The contribution and spatial distribution of Ob and Yenisei runoff on surface layer of the Kara Sea

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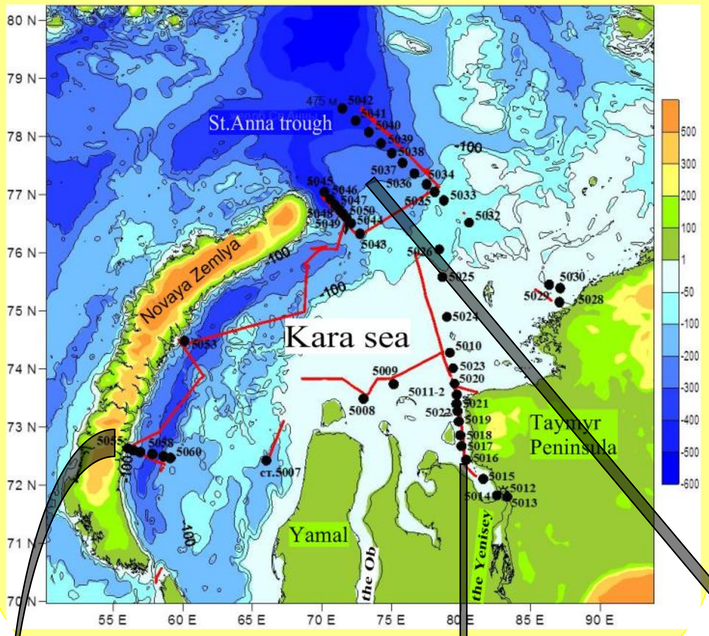
Materials.

Region of research – southern-west part of the Kara sea. It was divided into 4 parts, defined by hydrometeorological and hydrochemical conditions:

1. Section “Yenisei” (16 stations)
2. Section “St.Anna through-east” (11 stations)
3. Section “St.Anna through-west” (8 stations)
4. Section “Novozemelskiy trough” (6 stations)

In total, the vessel's laboratory performed **3805** hydrochemical determinations in water samples, including: dissolved oxygen (374 analysis), pH (550 analyzes), the values of total alkalinity (550 analyzes), the content of inorganic phosphorus (448 tests), total phosphorus (147 tests), dissolved silica (538 analysis), nitrite nitrogen (330 tests), nitrate nitrogen (330 tests), ammonia (323 analyzes) and total dissolved nitrogen (215 tests). The recording time of **pH in surface waters** on the course of the vessel was **330 hours**.

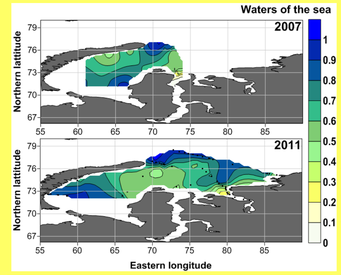
Region of research

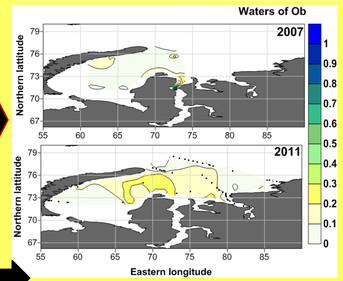


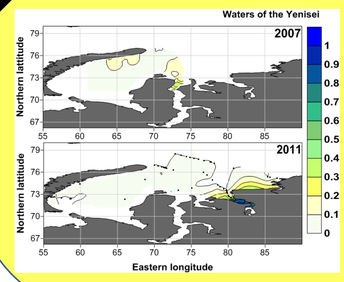
Introduction.

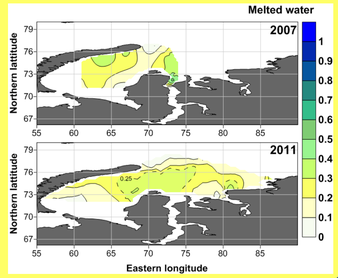
Hydrochemical researches of the Kara Sea were included into the works of complex expedition in 59th cruise of R/V "Academic Mstislav Keldysh" (on September, 11th - on October, 7th, 2011). This data supplements results of expeditions of Institute of Oceanology RAS to the Kara Sea in the autumn 1993 (R/V ”Dmitry Mendeleev”) and 2007 (R/V "Academician Mstislav Keldysh"). In these cruises were met and described **lenses of fresh water contained Ob and Yenisei waters defined on hydrochemical parameters.** Difference of the data of 2011 from last years is that sampling for researches of distribution of river runoff (on silicon, pH and the general alkalinity) was spent in flowing system from horizon of 1-1,5 m on a course of a vessel with high frequency of sampling. Such technique of sampling allows to investigate a surface water area with high discretness which plays the main role in definition of the contribution of waters of Ob and Yenisei in surface layer of the Kara Sea.

Contribution of different sources in the formation of the surface layer of the Kara Sea

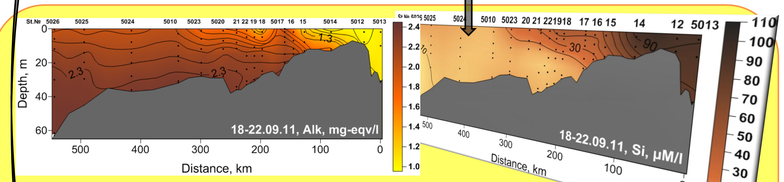






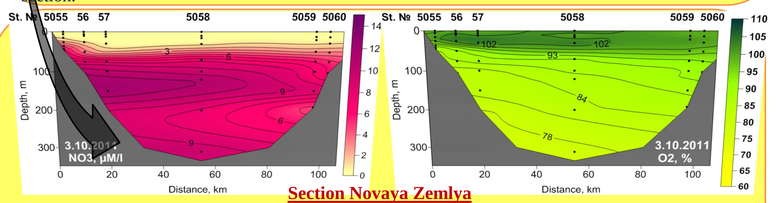


Following the methods developed by Peter N. Makkaveev there was calculated the contribution of the Ob and Yenisei and the ice melt water in the surface layer of the Kara Sea. It was found that in the central part of the sea the Ob water is dominated, while water from the Yenisei rejected the right of the Gulf of Yenisei. Comparison with the data in 2007 showed that the meteorological conditions strongly influence the movement of the freshened water lenses on the Kara Sea. Depending on the amount of river flow and direction of wind, the Yenisei water can reach the coast of Novaya Zemlya or to navigate towards the Taimyr Peninsula. Ob water may spread to the shores of Novaya Zemlya or stay near the exit of the Gulf of Ob.



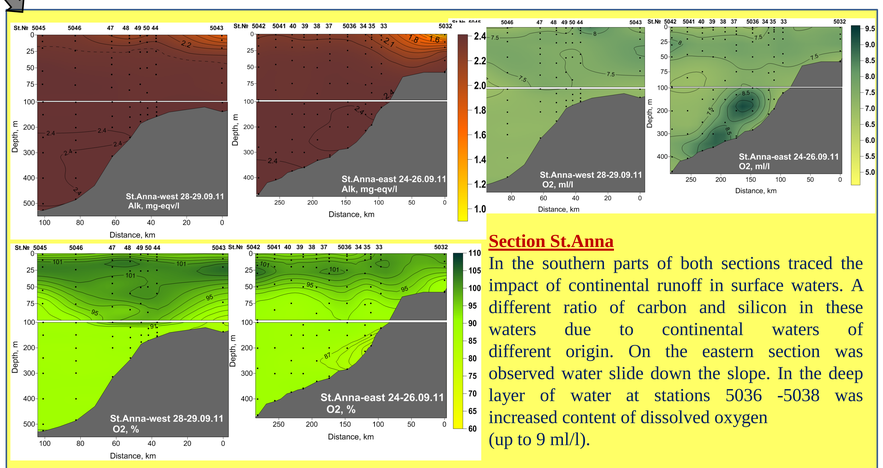
Section “Yenisei”

Total alkalinity and dissolved silica are the most conservative markers of river runoff.
The estuarine mixing zone is clearly visible on these hydrochemical parameters.
This zone has a complex structure and consists of two parts - the vertical frontal zone, located between stations 5012 and5013, and the horizontal frontal zone which can be traced almost to the end of the section.



Section Novaya Zemlya

As well as on the section along St.Anna trough there was observed a layer of water with high content of dissolved oxygen. Below 25 meters degree of saturation is uniformly decreasing. The distribution of different forms of dissolved nitrogen (nitrite, nitrate and ammonium) was more complex than other hydrochemical parameters. Distribution of nitrates was characterized by the presence of a maximum on the 150 m. This maximum was more pronounced in the western part of the section.



Section St.Anna

In the southern parts of both sections traced the impact of continental runoff in surface waters. A different ratio of carbon and silicon in these waters due to continental waters of different origin. On the eastern section was observed water slide down the slope. In the deep layer of water at stations 5036 -5038 was increased content of dissolved oxygen (up to 9 ml/l).

It was also discovered an interesting feature in the distribution of oxygen. Nearly all stations in both sections of the layer 20 - 30 m of water supersaturated with oxygen was observed: in this layer, the relative content of oxygen was 100 -105% or more(maximum value 109%). This layer is slightly below the halocline. The origin of this layer due to the fact that large numbers of spring water, taken out with the tide, cut off the surface waters of the sea, which at that time actively took place in spring bloom. A similar phenomenon was observed in individual stations during the 54th cruise of R/V "Akademik Mstislav Keldysh", and has been described and explained P.A.Stunzhas.

Method of calculating *(by Peter N. Makkaveev)*

Salty sea water on the surface of the Kara Sea are covered freshened layer with a salinity of 15 to 28 psu. The thickness of this layer was an average of about 10 meters.
This layer is formed by mixing sea and river waters. The total flow of the rivers Ob and Yenisei into the Kara Sea is more than 80%.
Another factor involved in the formation of surface water - water is formed by the melting of sea ice.
Chemical composition of river flow is different for each river basin and is determined by the nature of its catchment area. This fact makes it possible to trace the distribution of water from various sources for the sea area.
Upon mixing of waters of the conservative value of the parameter C_o is described by the following equation:

$$C_o \cdot V_o = C_1 \cdot V_1 + C_2 \cdot V_2 + C_3 \cdot V_3 + \ldots;$$

where V_i – volume of water and C_i – the value of the corresponding parameter, given that $\mathbf{V_o}=\sum \mathbf{V_i}$ can express the relative contribution of each water mass as $K_i=V_i/\Sigma V_i$. Then the equation becomes: $\mathbf{C_o}=\sum(\mathbf{C_i}\cdot \mathbf{V_i}/\sum \mathbf{V_i})=\sum(\mathbf{K_i}\cdot \mathbf{C_i})$;
The sum of the relative contributions of each water mass $\mathbf{\Sigma K_i=1}$, we obtain a system of linear equations, which, knowing the values of the parameters $\mathbf{C_i}$, can be solved with respect to $\mathbf{K_i}$. Moreover, the use of **N** parameters can be carried out calculations for **N+1** water masses.
For the calculation we used the data on the content of dissolved silica, total dissolved inorganic carbon and salinity of the waters of the Yenisei, Ob and surface waters of the open sea. Also for melted ice the content of silicon, carbon, and salinity were taken equal to 0.

References

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