Observations of Atlantic Water pathways and velocities in the Nordic Seas

Małgorzata Cisek, Waldemar Walczowski, Piotr Wieczorek
gosiak@iopan.gda.pl
Institute of Oceanology Polish Academy of Sciences, 81-712 Sopot, Powstańców Warszawy 55, Poland

Rapid climate changes observed in the last decades caused increasing of interest of the ocean role in climate shaping. Atlantic Water (AW) carried into the Arctic Ocean by system of oceanic currents is the very important medium transporting northward huge amount of salt and heat. Institute Oceanology Polish Academy of Sciences (IOPAS) investigates AW properties, variability and transformation in the Nordic Seas since 1988. Since 2000, every year we perform 200 CTD profiles, make VM ADCP and LADCP measurements. Last summer from the board of IOPAS vessel, R/V Oceania first Argo floats were lunched. The goal of the experiments was to learn pathways, velocity of currents and transformation of AW in Nordic Seas. These and other ARGO data were compared with the results of the R/V Oceania cruises into the Nordic Seas and output from numerical modeling.

Hydrological situation in Nordic Seas area

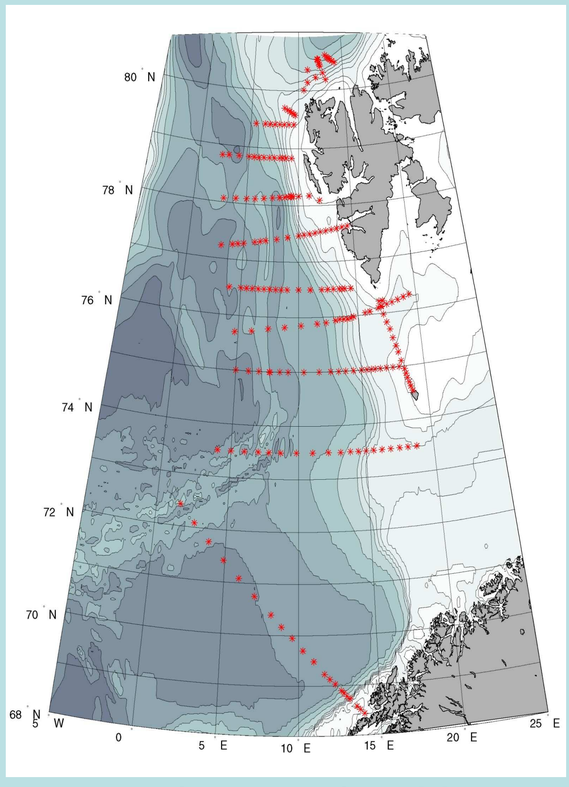

Fig. 1. Map of stations performed during R/V 'Oceania ' summer 2005 cruise.

Data collected by the IOPAS during cruises of the R/V 'Oceania' into the Barents, Norwegian and Greenland Seas gave interesting information about the Atlantic Water advection, pathways and transport by the West Spitsbergen Current (WSC) and heat, salt and volume fluxes. Every year we conduct quasi-synoptic measurements of the WSC, crossing it by series of sections located perpendicular to the expected flow direction. In the southern part of our polygon the coverage by measurements is poor, so interpolated fields are not too accurate, but in Fram Strait vicinity the coverage is much better, so interpolated hydrographic fields and computed currents are much more precise.

Our measurements show that except the main branch of the WSC flowing along the Barents Sea slope and Spitsbergen shelf-break, the second, colder and less saline branch exists. It is also topography steered and continues along the Mohns and Knipovich Ridges as a jet stream of the Arctic Front. Part of AW carried by this branch crosses Arctic Front over the Mohns Ridge and enters the Greenland Sea in form of the anticyclonic eddies. During its northward flow, water carried by the eastern branch interacts with the shelf waters, penetrate Barents Sea, Spitsbergen shelf and fjords, mixes cross the Polar Front.

Presented horizontal distributions of water temperature and calculated baroclinic currents show multi-pathways structure of AW transport.

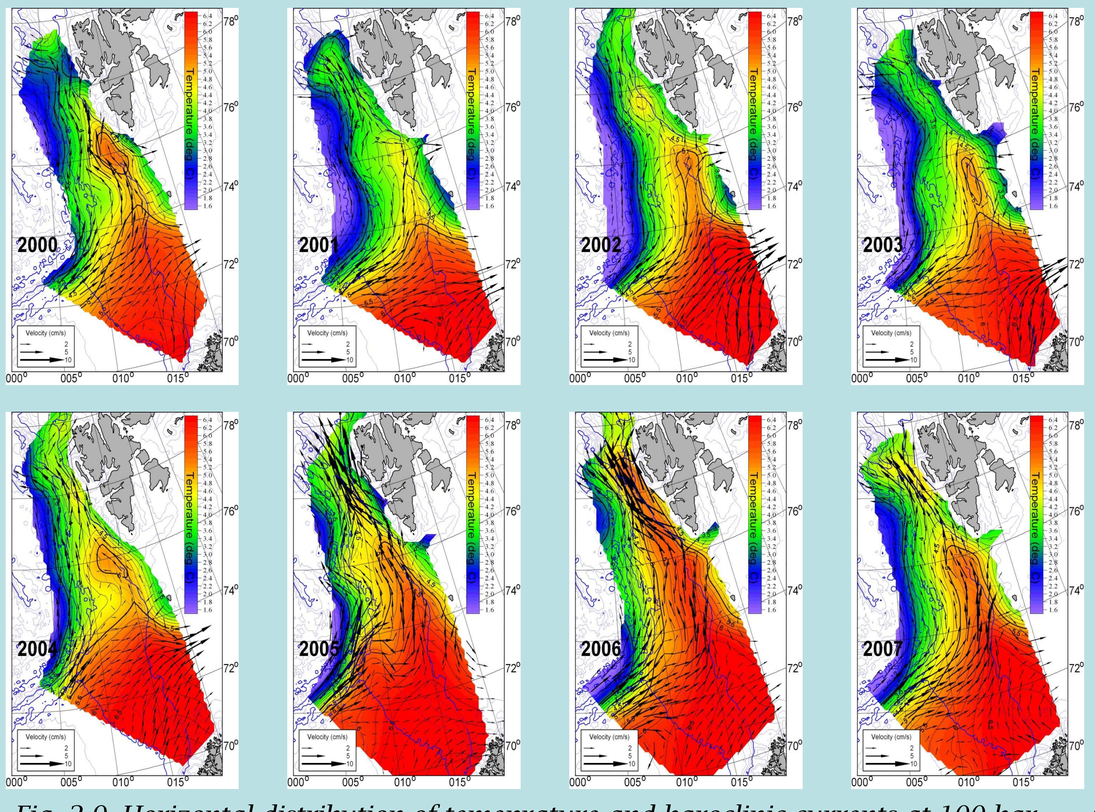

Fig. 2-9. Horizontal distribution of temeprature and baroclinic currents at 100 bar in subsequent years

Argo floats experiment

During cruise in summer 2009 four Argo floats were deployed from board R/V 'Oceania'. Two floats were from Institute of Oceanology Polish Academy of Sciences, Sopot and two from Alfred Wegener Institute for Polar and Marine Research, Bremerhaven. The localization of deployment (Fig. 10) was chosen based on measurements conducted years before. Floats were deployed at section along the 75˚00 N parallel, north of the Bear Island. The aims was to investigate the WSC pattern and velocity in its various parts (branches) and to test various ice detecting algorithms and different data transmission systems. Float no 1 was deployed in the core of the WSC, over the Barents Sea slope; float no 2 – on the western edge of the WSC core; float no 3 – in the central part of WSC; float no 4 – in the western branch of the WSC, over the Knipovich Ridge.

Only one of these floats worked for over 7 months (remaining didn't transmit) and now it remains under ice, its trajectory is on figure 10. At the beginning the float was circulating in the area of launching and headed north with the WSC. Change in the direction of drift of the float over the Knipovich Ridge is probably caused by bathymetry. Recorded decreases in the value of temperature and salinity indicate leaving warm and salty Atlantic Water and flowing in the region dominated by Arctic Water masses.

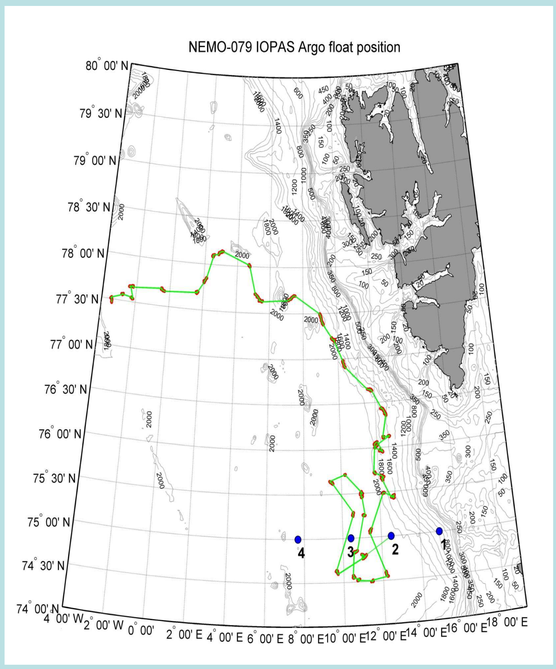

Fig. 10. Positions of the floats deployment by IOPAS and trajectory of one float.

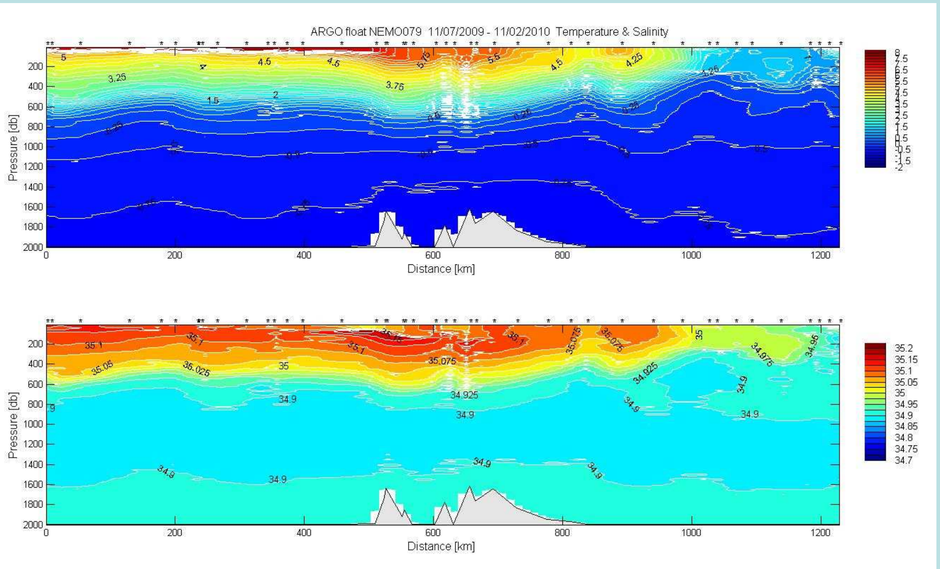

Fig 11. Time series of temperature (top) and salinity (bottom) from Argo float deployed by IOPAS (11 July 2009 – 11 February 2010)

Floats in Nordic Seas

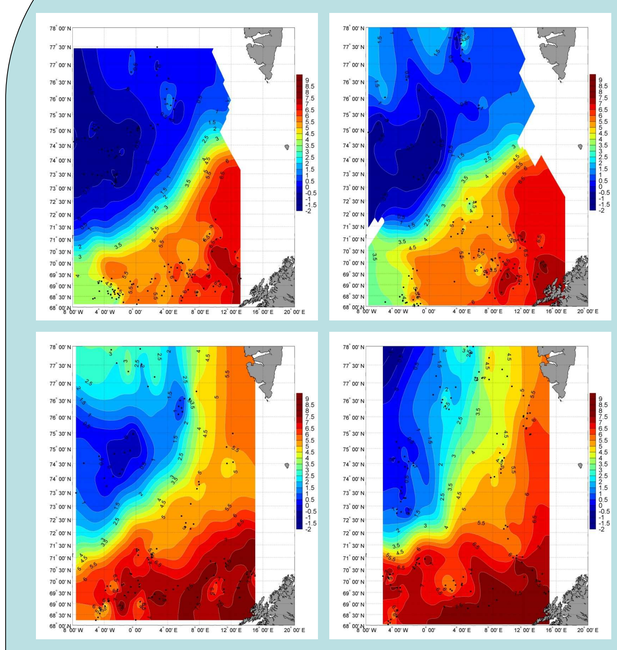

Fig. 12-15. Horizontal distribution of temperature on 100 m, data collected by Argo floats in 2009. Fig 12. January – March, Fig 13. April – June, Fig 14. July – September. Fig. 15. October - December

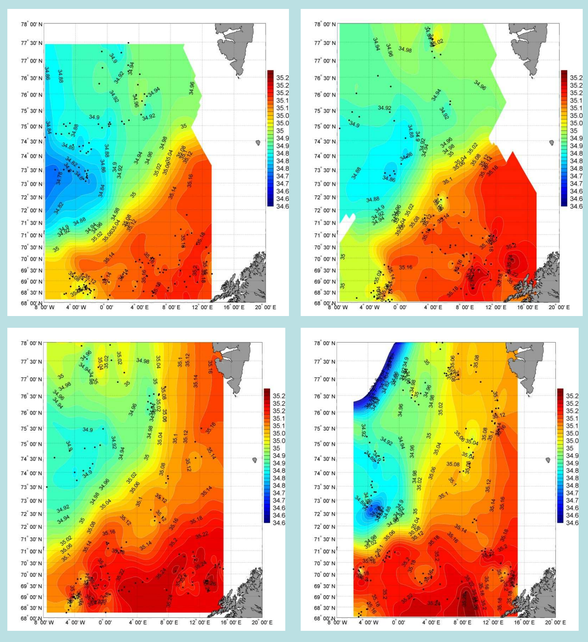

Fig. 16-19. Horizontal distribution of salinityon 100 m, data collected by Argo floats in 2009. Fig 16. January – March, Fig 17. April – June, Fig 18. July – September. Fig. 19. October - December

Argo data give the possibility to analyze hydrological situation in mentioned area all year round. The horizontal distributions of temperature and salinity on the depth of 100 meters in subsequent quarters of 2009 are show on figures 12-19. On average, there are 150 profiles on one quarter in this region and in view of bathymetry most of the floats are located in regions of Greenland and Lofoten Basins. Although warmer and more saline Atlantic Water can be observed flowing north with West Spitsbergen Current, especially in the second half of the year.

Combination of Argo data from July 2009 and data collected from board IOPAS R/V 'Oceania' during summer 2009 gives an image more accurately identifying the structure of the WSC over the shelf.

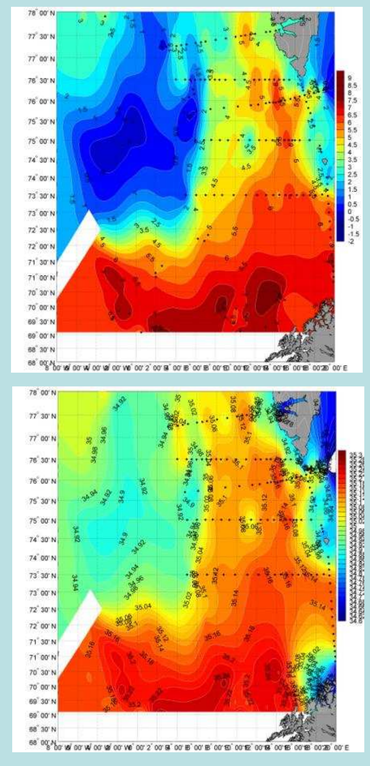

Fig. 20-21. Horizontal distribution of temperature (top) and salinity (salinity) on 100 m, combined CTD data from Argo floats and data collected during cruise , both from July 2009