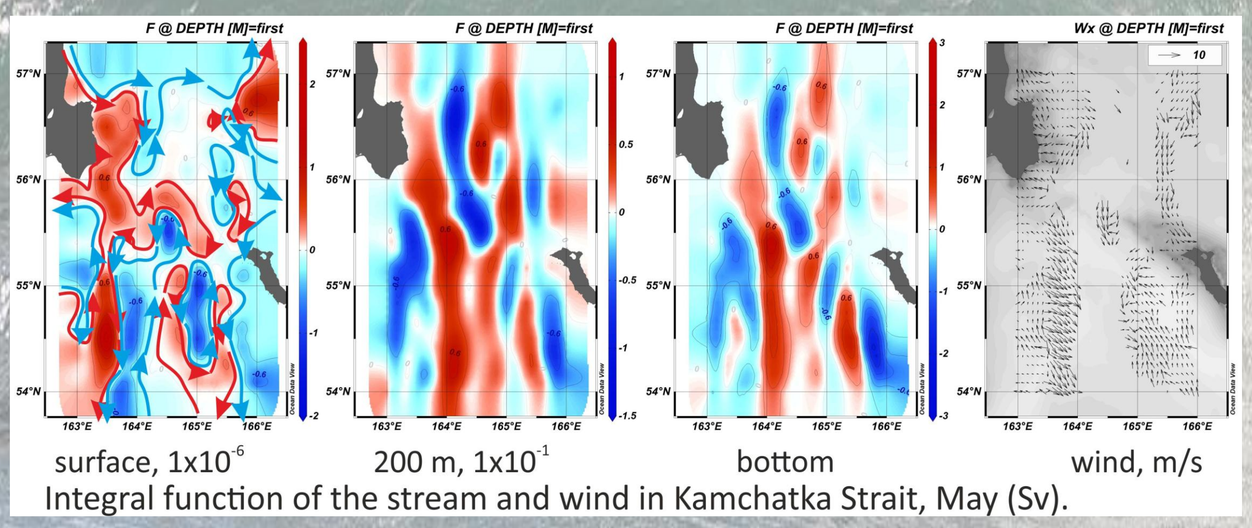
## Research methods

The hydrodynamic model adapted to the ODV software. The integral current functions were calculated on the surface, from the surface to a depth of 200 m and from the surface to the bottom. Also model output parameters are the vertical components of the flow velocity (with the fields of surface pressure), the surface temperature, salinity; as well as the tangential stress and wind speed, drift and gradient components of the flow velocity, the depth of the homogeneous layer and other oceanographic and meteorological values in a specific period of time. The model also takes into account the spatial distribution of input parameters, orography of the coast and water exchange through the straits. Input data for model was carried out with ODV tools.

For the calculations, the transitional spring hydrological period (May, June) was used as an example of the transition from the winter subarctic regime of waters to the summer moderate. At this point in time, this season has not been studied enough for various objective reasons.

## Purpose

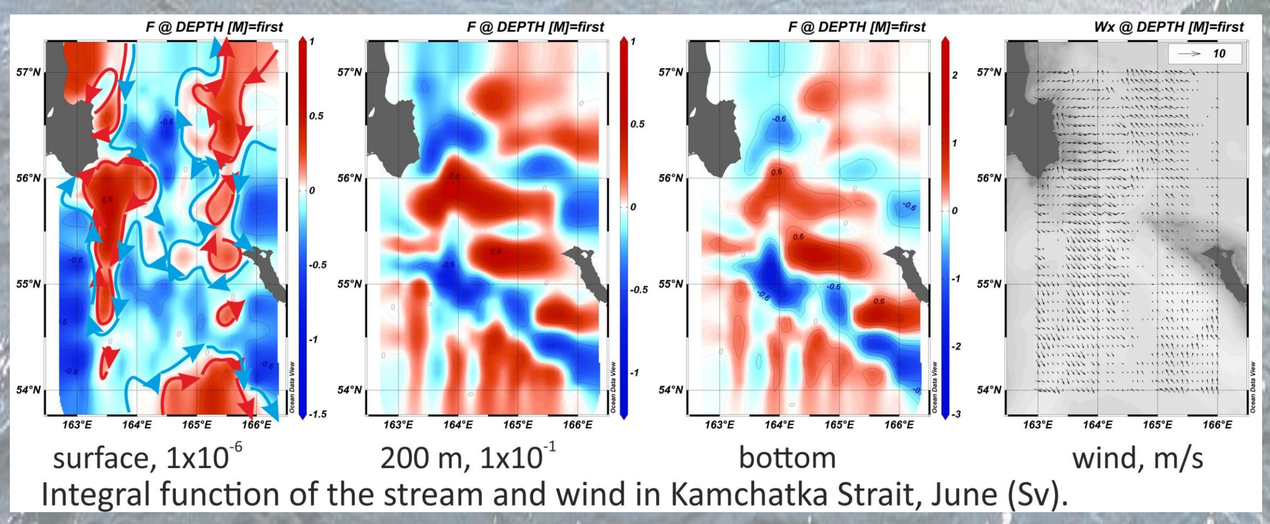
**To study of the spatial and temporal variability of water circulation in the Kamchatka Strait in the spring season for the period 1950-2017. The spring season was used as an example of the transition from the winter to the summer due to its poor knowledge.**




Integral function of the stream and wind in Kamchatka Strait, May (Sv).

## Results of a research

According to results of most of the previous studies, it was concluded that cyclonic activity prevails in the Kamchatka Strait and the Bering sea waters are mainly carried out by the Kamchatka current. However the calculations showed that a slightly different hydrodynamic situation is observed in the studied water area in the spring period. First, the Kamchatka current during a transition period does not constitute a single, unbroken flow of water masses. Instead, in this area in May in the western part of the Kamchatka Strait on the surface there are three hydrodynamic cycles: two cyclonic and anticyclonic separating them. This may indicate the quasi-stationarity of such a hydrodynamic situation, which may form the structural features of the Kamchatka current in general and, in particular, according to the seasons. In some references (Prants et al. 2014) the quasi-stationarity of the anticyclone in the specified area is confirmed in the winter and summer periods: in winter it is located to the north, and in summer it coincides with our calculated data. This is probably due to the transition period "spring-summer", when the summer regime of waters begins to be established. In the eastern part of the strait, cyclonic activity with anticyclonic eddies of various sizes and intensities prevails. Dobrovolsky and Arsen'ev (Dobrovolsky et al. 1961) noted local anticyclonic circulation around Commander Islands. Water transport in May does not exceed 3 SV.




Integral function of the stream and wind in Kamchatka Strait, June (Sv).

In June, the hydrodynamic picture changes somewhat due to increased solar activity, acceleration of ice destruction and the continuation of the processes of formation of the surface layer (Khen et al. 2009). In the western part of the strait on the surface, the May hydrodynamic structures are preserved, but spatially changed. The anticyclone is extended meridionally, and northern and southern cyclonic formations occupy a larger area and are more intense. In the eastern part of the strait, anticyclonic activity is activated and anticyclones are expressed more clearly. At the same time, anticyclonic formations on the surface have a meridional orientation, in the 0-200 m layer and from the surface to the bottom – zonal. This indicates that on the surface there is a meridional flow (inflow) of water, and with depth increases the advection of water. It should be noted that the lowering of water in the shelf and over slope anticyclonic gyres create additional conditions for deep circulation. Water transport in June does not exceed 2 SV.

## Conclusions

All of the above indicates that the water exchange in the strait has a two-way flow pattern: both the removal of the Bering Sea waters and the inflow of the Pacific. And with the depth, the restructuring of the flow pattern occurs. At the same time, take away prevails over entry.