Temporal variability of the Nordic Seas intermediate and deep water properties based on Argo floats data in 2008-2017 period

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The Nordic Seas play an important role in global climate change. Compared with other areas, this region has the largest ocean surface and air positive temperature anomalies in the world. It is particularly important for the water masses formation and modification and for interactions between the ocean and atmosphere. This region is also the main route for freshwater and heat exchange between the North Atlantic and the Arctic Ocean.

Every summer the Institute of Oceanology, Polish Academy of Sciences conducts measurements along more than 10 hydrographic sections, including about 200 stations and covering the area between northern Norway and Fram Strait (Fig. 1). These time series allowed us to analyze how the parameters of the intermediate and deep water have changed over the last decades (Fig. 2).

However, because the ship-borne measurements are performed usually during the spring to the autumn season, there is no data to analyze seasonal changes in the intermediate and deep water. The Argo floats, operating throughout the whole year, allow observation of seasonal changes that occur in particular regions. This is especially important in the Nordic Seas, where conditions of the oceanographic observations are very difficult even during the summer.

In this study we compare the summer hydrographic data collected by IO PAN with the data from Argo floats in the Nordic Seas region in 2008-2017. Based on the data, both the temporal and spatial variability of the basic physical properties of the intermediate and deep water were analyzed. It allowed determining how the parameters of these waters changed both seasonally and spatially.

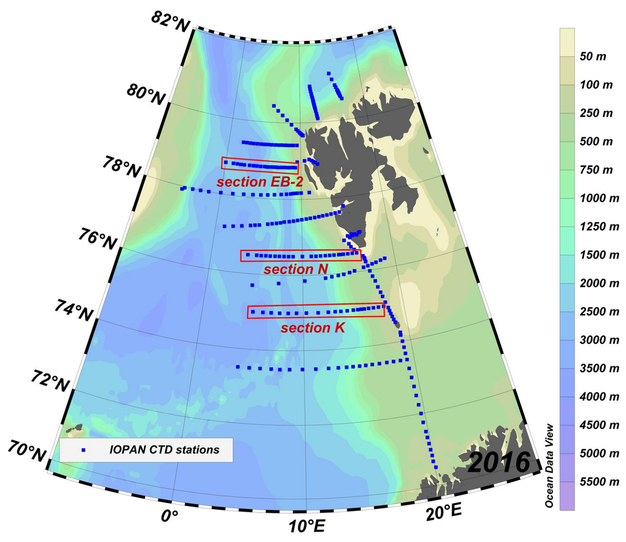


Fig. 1 The standard grid of CTD stations repeated annually during the AREX observational program carried by IO PAN.

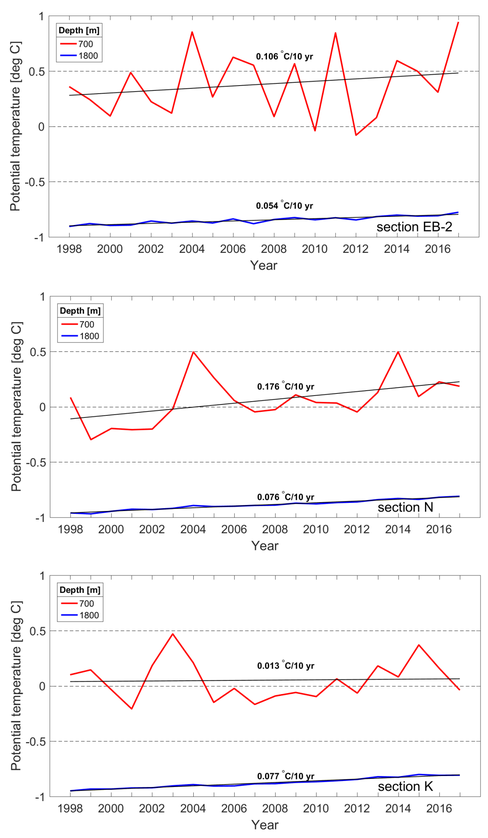


Fig. 2 Mean potential temperature at 700 m and 1800 m, across section EB-2, N and K in 1998-2017.

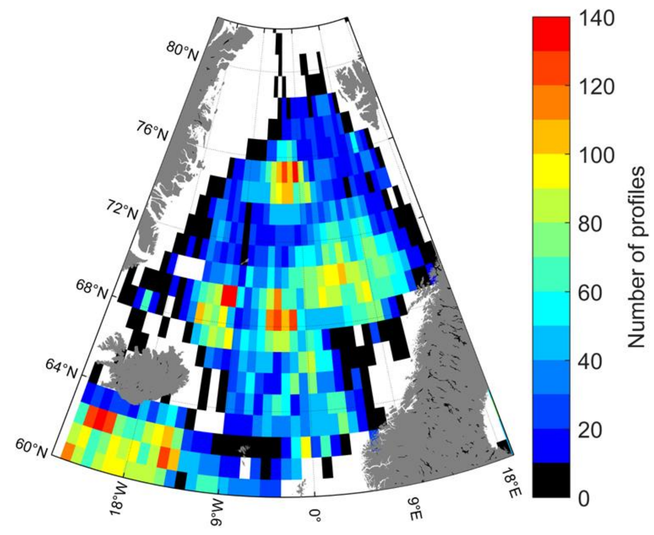


Fig. 3 Argo profiles density map for 2008-2017.

The spatial coverage of Argo measurements in the open ocean is satisfactory, while in the Arctic regions the network of Argo profiling floats is poorly developed. This results in insufficient coverage of measurements of intermediate and deep ocean layers. Only a small number of places have more than 100 profiles per 10 years (Fig. 3). The Nordic Seas are dominated by areas with less than 30 profiles per decade. This particularly applies to the north part of the Nordic Seas, including region where IOPAN performs annual measurements.

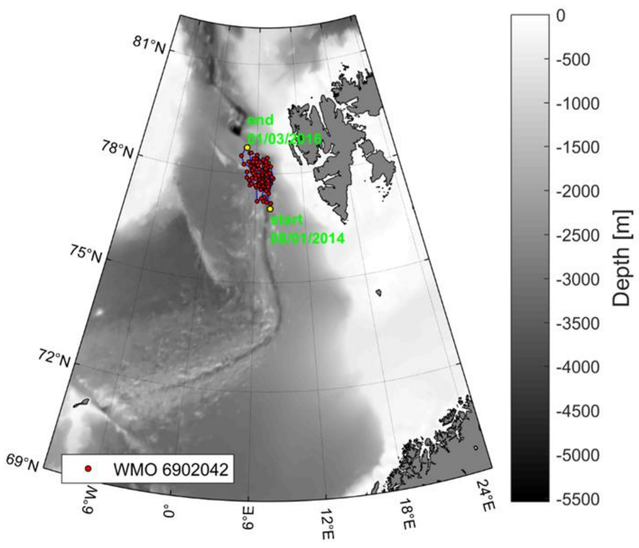
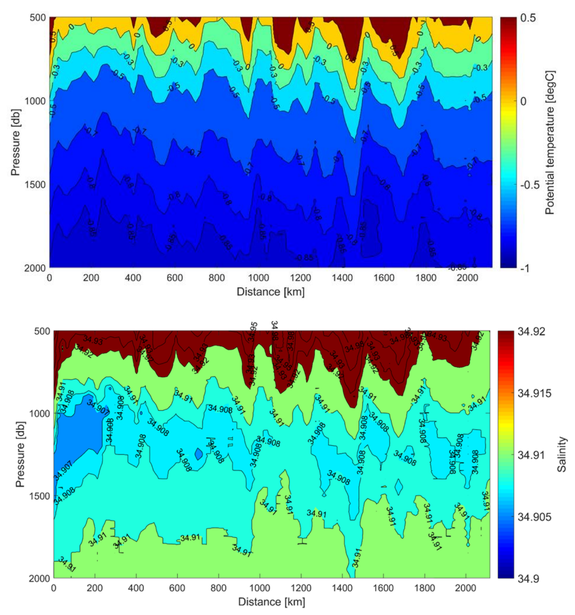


Fig. 4 Trajectory of the Argo float deployed in 2014 (WMO6902042).



Rys. 5 Distribution of the potential temperature (upper) and salinity (lower) (WMO6902042).

The Argo float, launched by IOPAN in the summer 2014 (Fig. 4), allows to observe seasonal variability of water properties. During almost 1.5 years of the mission, the float performed measurements in a very limited area. This allows to observe seasonal changes in intermediate and deep water (Fig. 5).

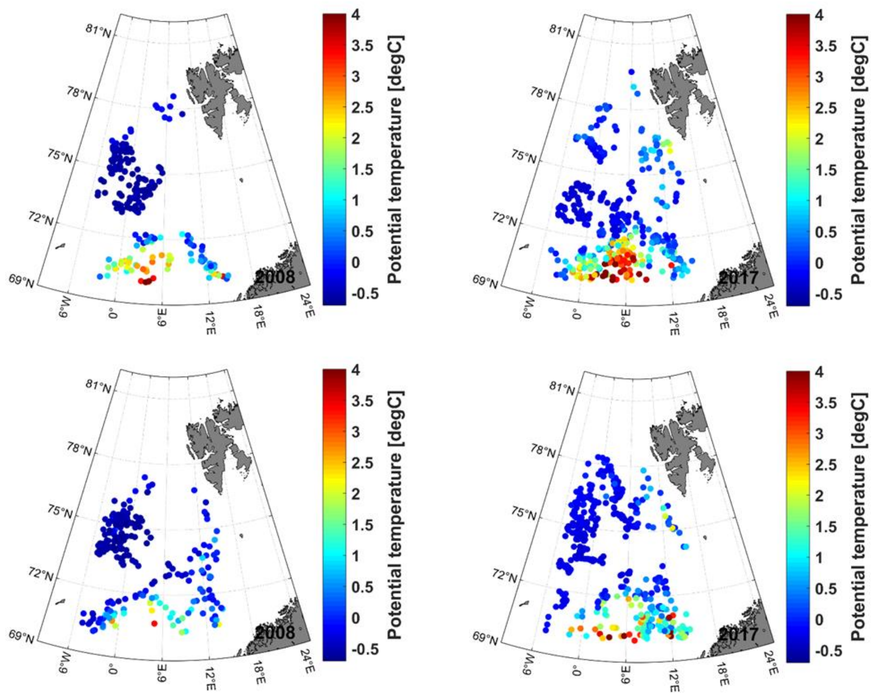


Fig. 6 Potential temperature at 700 m in the summer season (1.05-31.10) (upper) and in the winter season (1.11-30.04) (lower).

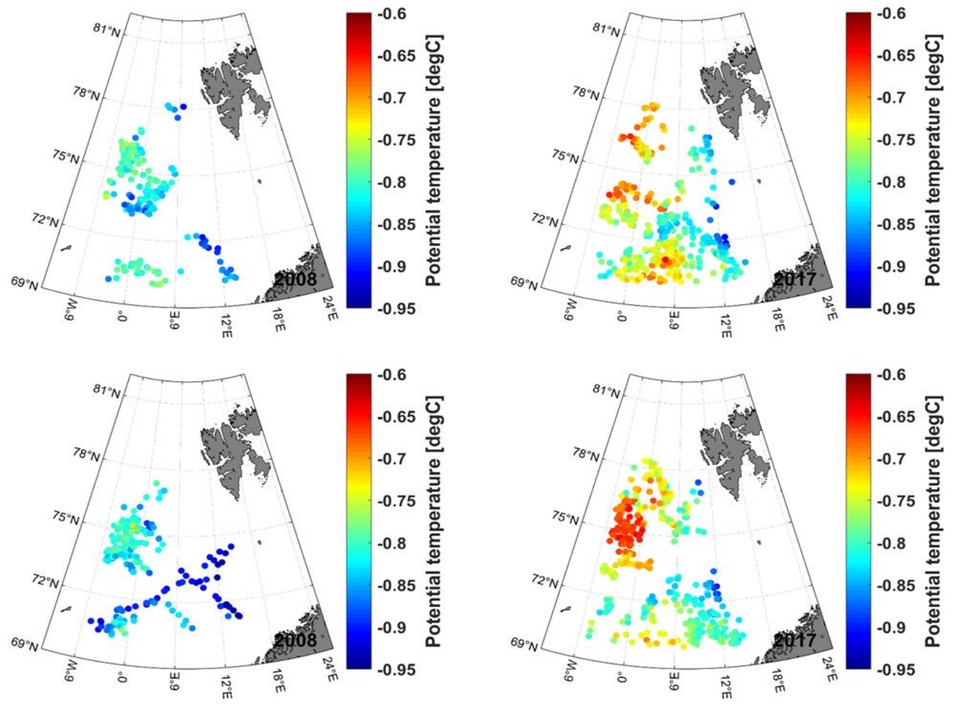


Fig. 7 Potential temperature at 1800 m in the summer season (1.05-31.10) (upper) and in the winter season (1.11-30.04) (lower).

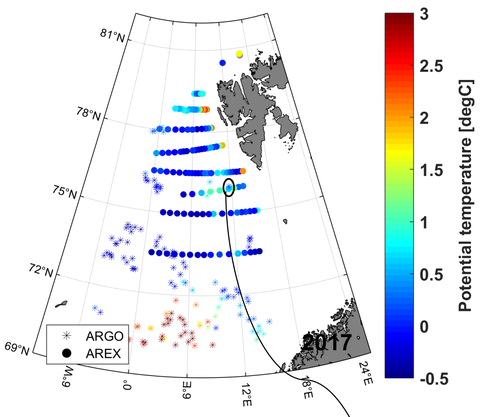


Fig. 8 Potential temperature at 700 m. Data comes from Argo floats and AREX program from summer 2017.

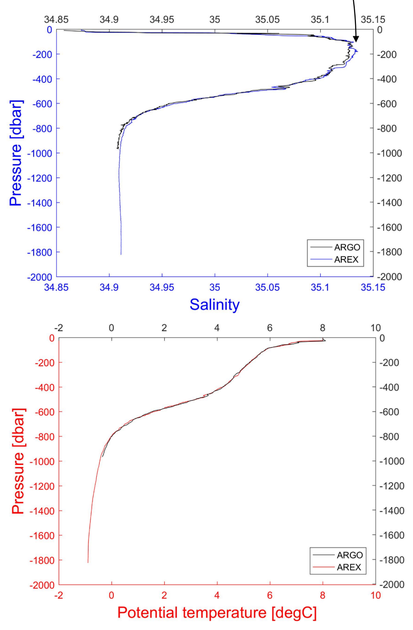


Fig. 9 Comparison of the profiles from Argo and AREX data.

Conclusions:

- data from Argo floats are extremely valuable, especially in regions so important for global climate change and so difficult due to harsh weather conditions and ice situation like the Nordic Seas,
- comparison of profiles from Argo floats with profiles from AREX program confirmed that data from Argo floats have very good accuracy. They can be used to extend the ship-borne measurements, both temporarily and spatially,
- far too few Argo floats are launched in the Nordic Seas, especially in the northern part,
- in many regions of the Nordic Seas the number of profiles is insufficient to include these areas in long-term analyzes of changes in water properties.

Acknowledgement

The study was funded by the Ministry of Science and Higher Education, Poland under grant agreement No. DIR/WK/2016/12 for the research infrastructure EURO-ARGO ERIC and the National Science Centre, Poland within the DWINS Project (2016/21/N/ST10/02920).