Monitoring of the Water Exchange between the Atlantic and the Arctic Oceans (the 38th and 39th Cruises of the R/V Akademik Ioffe)

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The water exchange between the Northern Atlantic and the Arctic Ocean occurs through the relatively shallow straits between Greenland and Scotland. The warm waters of the Atlantic Ocean’s upper layer flowing to the north compensate for the inflow of the cold deep water mass.

The main objectives of the studies in 2011 and 2012 were the following:
— to obtain the quantitative assessment of the seasonal and interannual variability of the characteristics of the Arctic and Atlantic water masses flowing above the Greenland–Scotland Ridge;
— to measure the rates of the water exchange and the exchange of heat and freshwater between the Atlantic and the Arctic oceans at their common boundary.

These observations follow the research started under the international projects Variability of Exchanges in Northern Seas in 1997–2000 (VIENS) and Arctic–Subarctic Ocean Fluxes in 2000–2008 (ASOF).

A special feature of the Russian studies is to obtain detailed, quasi-synchronous, frequent, and highly accurate estimates of the intensities of the water transport through all the straits (from coast to coast) between the Northern Atlantic and the Arctic oceans for several years [1]. Repeated measurements in the straits within several days make it possible to filter the short-period and synoptic “noise” caused by the passage of eddies and the pulsation character of the water exchange in the straits.

In 2012, 14 sections were performed through the straits between Greenland, Iceland, and the Faroe and Shetland islands (figure).

The sections were observed again in May–June of 2012 during the 38th cruise of the R/V Akademik Ioffe: three sections through the Faroe–Shetland Channel, four sections over the Iceland–Faroe threshold, and two sections through the Denmark strait (sections 1, 2, and 3 in the figure, respectively).

In total, 139 hydrogeologic stations were performed: 46 in the Faroe–Shetland Channel, 76 over the Iceland–Faroe Ridge, and 17 in the Denmark Strait. Due to the difficult ice situation, we did not manage to cross the Denmark Strait completely; however, the basin through which the cold waters are mainly transported to the Northern Atlantic was crossed twice within 24 hours. At each station, the CTD/LADCP measurements were performed from the surface to the bottom. The distance between the stations amounted to about 10 miles. To improve the spatial resolution between the stations performed during drifting, the STD soundings were performed en route by UCTD at a rate of 8–9 nodes. In total, 99 such soundings were made at the thresholds. The water samples were taken at 7–16 horizons at each station to determine the concentration of the dissolved oxygen and biogenic elements.

In September 2012, the section through the Denmark Strait was performed three times within 6 days during the 39th cruise of the R/V Akademik Ioffe. One section was made over the Faroe–Iceland Ridge and one through the Faroe–Shetland Channel (figure). In total, measurements were made at 102 hydrological stations and 117 stations along the route of the vessel on September 16–27.

To preserve the continuity of the observations, the position of the sections was oriented to the standard hydrographic sections. The positions of the sections guaranteed the intersection of the main flows of the Atlantic and Arctic waters between the ocean basins.

The vertical distributions of the sea water parameters were observed during all the cruises using an SBE 911 plus submersible oceanographic complex equipped with two pairs of electrical resistance temperature sensors (SBE3 and SBE4), an SBE 43 oxygen sensor, a turbidity sensor, 24 5-liter bathometers, and a Benthos PSA 900D altimeter. The soundings at the stations were performed from the surface of the ocean to 5–10 m from the bottom. To control the accuracy of the electri-
The water samples were analyzed for salinity en route by an Autosal Salinometer 8400B. The data on the salinity obtained by the salinometer were used to control the temporal drift of two SBE4 electrical conductivity sensors. The calibrations of the SBE3 and SBE4 before and after the cruises at the laboratory of the sensors producer showed that the accuracy of the temperature measurements was 0.001°C, while that of the salinity was less than 0.002 PSU with respect to the control of the accuracy under the marine conditions.

The content of dissolved oxygen in the selected samples was determined by potentiometric Winkler titration in the modification of the Institute of Oceanology of the Russian Academy of Sciences using a Metrohm 794 Basic Titrino automatic titrator. The accuracy of measuring the oxygen concentrations in the sea water was 0.01 mL/L. The concentrations of silicates and phosphates were estimated according to the colorimetric method by a Varian Cary 100 spectrophotometer using the Korolev and Morphy–Riley methods. The relative errors of the method in determining the concentration of the silicates and phosphates was ±2.5–4% and ±1%, respectively.

The current velocities were observed, together with the CTD soundings, using two Workhorse Sentinel 300 kHz acoustic Doppler current profilers (LADCPs) in up- and down-looking configurations. A TRDI OS 38 kHz bottom-mounted acoustic profiler was used by the R/V Akademik Ioffe. Its maximum measurement depth was 650–750 m.

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The analysis of the currents through the Faroe–Shetland Channel for two years showed that the transformed East-Iceland current (TEIC) always flowed into the channel from the north. The TEIC was a source of increased dissolved oxygen content in the...