P1.25 DATABASE FOR ECOLOGICAL STUDIES OF THE ARCTIC SEAS: BARENTS, KARA, LAPTEV, AND WHITE SEAS (1810-2001)

I. Smolyar*, R. Locarnini, R. Tatusko, T. Boyer, S. Levitus
(Ocean Climate Laboratory, NOAA/NESDIS/NODC)

G. Matishov, A. Zuyev, V. Golubev
(Murmansk Marine Biological Institute, Russian Academy of Sciences)

1. INTRODUCTION

The natural resources of the Barents, Kara, Laptev, and White Seas are rich and diverse. For many decades, they have supported an enormous and lucrative fishing industry, and today this region continues to be a zone of intensive navigation by providing cargo transportation between the cities of Europe, Asia, and the Far East. In addition, the petroleum sector is actively exploring potential oil and gas fields for development. Consequently, the exploitation of natural resources in this region makes it necessary to study a broad range of environmental issues, among which is a priority to better understand the impact on these resources due to changes in climate. This is even more crucial since the Arctic is inhabited by a variety of human populations, many of whom derive their livelihood from the resources in the Arctic, and it boasts terrestrial and marine ecosystems that do not exist anywhere else.

Climate studies of the Arctic have resulted in a large number of publications that describe various changes taking place within this region and which document and explain sources of variability in the Arctic climate system. However, because this has been an area of chronically poor data coverage, the ability to quantify high-latitude climate variability on interannual to inter-decadal temporal scales has been limited. Thus, this product will provide a more comprehensive series of oceanographic and biological observations in the Barents, White, Kara, and Laptev Seas, which can be used for long-term global change monitoring.

2. DATABASE

All primary data presented in this work available electronic part (DVD) of the work (Matishov *et.al*., 2004). Consider elements of this data set.

* *Corresponding author address*: Igor Smolyar
Ocean Climate Laboratory, NODC/NOAA, E/OC5
1315 East West Highway, Silver Spring, MD 20910
e-mail: Igor.Smolyar@noaa.gov

2.1 Inventory

Figure 1 depicts the main characteristics of the primary data. Figure 2 and 3 present monthly data distribution plots for all variables. Data distribution plot for plankton depicted on Figure 4. Main sources of data are the following:

- NOAA Central Library
- Various libraries in USA, Russia, Norway and Finland
- Murmansk Marine Biological Institute, Russian Academy of Sciences
- World Ocean Database 2001 (Conkright *et al.,* 2002)
- BarKode (Golubev and Zuyev, 1999).
- Oceanographic data (surface marine reports) from Norwegian commercial ships for 1867-1912 were provided by Torgny Vinje (Norwegian Polar Institute).

2.2 Data access

A provision was made to enable the user to access the data via two ways. The first method provides data access according to the cruises. This category of data includes:

- 186 cruises by the Murmansk Marine Biological Institute during 1952-2001;
- 30 cruises during which scientists of the Murmansk Marine Biological Institute collected ichthyology data;
- 50 cruises sponsored by different institutions during 1870-1963. This data was obtained from various libraries;
- 168 cruises by Norwegian commercial ships during the period 1867 - 1912.

These cruises provide access to 62,453 stations within the Barents, White, Kara, and Laptev Seas.

The second method provides access to the data organized by one-degree squares. The structure of this data access is as follows: First, the entire set of stations is divided into 12 subsets in accordance to the month when the observations were performed. Second, the monthly set of stations is sorted by one-degree squares.

In this case, the name of the file indicates the coordinates of a one-degree square and the month. For every month, a distribution map of stations is generated that allows a user to access data from a square to which the cursor points. For this purpose, it is necessary to place the cursor on the desired square and right-click on the mouse. All data are presented in the CSV format, which can easily be exported into Excel or another database application.

2.3 Data format

During the expeditions to the Arctic seas, a diverse amount of information was collected. In addition to the traditional meteorological and oceanographic information, cruise reports also contain data on sea mammals, birds, fish, benthos, plankton, geological data, and other information. This information can be used to help provide answers to a wide range of issues; therefore, it is worthwhile to include these other variables into the database. Let us consider the data format.

The current approach for standardizing data is based on the format of parameter descriptions utilized at the Murmansk Marine Biological Institute. This format has a block structure that, with slight changes, is preserved in the data description. This format consists of two blocks: **STATION** and **TYPE.** The block **STATION** has information about the location and time of data collection. The block **TYPE** contains the data consisting of the following elements: **Meteorology, Hydrology, Zooplankton, Phytoplankton, Benthos, Birds, Marine Mammals, Ichthyology, Geology, Paleontology,** etc. The names of the elements indicate the type of the data they contain. This format is described in more detail in Matishov *et al.* (2000).

When formatting older data, it is often necessary to establish the longitudinal/latitudinal coordinates of the stations since the cruise reports present these in local geographical terms (*e.g.,* 3 miles north of Kildin Island). This is very typical; many expeditions of the late 19^{th} and the first half of the 20^{th} centuries were conducted in the vicinity of the shore, and a mate could easily determine the ship's location in terms of the shore outlines. Establishing the longitudinal -latitudinal coordinates was required for 50-70% of all the stations on these earlier cruises.

The error in determining the ship's location is an integral part of the data-quality assessment. Therefore, the user of this database should know whether the coordinates were created from the qualitative information or they were determined by using instrumental methods. The parameter, COORD DETERM=DESCRIPTION, indicates the method of determining coordinates. If this parameter is empty, the ship's coordinates were determined by instrumental methods.

ANNUAL CLIMATIC CYCLE OF TEMPERATURE AND SALINITY

In order to quantify the annual climatic cycle of temperature and salinity the following climatic fields have been created:

- Mean monthly maps of temperature and salinity distributions for the Barents, White, Kara, and Laptev Seas for the levels 0 m, 25 m, 50 m, 100 m, and 200 m. Examples of surface temperature and salinity climatic charts for September presented on Figure 5.
- Mean monthly fields of temperature and salinity distributions along five sections (Figure 6) on the Barents, Kara, White, and Laptev Seas. . Examples of temperature and salinity climatic fields along section A for September presented on Figure 7.

The procedure for building climatic fields (an objective data analysis) used in this study corresponds to a scheme proposed by Barnes (1973) and the calculation technique of spatial data distribution and map construction (Levitus and Boyer, 1994). This procedure consists of two stages.

At the first stage, a grid was created in which the Barents, Kara, and Laptev Seas were divided into squares of 50 x 50 km. Temperature and salinity profiles at all points within this grid were assembled for every month and individual year. Data unavailability was marked with a special code.

At the second stage, calculations were made of mean monthly temperatures and salinities for each of the squares in the grid. Where there was a square with less than four years worth of data, this square was not used to compute the climatology.

When building the climatic fields of temperature and salinity along sections A, B, C, D, and E, data were used that were located within a distance of 50 km on both sides of the section line. The further away the station from the section line, the lesser the effect of temperature and salinity values at this station on calculated climatic characteristics (Golubev and Zuyev, 2003).

The mean monthly distribution maps for temperature and salinity on the surface and at different levels presented on the DVD (Matishov *et.al*., 2004) clearly show an annual cycle of temperature and salinity variations, primarily for the Barents Sea. For this sea, there is a clearly observed annual cycle of air-temperature variations at individual points (Figure 8). In general, for the Barents Sea, in the corresponding time periods, there is a correlation between structures of the fields of air and water temperatures in winter and summer (Figure 9 and 10).

The White, Kara, and Laptev Seas are covered with ice during the winter months, which significantly reduces the amount of data available for these months. Consequently, it is very difficult to determine the annual cycle of temperature and salinity variability in these seas. However, the annual cycle of the ice edge in the Barents, Kara, and Laptev Seas can be used as an indirect proxy to describe these cycles.

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We are grateful to the NOAA Central Library (Silver Spring, MD, USA), the Slavic and Baltic Branches of the New York Public Library (USA), the New York Museum of Natural History Library (USA), the Dartmouth College Library (Hanover, NH, USA), the Slavic Library (Helsinki, Finland), and the public libraries of Moscow, Murmansk, and St. Petersburg (Russian Federation), which have served as important sources of data for this product.

We appreciate the assistance of the staff of the Murmansk Marine Biological Institute (MMBI) and the NOAA Ocean Climate Laboratory during the creation of the database, and we wish to thank Valentina Suvorova-Harlowe (Yanuta) for translating this product from Russian into English.

We would like to express special gratitude to Torgny Vinje, Norwegian Polar Institute, who provided us with the observational results obtained by Norwegian ships during the period 1867-1912.

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Time period:	**1810-2001**
Number of stations:	**433,179**
January:	16,512
February:	19,621
March:	30,363
April:	34,424
May:	41,612
June:	59,163
July:	47,791
August:	62,710
September:	55,726
October:	29,953
November:	17,620
December:	17,684
Regions	
Barents Sea	219,077
Norwegian Sea:	160,512
White Sea:	20,348
Central Arctic:	13,870
Kara Sea:	13,591
Laptev Sea:	5,781
Countries	
Russia:	178,356
Norway:	122,593
Unknown:	54,386
USA:	36,469
United Kingdoms:	17,426
Germany:	6,648
Poland:	2,740
Holland:	1,242
Canada:	1,226
Sweden:	383
Japan:	340
Finland:	221
Iceland:	177
France:	164

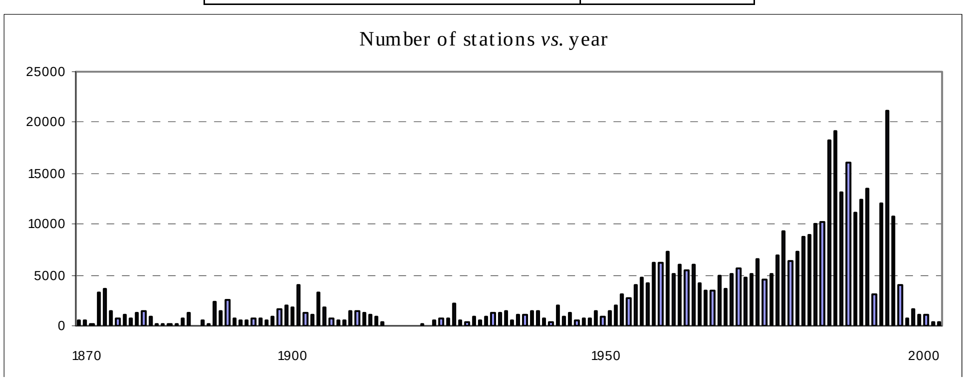


Figure 1. Characteristics of the database

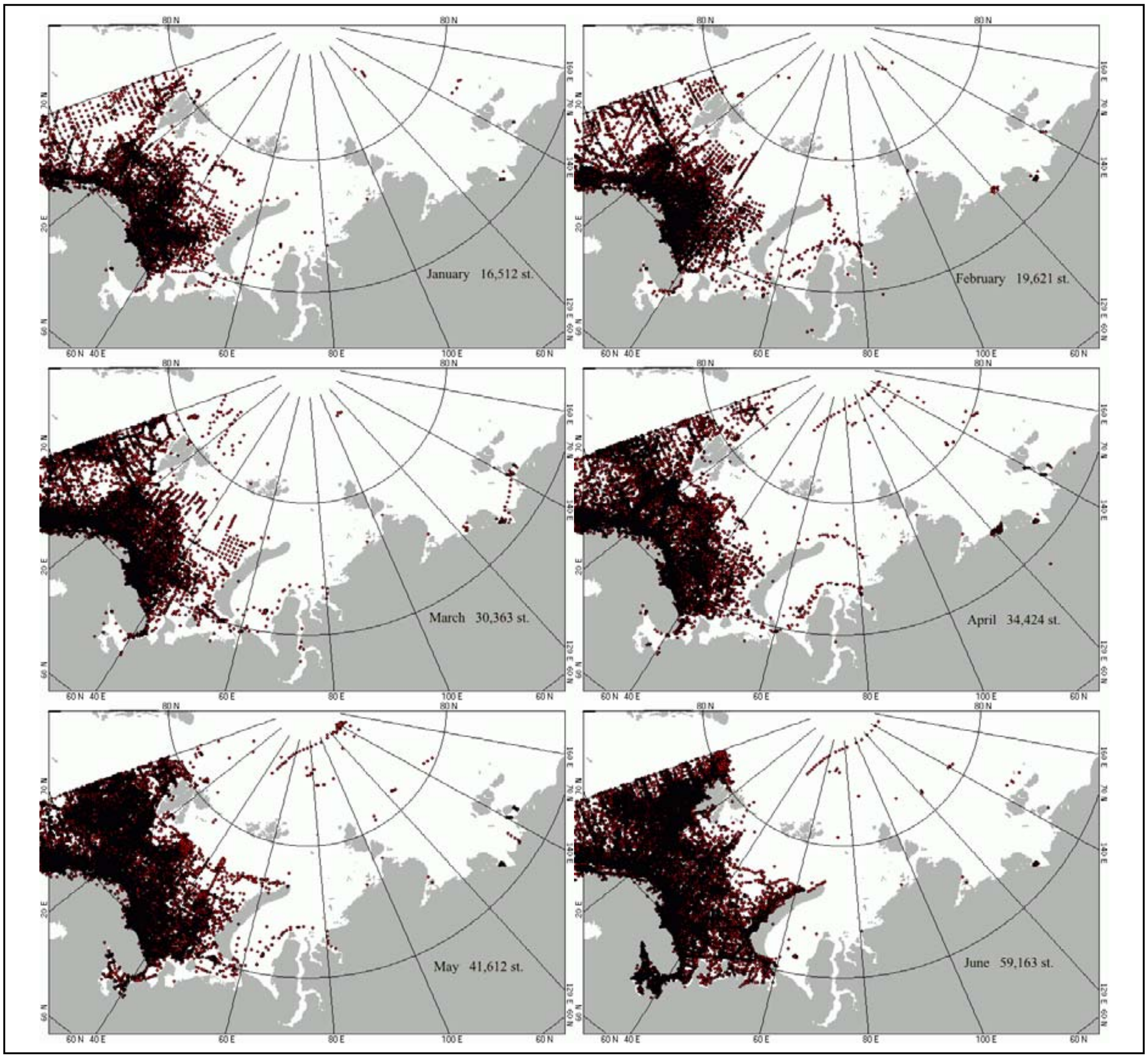


Figure 2. Monthly data distribution plots. January – June

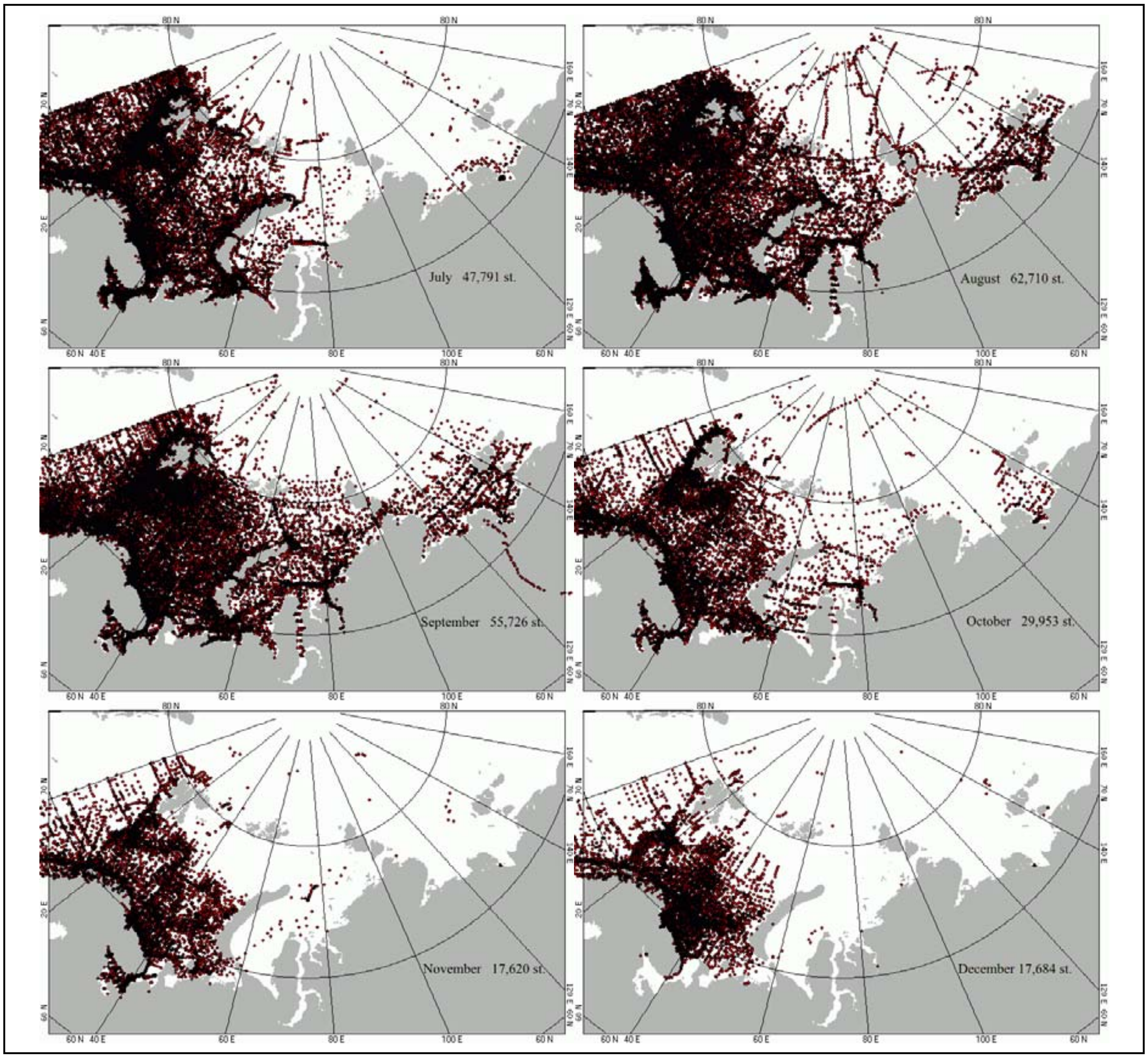


Figure 3. Monthly data distribution plots. July - December

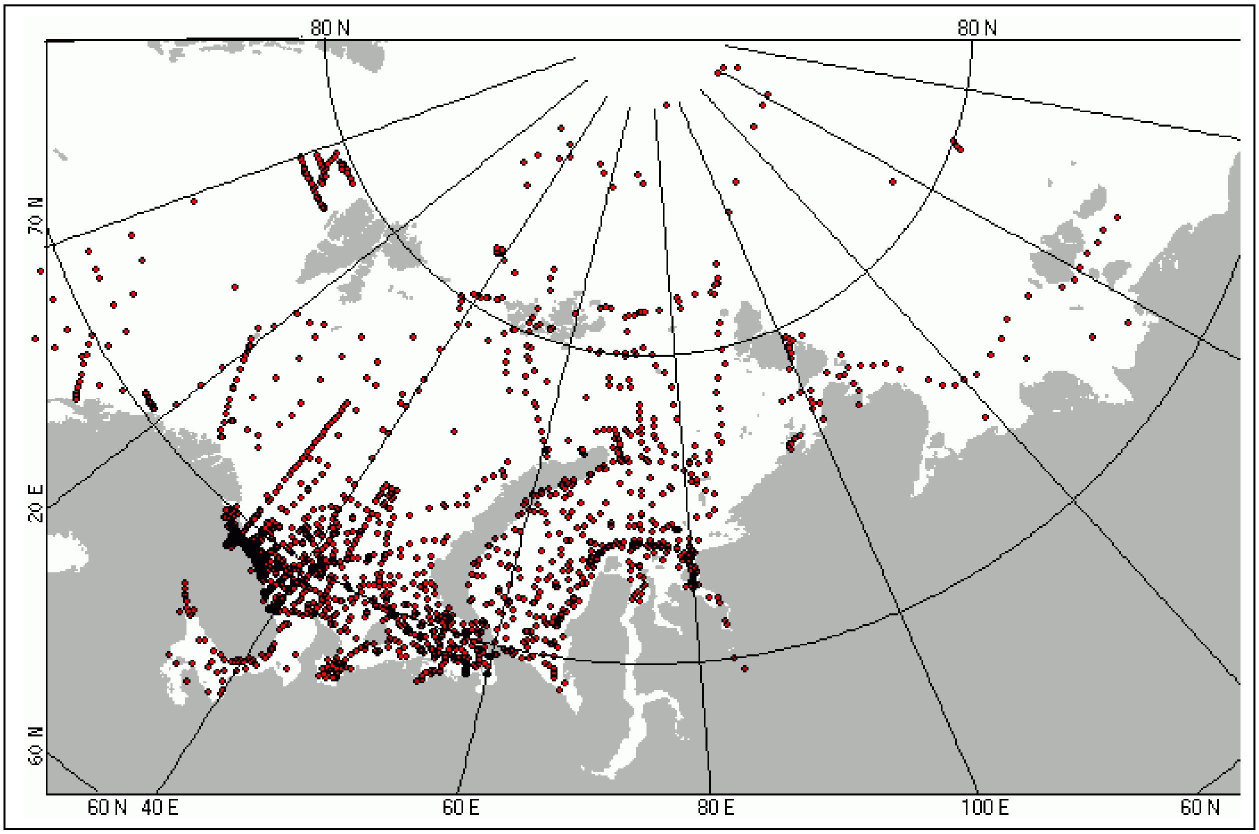


Figure 4. Plankton distribution. 1913-2001

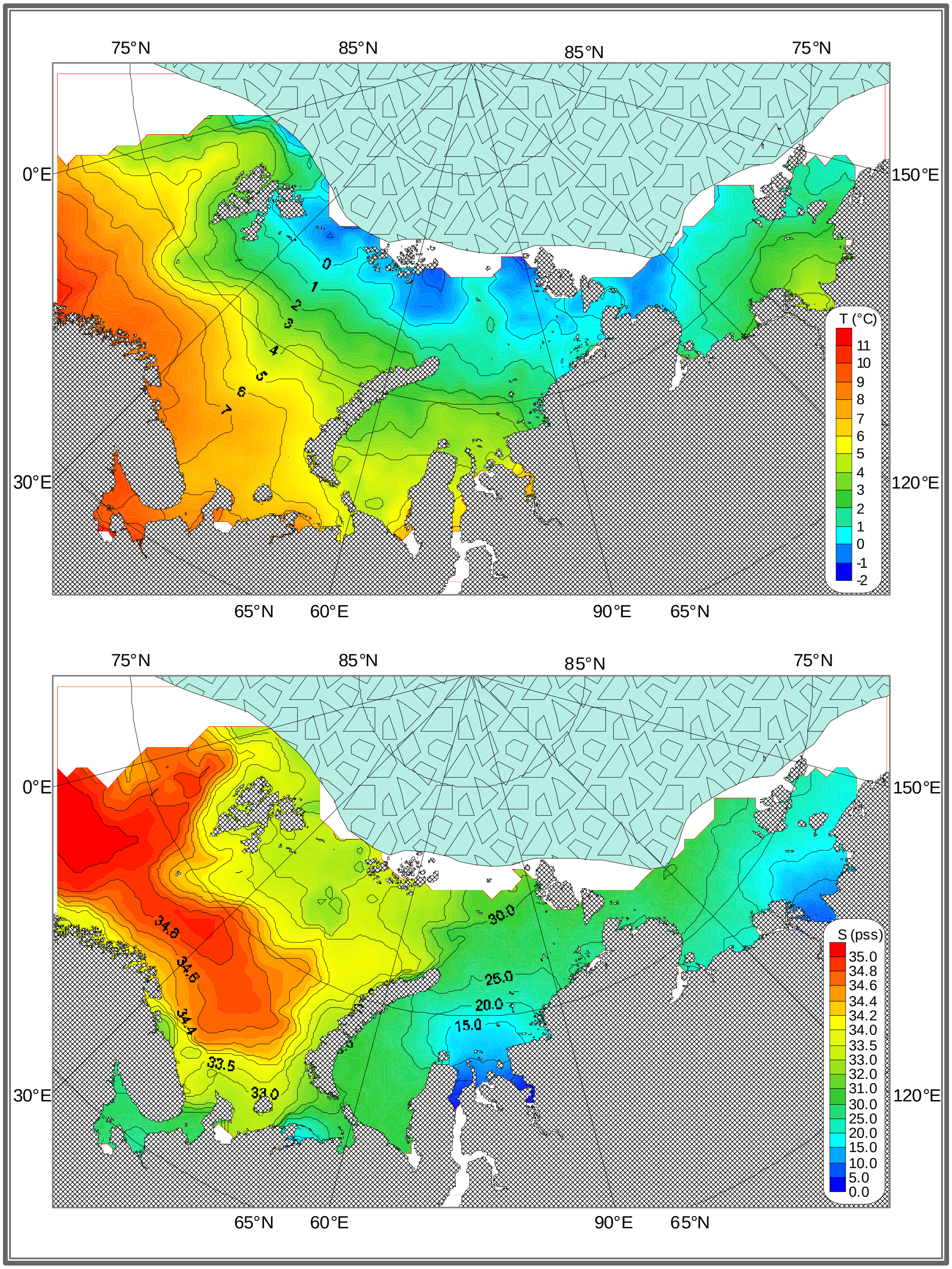


Figure 5. Temperature (°C), salinity (pss). September. Surface

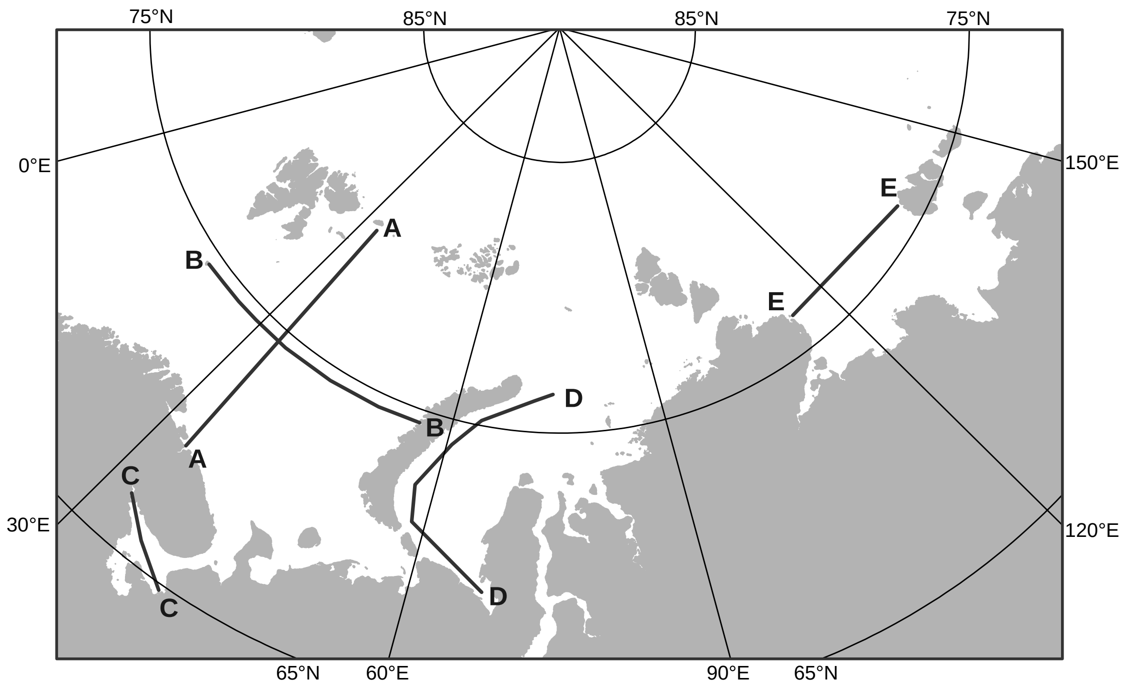


Figure 6**.** Positions of the sections for which the mean monthly climatic fields of temperature and salinity have been created.

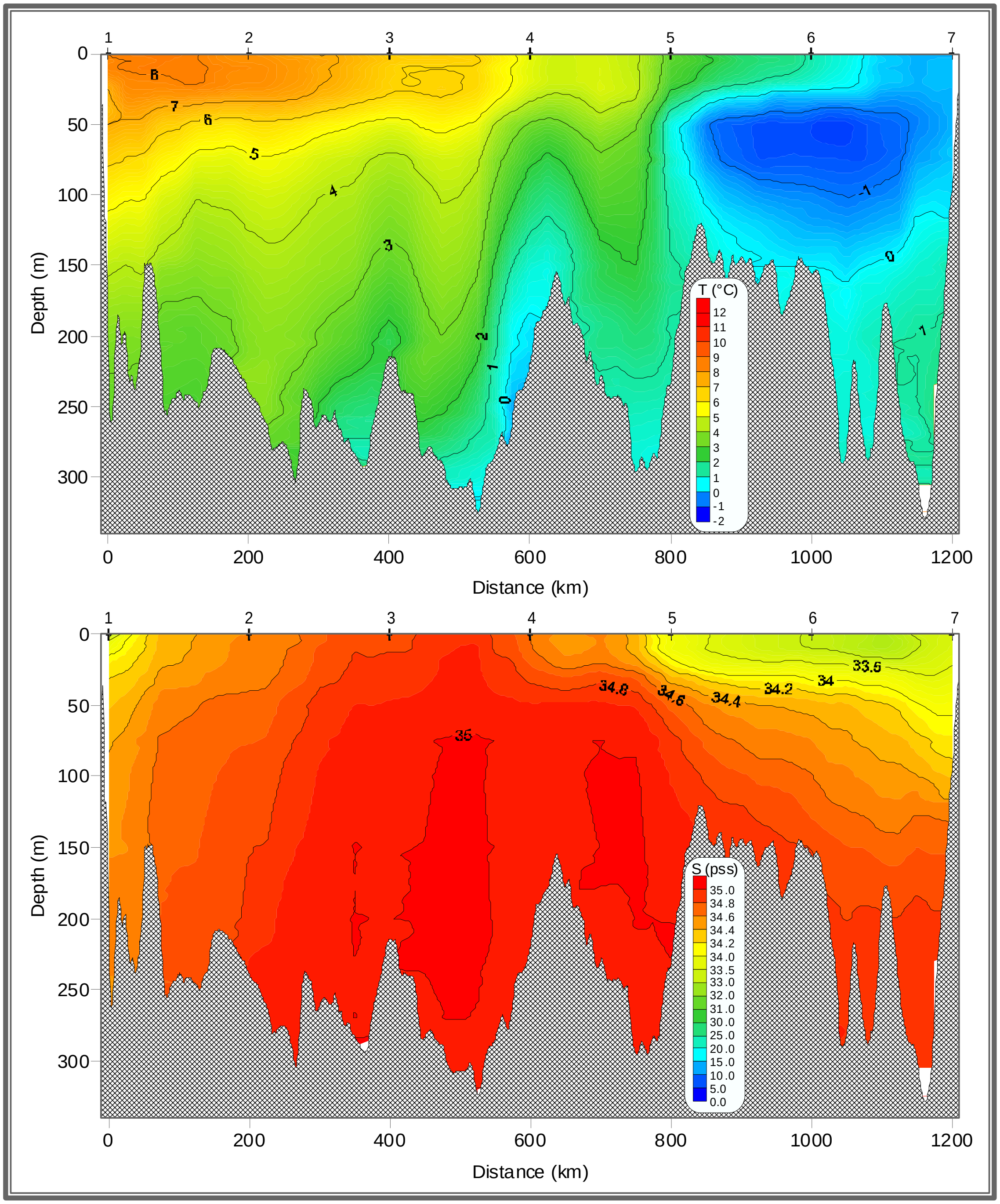


Figure 7. Temperature (°C), salinity (pss). September. Section A.

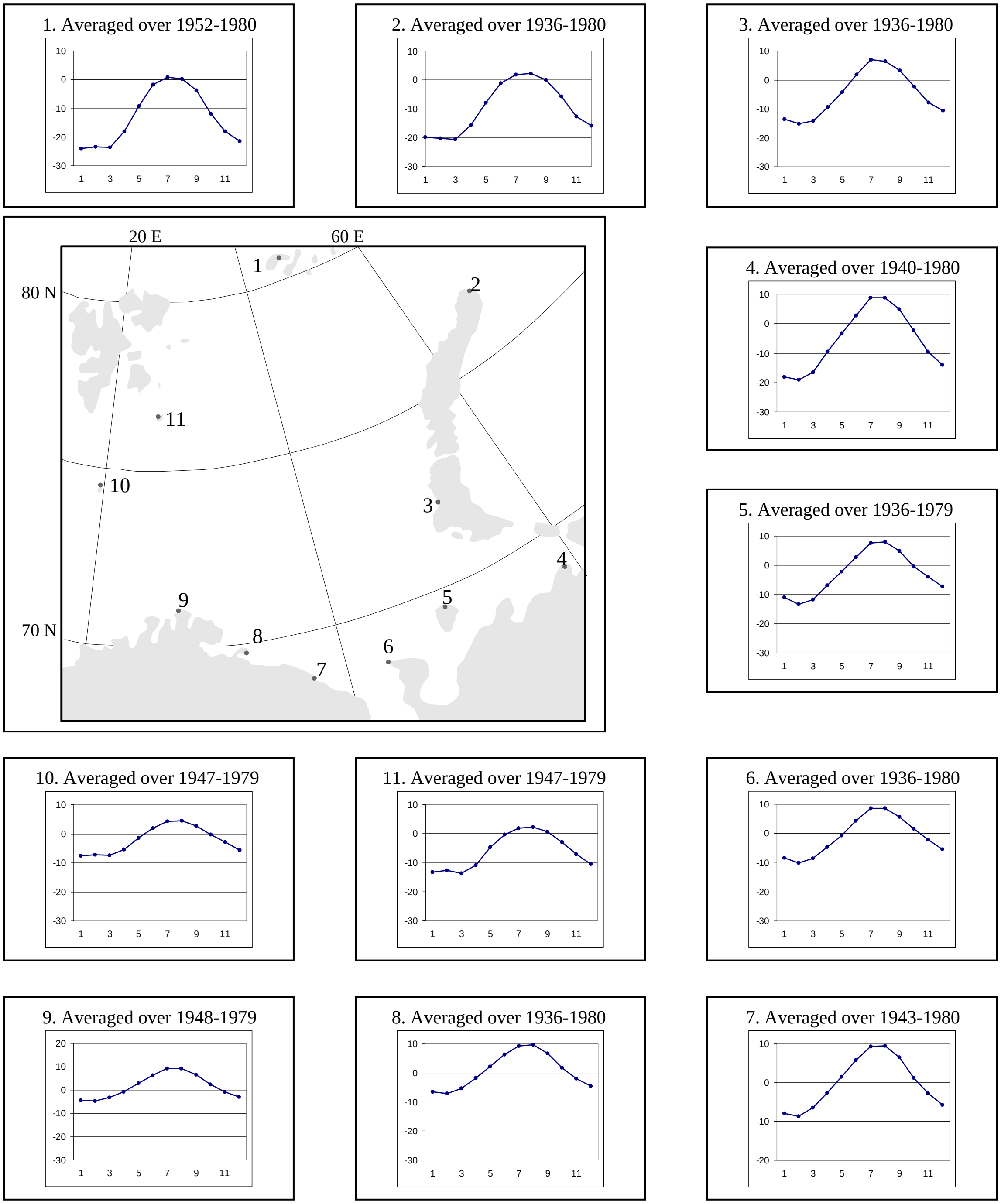
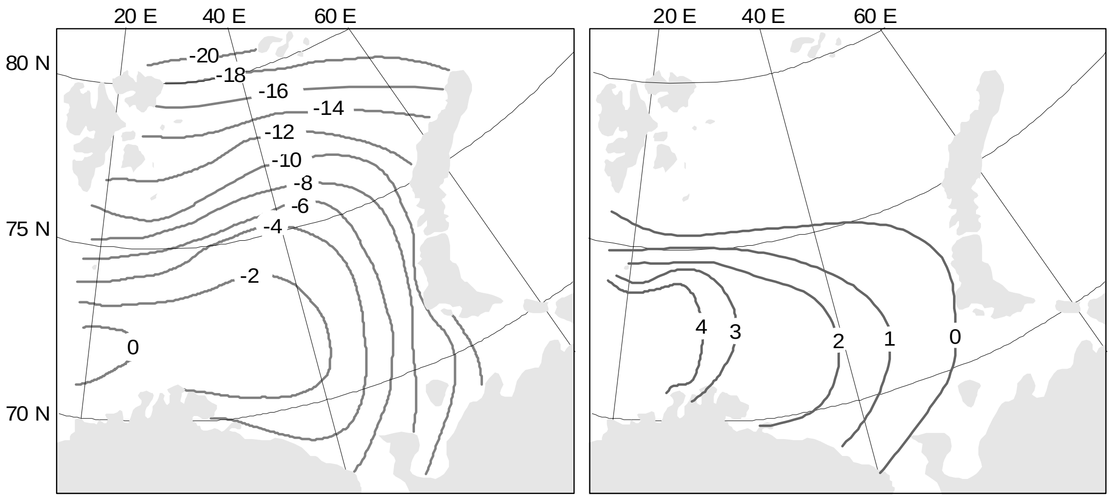
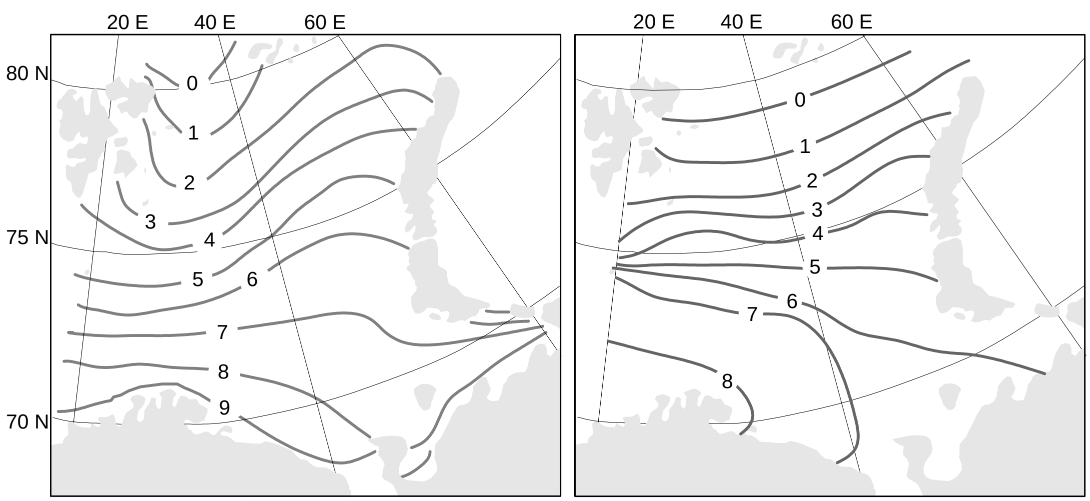


Figure 8. Barents Sea: annual cycle of air temperature (^{o}C) as a function of geographical coordinate



Air temperature above the sea surface. Temperature of the sea surface.

Figure 9**.** Climatic fields of air and sea water temperature (^{o}C) during winter



Air temperature above the sea surface. Temperature of the sea surface.

Figure 10. Climatic fields of air and sea water temperature (^{o}C) during summer