Description for general public

Changes in the Earth's climate observed in recent years arouse a lot of excitement and anxiety among all societies. Therefore, climate research focused on understanding its changes and predicting its future is one of the most important tasks of modern scientists.

Until recently, the climate and its changes were mainly associated with changes in the atmosphere. Only the last IPCC report (IPCC, 2013) included a statement that 'the evolution of climate on timescales from the season to the thousands of years is closely connected with the ocean'. The ocean is extremely important component of the Earth's climate. Water has an enormous heat capacity and absorbs over 90% of the solar radiation which reaches the surface. The heat stored by the oceans in the tropics is distributed towards the poles by the current system, called thermohaline circulation. Deep waters play an important role in this process. Their formation in the Arctic and Antarctic drives this cycle. Deep water is also a major reservoir of dissolved carbon dioxide, which is the most important greenhouse gas. Ocean contains more than 50 times more carbon dioxide than the atmosphere, and the cold deep water is its main reservoir.

In recent years an increase in temperature of deep water has been observed. Because the warm water stores less gases than the cold water, greenhouse gases are released from the ocean and their concentration in the atmosphere increase, warming the earth system. More than 90% of the heat excess, remaining in the Earth's climate system as a result of the greenhouse effect, is absorbed by the oceans. Due to warming of the deep ocean layers a huge amount of carbon can be released into the atmosphere, which then may intensify the greenhouse effect.

Other important phenomenon is thermal expansion of the water. The warmer water has greater volume than the cold one. In addition to excess water from melting glaciers, warming of the oceans is the main cause of sea level rise.

The European Arctic has been studied by the Institute of Oceanology (IOPAN) since the early 90's. The previous work was focused mainly on warm and salty waters of Atlantic origin, their importance for climate and the impact on the sea ice. During more than 30 years of regular measurements IOPAN collected the unique set of oceanographic data from the Nordic Seas and European Arctic. In my PhD research this data set will be used to study changes in the deep ocean. Understanding the scale and drivers of changes in the physical properties of deep water in the Arctic is extremely important for a better understanding of the global climate change, which has intensified in recent years.

The main aim of my PhD study is to investigate the temporal and spatial variability of the basic physical properties of deep and intermediate water in the Norwegian and Greenland seas in 1997-2018. The special attention will be paid to quantification of changes in temperature, salinity and heat content in the studied water masses and finding potential drivers of these changes.

The hypothesis of the research project DWINS is based on a preliminary analysis of hydrographic data collected by IOPAN and assumes that the deep and intermediate waters in the studied area warm up by approx. 0.1-0.2 ° C per decade, which is much faster than the global average (0.015°C/decade at the depth of 700 m). If this hypothesis is confirmed, it will mean that changes in the properties of these waters have a much greater impact on intensifying climate change than previously thought. The ocean circulation, the amount of dissolved oxygen and carbon dioxide in the deep sea, as well as sea level rise may change at a much faster rate.

For the verification of this hypothesis analysis of oceanographic data will address different spatial scales: large scale covering the entire studied area, mesoscale with selected sections in the analyzed area and small scale including selected profiles, repeated each year over the analyzed 22 years. This will reduce uncertainties of obtained results.

Hydrographic data obtained during the annual *r/v Oceania* cruises in the Nordic Seas region in 1997-2018 will be used in this study, in particular temperature, salinity, dissolved oxygen concentration and velocity and direction of ocean current. Two methods will be employed for the analysis of properties and distribution of individual water masses in the studied basins: the classical T/S analysis (temperature/salinity) and the Optimal Multiparameter Method (OMP).