Environmental Development 17 (2016) 33–45

Contents lists available at ScienceDirect

Environmental Development

journal homepage: www.elsevier.com/locate/envdev

Trends in hydrological and ice conditions in the Large Marine Ecosystems of the Russian Arctic during periods of climate change

G.G. Matishov [a,b], S.L. Dzhenyuk [a], D.V. Moiseev [a,*], A.P. Zhichkin [a]

[a] Murmansk Marine Biological Institute, Vladimirskaya St., 17, Murmansk 183010, Russia
[b] South Science Centre, Rostov-on-Don, Chekhova Av., 41, Rostov-on-Don 344006, Russia

ARTICLE INFO

Article history:
Received 10 April 2015
Received in revised form
25 September 2015
Accepted 1 October 2015

Keywords:
Arctic Seas
Large Marine Ecosystems
Climate trends
Hydrology
Ice cover
Atmospheric blocking

ABSTRACT

Present climatic trends in the Barents Sea and Kara Sea Large Marine Ecosystems are estimated using Russian observational data and external information sources. It is shown that a warming period which reached its maximum in the beginning of the 21st Century was replaced by a cooling trend of water masses and a decrease in ice covered area. Regularities of large warm anomalies formation in the Arctic were accompanied by a strong cold event in Southern Europe.

1. Introduction

The dynamics of Large Marine Ecosystems (LMEs) of the Arctic are influenced by natural and anthropogenic factors (Sherman et al., 2013; Sherman, 2014). Murmansk Marine Biological Institute (MMBI) has conducted ecosystem research since the 1980s (Fig. 1). During the years 2012–2014, large areas of the Russian Arctic from the Kara to the East-Siberian Seas were covered by MMBI expedition cruises. In particular, unique time-series of pelagic and bottom trawling allowed update the fish species list of the Kara and Laptev Seas (Fig. 1) (Matishov et al., 1985, 1986a, 1986b; Matishov, 1992).

Long term effects of climate change as evident from water temperature, salinity and ice conditions have a special role in ecosystem functioning (Matishov et al., 2003). The most pronounced climatic anomalies in the Arctic LMEs were observed in the 20th and early 21st centuries (1920–1930; 2000–2010) warming, cooling in the middle and in the last years of the 20th century.

Heat advection by the Gulf Stream, the North Atlantic, and the North Cape currents regulates climate of the Western Arctic seas. Extension of Atlantic waters in the Barents Sea LME, leads to the formation of a stable frontal zone separating the freezing south-western part from the rest of the water body with transformed water mass and seasonal ice cover. Distribution of the Atlantic waters along submerged troughs wedged by continental ice during the Quaternary glaciation (Matishov, 1997), causes significant spatial and temporal variability of water temperature, so to interpret climate trends it is necessary to use averaged characteristics (Matishov et al., 2009).

* Corresponding author.
E-mail address: denis_moiseev@mail.ru (D.V. Moiseev).

http://dx.doi.org/10.1016/j.envdev.2015.10.001
2211-4645/

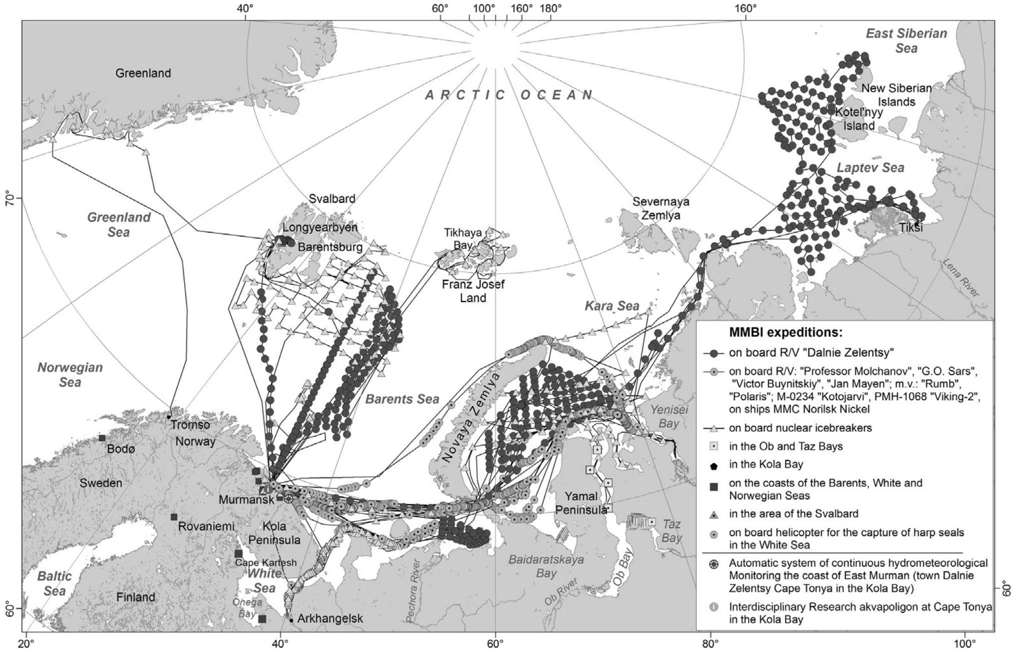

Fig. 1. MMBI expeditions in 2012–2014.

Powerful inflow of Atlantic water, its spatial and temporal changes, and the position of the Polar Front is best determined through temperature and salinity measurements on standard sections. Due to the complexity of taking current speed and direction measurements *in situ*, the largest database for standard sections is collected for temperature and salinity (Levitus et al., 2009). In this regard, analysis of thermohaline characteristics in standard sections seems highly relevant, which should be carried out while taking into account bottom glacial geomorphology (Matishov, 1984).

The temperature regime was given special attention in the history of the Barents Sea LME research as information on water temperature is of crucial importance in fishery research. Hydrophysical and acoustic processes in the water column depend primarily on water temperature, whereas salinity variability in the pelagic zone of the Barents Sea is relatively small. Thermohaline observational data is constantly used for water circulation and water exchange calculation using dynamic methods. This is why regular surveys are so important for planning standard sections and formation of oceanography data bases.

The aim of the paper is to estimate the trend and scales of present climate variations in large marine ecosystems of the Russian Arctic and to show the dependence of water masses and ice cover state on the atmospheric blocking processes over the Eurasia.

2. Materials and methods

Murmansk Marine Biological Institute possess a database for more than 250 thousand stations extending over a period from 1870 to 2012 for the oceanographic regime of the Barents Sea, White Sea sub-area, and the eastern part of the Norwegian Sea LME assessment (Fig. 2).

The Kola Transect along 33°30′E (Fig. 2) is unique for the observation period and the duration conducted since 1900 (Knipovich, 1905), although some interruptions occurred from 1907 to 1920 and from 1942 to 1944. From 1945 to the present the series are continuous (Matishov et al., 2004). As a rule, the southern part of this section is mainly considered. However, the study of thermohaline structure to the north of 74°N is of special interest, allowing for the investigation of all of the Atlantic water flows into the Barents Sea and the polar front (Matishov et al., 2009). Mean temperature of the Atlantic water in 0–50 m and 0–200 m layers, remains a general indicator of climate variations, correspondingly reflecting the dynamic processes in the upper layer and in the entire water column of the northern European seas (Matishov et al., 2007).

Analysis of the Barents Sea LME long-term and seasonal ice coverage dynamics was based on combined data of the Murmansk Marine Biological Institute (MMBI) and the National Oceanic and Atmospheric Administration (NOAA): time series of monthly values of ice regime for the years 1960–2014. About 400 monthly ice charts (archival data of remote sensing from the Arctic and Antarctic Research Institute (AARI) of the Federal Service for Hydrometeorology and Environmental Monitoring site) were used. Anomalies of average annual ice cover of the Barents Sea LME were calculated in deviations from the rated value equal to 38%.