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BARENTS AND KARA SEAS OCEANOGRAPHIC DATA BASE (BarKode)

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В рамках сотрудничества между Мурманским Морским Биологическим Институтом (MMBI) и Администрация Международного Проекта (IAPO) в рамках Норвежской программы "Перенос и Судьба загрязняющих веществ в Северных морях".

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SUMMARY

Oceanographic data collected by ocean research organisations in Russia, the USA, the United Kingdom, Germany, Norway, and Poland for the Barents, Kara and White Seas region are presented in this atlas. Recently declassified naval data from Norway, the USA, and the UK are also included.

More than 1,000,000 oceanographic stations containing temperature and/or sea-water salinity data were originally selected. After correcting errors and eliminating duplicates, data from 206,300 checked stations were placed on CD-ROM, together with many figures describing the characteristics of both the single-input and combined data set.

In addition, temperature and salinity measurements were interpolated to the following standard horizons: 0, 25, 50, 100, 150, 200, 250, 300 m, and bottom. This atlas covers the 100-year period 1898 to 1998 and is, to date, the most complete oceanographic data collection for these Arctic shelf seas.

This data set is complemented by more than 9,000 measurements of sea surface temperature, which were recently digitized from ships' logbooks. They cover the same geographical area within the time period 1867–1912.

1. INTRODUCTION

The creation of this data base was carried out within the framework of the World Climate Research Programme's Arctic Climate System Study (ACSYS). The resulting data base is a contribution to the oceanography section in the Norwegian programme Transport and Fate of Contaminants in the Northern Seas.

The goal is to establish a data base of oceanographic data for the Barents, White and Kara Seas. The information gathered here (see Table 2.1) forms a development of a joint effort between the Murmansk Marine Biological Institute of the Russia Academy of Sciences (MMBI) and the Ocean Climate Laboratory of the National Oceanographic Data Centre of the USA (NODC), the Climatic Atlas of the Barents Sea, 1998: Temperature, Salinity, Oxygen (Matishov et al., 1998). All the information collected during the preparation of this atlas were included in the BarKode data base. Data from the Barents, Kara and White Seas received from various sources and collected by the International ACSYS Project Office were also used. To generate the data base the following actions were taken:

- Oceanographic data collected by the ocean research organizations in Russia, the USA, Norway, United Kingdom, Germany, Poland and by the Naval Hydrographic Services in USA, United Kingdom, Norway were converted into one format.
- Oceanographic data control methods were developed and produced as software.
- The data after tests were interpolated to standard levels.
- The data files, protocols, and statistics generated at different steps of the information processing were included on the CD.

2. DATA PROCESSING PROCEDURES

2.1 Information Sources

The organisations that conducted oceanographic cruises and made available the data used in this work are listed in Table 2.1. The table lists organizations that supplied their own data as well as organizations whose data were collected from sources other than their own.

The NODC and MMBI data collected during the early preparation of the Climatic Atlas of the Barents Sea (Matishov et al., 1998) were enhanced by the information received from the CD-ROM *World Ocean Data Base Atlas - 1998* (NODC, 1998). New data prepared by MMBI for the international GODAR (Global Oceanographic Data Archaeology and Rescue) project (Levitus et al., 1994) also were part of this enhancement.

The *Murmansk Marine Biological Institute* data base was derived from the Institute's own observations and literature, as well as from information acquired during joint ventures with other regional organisations, such as the *Murmansk Department for Hydrometeorology,* the *Northern Reconnaissance Service* and the *Polar Institute of Fishery and Oceanography.*

The structure of the original data sets was quite diverse. In some sources the data were kept in one or two formats, in others (i.e., the Norwegian Polar Institute, Appendix 8) a wider variety was used.

For the time period 1898–1998 (Table 2.2) more than 1,000,000 oceanographic stations were selected for primary processing from all the sources of information on the Barents, White, and Kara Seas (Fig. 2.1). The final product – after assembly, quality control, and elimination of duplicates – contains viable data from 206,300 stations (Fig. 2.2).

Table 2.1: Data Source

No.	Source Code	Data Source	Data Source Abbreviation	Notes
1	**U**	US National Oceanographic Data Center - World Data Center - A a) Data collected earlier for the preparation of the CD-ROM: "Climatic Atlas of the Barents Sea 1998: temperature, salinity, oxygen". (Matishov et al., 1998) b) CD-ROM: World Ocean Data Base Atlas-1998, Volume 1,3.	**NODC** **CL. Atlas** **WA-1998**	Data received from two sources: Same format Same format
2	**M**	Data from the scientific archives of the Murmansk Marine Biological Institute, Russia a) The data collected earlier at the preparation of the CD-ROM: "Climatic Atlas of the Barents Sea 1998: temperature, salinity, oxygen". (Matishov et al., 1998) b) New data prepared from the MMBI for the international project GODAR (Global Oceanographic Data Archaeology and Rescue)	**MMBI** **CL. Atlas** **1988-1999**	Data received from two sources: Same format Two data format variations
3*	**C**	US Naval Oceanographic Office (NAVOCEANO)	**US Navy**	One format
4*	**K**	UK Hydrographic Office (UKHO)	**UK Navy**	One format
5*	**D**	Alfred-Wegener Institute for Polar and Marine Research (AWI), Germany	**AWI**	Two data format variations
6*	**P**	Institute of Oceanology, Polish Academy of Sciences (IOPAN)	**IOPAN**	One format
7*	**E**	Joint Russian-US Environmental Wor-king Group; Data of AARI, Russia	**EWG**	One format
8*	**I**	CD-ROM: Eastern Arctic Ice, Ocean and Atmosphere Data, Volume 1, 1991	**CEAREX**	One format
9*	**F**	Norwegian Defence Research Establishment (NDRE)	**N Navy**	Three data-format variations
10*	**N**	Norwegian Polar Institute (NPI)	**NPI**	There are 23 data format variations (see App. 8)
11*	**B**	US Naval Oceanographic Office (NAVOCEANO): SALARGOS buoy data set	**ARGOS**	Two variants of data formats

* Data received under the ACSYS project.

Table 2.2: Data-Source Characteristics

No.	Source Code	Source Name	No. of Files	Total No. of Stations	Final No. of Stations	Start date	End date
1	U	CL. Atlas WA-1998 **NODC**	82 154 **236**	458,334 192,101 **650,435**	**404,979**	**1898.05.23**	**1996.12.12**
2	M	CL. Atlas 1988-1999 **MMBI**	72 170 **242**	101,957 3,599 **105,556**	**93,996**	**1903.07.26**	**1997.08.01**
3	C	US Navy	6	63,343	61,774	1901.02.11	1996.04.13
4	K	UK Navy	1	43,066	43,038	1900.04.05	1996.10.04
5	D	AWI	309	342	327	1987.07.07	1998.09.16
6	P	IOPAN	604	604	585	1988.07.14	1997.07.06
7	E	EWG	9	863	471	1989.08.24	1995.10.06
8	I	CEAREX	1	3,281	2,245	1905.07.07	1989.05.19
9	F	N Navy	538	536	508	1992.05.07	1998.09.07
10	N	NPI	3,358	7,031	6,528	1959.09.19	1995.09.07
11	B	ARGOS	12	172,717	24,693	1988.05.20	1992.10.08
TOTAL			3,717	1,047,774	639,144	1898.05.23	1998.09.16

2.2 Data Processing Steps

The data processing was implemented by a sequence of steps. The step sequence and the number of profiles processed at each step are shown in Table 2.3 and Fig. 2.3. The error and result codes are given in Appendices 1 and 2. The codes were calculated at each stage and for each station. Also, for each station, when possible, the ship codes (according to the NODC system), cruise number, and the instrument code were determined. These data, as well as the data source code (column 2 of the Table 2.1.) were preserved for each station during the work on the data.

At each step the data were divided into two parts, one that passed this step and one that was rejected.

Station heading examples, both for correct and for the erroneous stations, are given in Table 2.4. The data of R/S "Lance" of the Norwegian Polar Institute are taken as an example. The headers of defective stations at one stage in the quality control of the data are given in lines 1-4 (the HEX-code of a processing stage is equal 0x1). The data, sorted by month, in lines 5-7 (0x3 = 0x1 and 0x2). The data, which have passed the control on the duplicates (0x7 = 0x1 and 0x2 and 0x4) but were recognized secondary, in lines 8-10, and the data, which after duplicate control have remained in the information base, in the lines 10-13. The headers of stations after interpolation to standard levels are given in lines 14-16 (0xF = 0x1 and 0x2 and 0x4 and 0x8).

Line 1 of *Table 2.4* specifies that this station is defective because it is located on land (see App. 2, code 0x800). The station in line 2 has an error code and condition 0x5C = 0x4 and 0x8 and 0x10 and 0x40. This means that the station was defective because no data were included (0x40) after errors in the order of levels were detected (0x4), because errors in hydrostatic stability (0x8) and values beyond allowable limit (0x10) were detected.

The codes in lines 8-10 mean that these stations were recognized as secondary during the duplicate control (0x4000), and additionally that the depth (0x1) was calculated for the station in line 10 and that the station in line 9 had stability errors (0x8). This code can be deciphered unequivocally and allows the definition of which transformations were made during the data processing and for what reason the station was considered defective.

The resulting data from sequential processing steps were placed on the CD-ROM, together with the headers of defective stations. The geographical distribution of stations after the duplicate control is given in Fig. 2.2.

Step 1. Primary Sampling

The data from the various sources were originally in different formats. Thus, the first step of the processing was to transfer them into one format as described in section 3.2 (Table 3.1). The transfer of data into consistent units of measure (psu, ºC) and the exclusion of those with gross erroneous values were carried out simultaneously. In the final variant of the format a requirement to preserve not more than 101 levels was imposed. Thus, in case of surplus, the initial levels were subjected to thinning out (code of a condition 0x20). First of all the levels closest to the standard levels and to the bottom were selected. After that the intervals between the standard levels were filled in such a way so to provide the best restoration of the vertical profiles of temperature and salinity.

There exists a large list of references specifying the allowable ranges of the oceanographic characteristics for different areas of the Barents, Kara, and White Seas, the adjacent areas of the North Atlantic and the Arctic Ocean. We used the criteria presented in one of the survey papers pertaining to the Barents Sea (Anonymous, 1990) for data control. At the first step, the criteria of exceeding the possible range of parameters were applied: for temperature the limits are -2.00 and 35.00°C; those for salinity are 0.000 and 45.000 psu. The maximal possible depth of observation cannot exceed 9990 meters. The values of the variables outside these limits were rejected.

Also, a progressive increase in the depths of observations was required. If, after the exclusion of the erroneous variables, no correct values of temperature and salinity were left at the station, this data profile was excluded.

Data for the time period 1898–1998 were selected which are inside the area of interest (66-84°N and 5-105°E; the White Sea is included within 63-66°N and 30-45°E) see Fig. 2.1.

For the sources where the cruise structure of the initial data was available, the sequence in time of the stations was tested. The speed of movement of the research vessel between two stations was assumed not to exceed 15 knots. During the processing, numerous errors in the station sequence were revealed. Therefore, the sequence/speed controls were not applied during the final processing.

After format conversion and a draft control, 639,144 stations (Table 2.3.) were accepted for subsequent processing. Converted into the final format, the data were merged into one file and subsequently processed together. The resulting data were placed on CD-ROM in the folder Data\Primary.

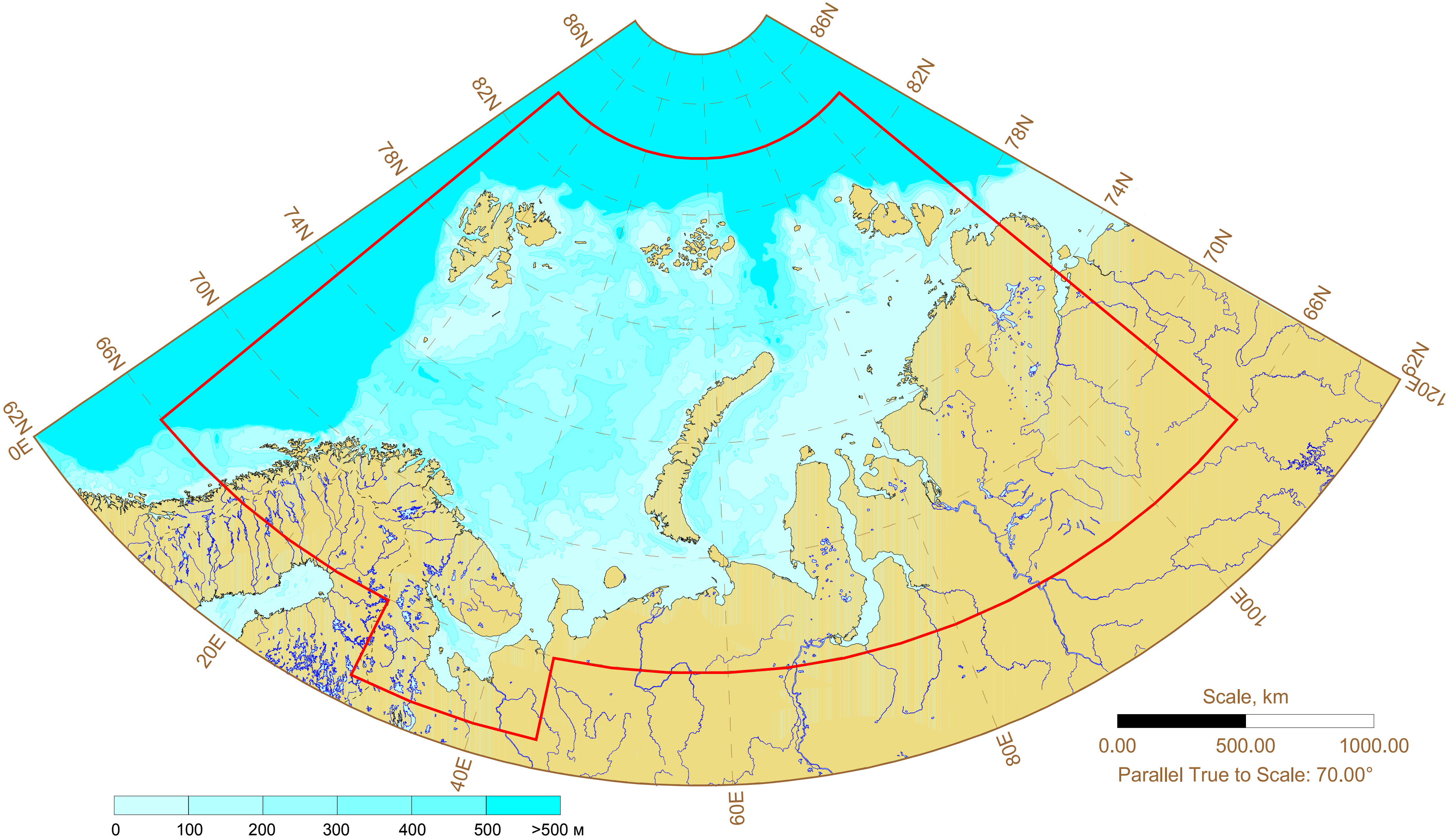

Fig. 2.1: Bathymetry and region boundaries for the BarKode data base

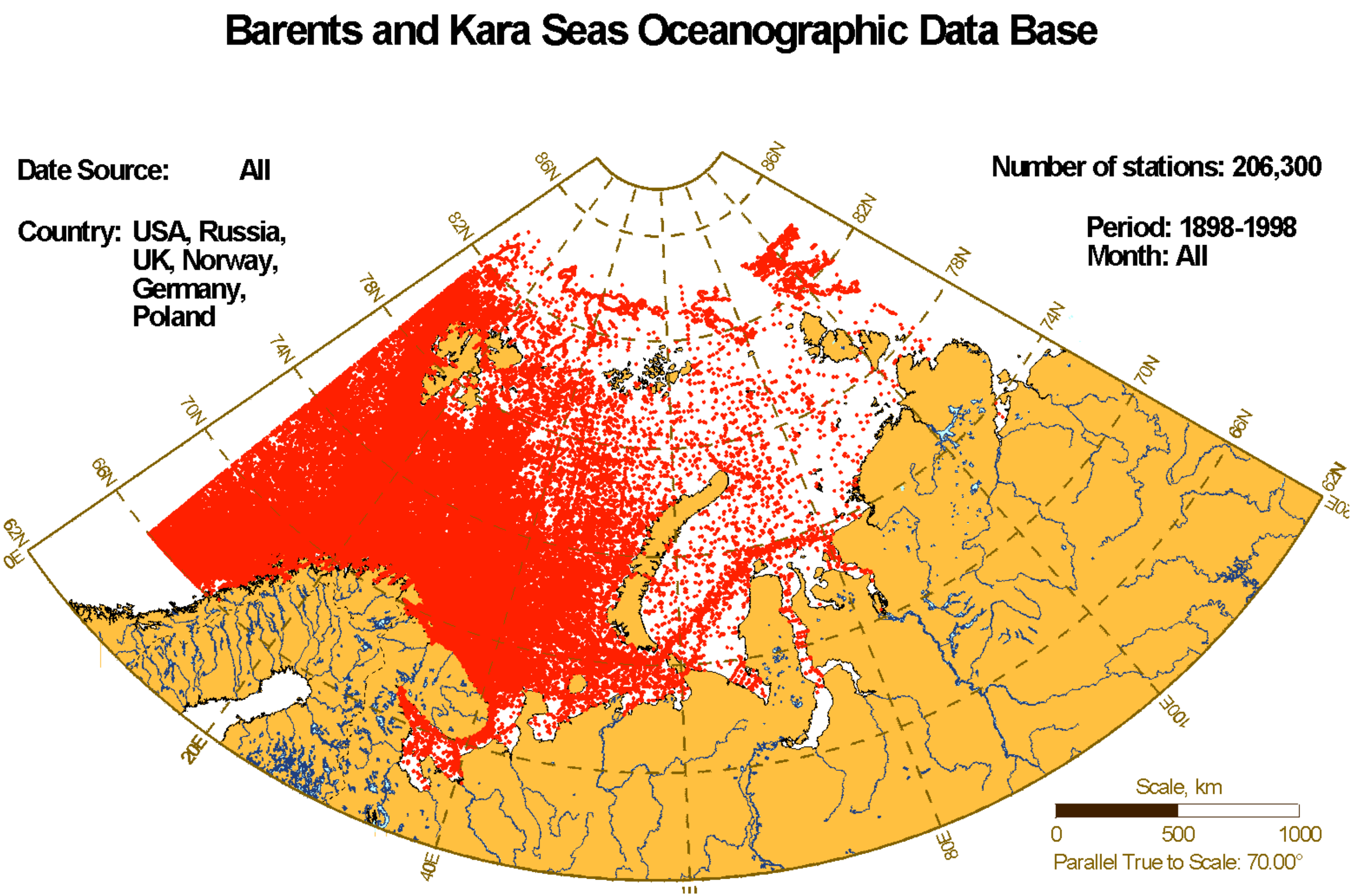

Fig. 2.2: Geographical distribution of the 203,600 stations of the BarKode data base

Table 2.3: Data Processing Dynamics for the Input Data Sources

Processing stage		**1**	**2**	**3**	**4**	**5**	**6**	**7**
N	**Code**	**Source Name**	**Number of stations after Draft Control**	**Number of stations after Coast Control**	**Number of stations after Depth Control**	**Number of stations after Limits Control**	**Number of stations after Duplicate Control**	**Number of stations after Interpolation on Standard Levels**
1	**U**	**NODC**	404,979	400,477	323,075	322,201	95,189	95,189
2	**M**	**MMBI**	93,996	91,162	68,906	68,792	22,189	22,189
3	**C**	**US Navy**	61,774	61,429	54,034	53,806	42,045	42,045
4	**K**	**UK Navy**	43,038	42,754	34,885	34,814	17,206	17,206
5	**D**	**AWI**	327	327	217	205	205	205
6	**P**	**IOPAN**	585	585	466	448	406	406
7	**E**	**EWG**	471	469	290	287	232	232
8	**I**	**CEAREX**	2,245	2,245	2,010	2,009	555	555
9	**F**	**N Navy**	508	507	329	309	309	309
10	**N**	**NPI**	6,528	6,518	3,430	3,386	3,336	3,336
11	**B**	**ARGOS**	24,693	24,693	24,680	24,628	24,628	24,628
		Total	639,144	631,166	512,322	510,885	206,300	206,300
Size (MB)			**165.3**	**164.1**	**133.4**	**132.0**	**52.2**	**33.4**

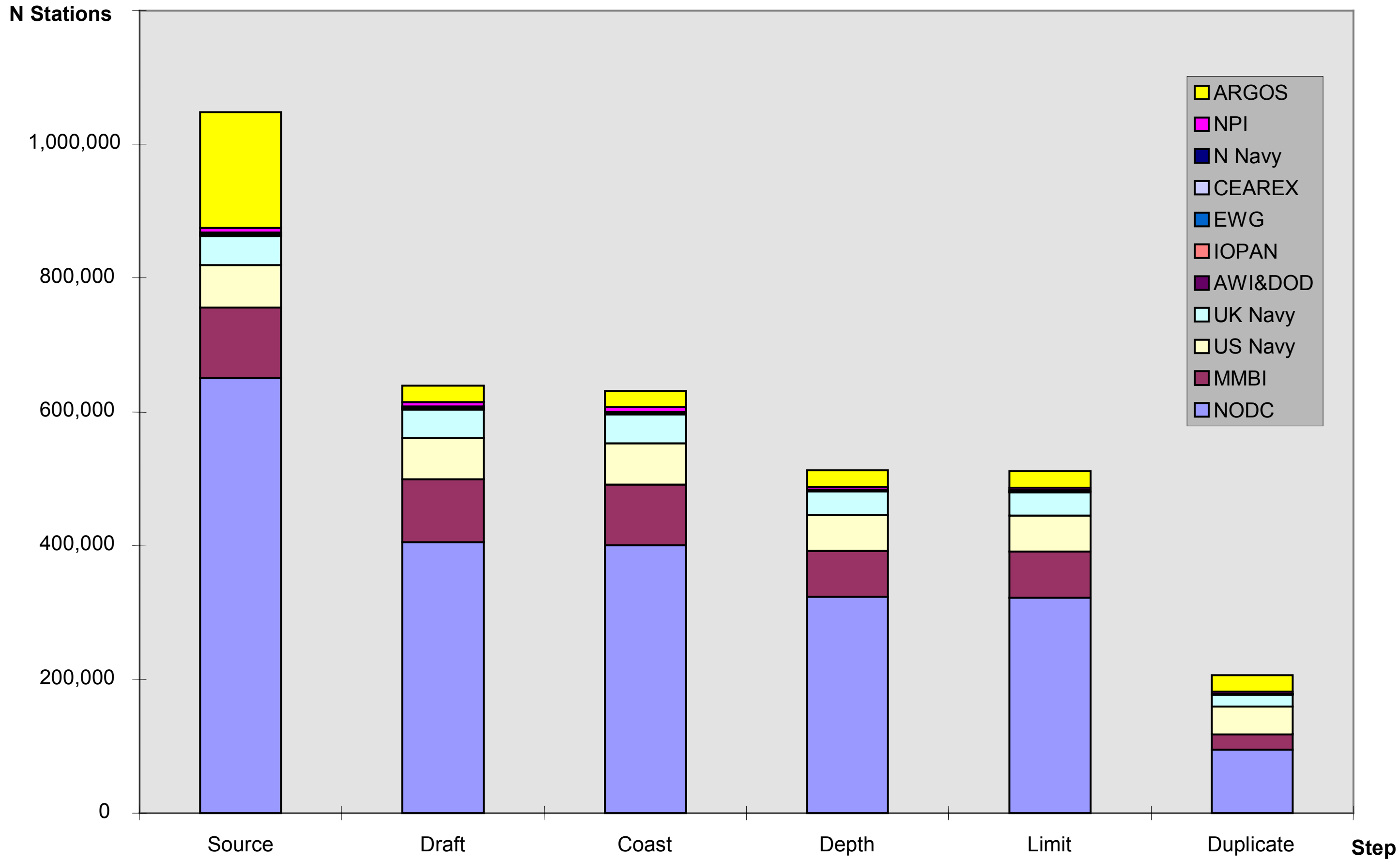

Fig.2.3: Data processing dynamics for the input data sources

Table 2.4: Examples of Oceanographic Station Headers after Processing (see text)

N	Station Code	Source Code	Result Code	Year	Month	Day	Time	Latitude	Longitude	Depth	Notes
1	N58LA98407C	1	800	1984	8	13	18.95	77.58333	17.50000	152.0	Delete, after coast control
2	N58LA99107C	1	5C	1991	7	31	5.45	77.66667	32.0000	132.0	Delete, after limits control
3	N58LA99404C	1	49	1994	4	22	1.17	75.96667	19.0000	188.6	Delete, after limits control
4	N58LA99307C	1	48	1993	7	16	6.28	74.30000	19.0000	100.6	Delete, after limits control
5	N58LA98308C	3	3000	1983	1	18	3.23	76.08333	15.63167	382.0	Delete, after depth control
6	N58LA99404C	3	2001	1994	4	19	16.28	73.43333	19.0000	462.7	Delete, after depth control
7	N58PO98504C	3	1000	1985	4	28	14.02	75.56667	17.15667	160.0	Delete, after depth control
8	N58LA98107C	7	4000	1981	8	1	0.38	79.66917	8.828667	438.0	Delete, after duplicate control
9	N58LA98107C	7	4008	1981	8	14	23.17	78.13600	9.999167	238.0	Delete, after duplicate control
10	N58LA99404C	7	4001	1994	4	26	11.60	76.83333	34.00000	175.0	Delete, after duplicate control
11	N58LA98107C	7	0	1981	9	1	7.83	79.93500	11.98333	307.0	OK, after duplicate control
12	N58LA98802C	7	8	1988	9	6	22.73	76.40000	34.49167	248.0	OK, after duplicate control
13	N58LA98802C	7	10	1988	9	10	16.72	79.03333	26.62667	182.0	OK, after duplicate control
14	N58PO98504C	F	0	1985	5	1	7.78	76.81667	23.08000	92.0	OK, after interpolation
15	N58PO98504C	F	8	1985	5	1	11.62	76.83333	23.20333	95.0	OK, after interpolation
16	N58LA99404C	F	1	1994	5	1	23.9	75.83333	25.00000	97.0	OK, after interpolation

Step 2. Regional Control

For the data resulting from the primary sampling, tests were carried out to check if the station location was on land. Land-based stations at a distance exceeding 5 km from the coast were rejected. For the control, the most exact contours of the coastline data from the CD-ROM General Bathymetric Charts of the Oceans (GEBCO, 1997) were used.

At this step 4,502 (1.2 %) stations were rejected because they were more than 5 km in-land from the coastline. 631,166 stations (Table 2.3) were accepted for the subsequent processing.

The station headers excluded at this stage were placed in a file named Data\Errors\Coast.csv.

Step 3. Depth Control

Station depth and the greatest depth of observation were examined. The 5'x5' GRID database from the US National Geophysical Data Center (NGDC, 1995) was used as the reference bottom topography.

The bathymetric map used for this data base is given in Appendix 7. Comparing this map with a standard data set (Terrain Base, 1995, Fig. 2.1) it can be seen, that the GRID fields reflect full details of the Barents, Kara and White Seas bottom relief and can be used to control the oceanographic stations' bottom depths in this region.

The nine grid cells closest to the computed US NGDC grid points determine minimal and maximal depth values. If some of the closest grid points of the depths appear on land, then "0" meters is accepted as a minimal depth value. If the maximal depth of 9 grid points is less than 25 meters, then 25 m is accepted as a maximal value. The allowable tolerance of depth computation is determined to be 12,5% from the maximal depth or from the depths of measurements on the station, if the latter is greater. The data for the station were rejected if: 1) the last level (or station depth) is greater than the maximal depth plus the allowable tolerance; or, 2) if the station depth is less than the minimal depth on the grid minus the allowable tolerance.

In cases where no station depth was reported, a station depth was computed by interpolation formula from the four nearest grid points. If the last level was located deeper than the computed depth but within the tolerance limits, then the last level is taken as the bottom level.

During the station-depth and last-level controls, 118,844 (18.6 %) stations were rejected. 512,322 stations (Table 2.3) were then accepted for subsequent processing. The exclusion of so many stations reveals the necessity of testing against a depth field with higher resolution in the future.

The headers of the stations excluded were placed on CD-ROM in a file named Data\Errors\Depth.csv.

Step 4. Statistical Control of the Variability Limits
Initial processing was 'light handed' in order to preserve occasional natural features that might exceed normal bounds. However, the 'light handed' approach may have permitted serious errors to remain in the data set. Therefore all data were subject to a additional stage of quality control, as follows.

In this stage, those values outside the limits of three standard deviations were excluded (Golubev et al., 1992; Levitus and Boyer, 1994). The three-sigma limit is quite generous in order that only gross errors were excluded. The checks for statistical homogeneity and for the exclusion of the clearly erroneous values were implemented independently for the Kara, Barents and White Seas at each of the thirty-three standard levels (Appendix 3).

The allowable limits of variability were determined directly from the data themselves. For this purpose, the data were interpolated to the standard levels, and for each level the averages and standard deviations (root mean square) values were computed. From these values, the allowable 3σ limits (see for instance, Levitus and Boyer, 1994) were calculated. The computed limits were additionally smoothed because suitable amounts of the data were not available for all standard levels. During data testing, the computed limits were interpolated to the levels of observations. All observed values outside these limits were excluded from subsequent discussions.

The methods described in "Step 6" were applied for the vertical interpolation.

About 0.3% of all data (1,437 oceanographic stations) appeared to lie outside the 3σ limit. This agrees with the theoretical estimate (Gaussian probability distribution) for the number of observations that should be outside this limit and indicates that this criterion is applicable for quality control of oceanographic data for this region.

After this step, 510,885 stations (Table 2.3) were accepted for subsequent processing.

Moreover, at this step, a calculation of the vertical density stability of the water layer (UNESCO, 1991) was carried out. The value ranges from – 3,500 to +∞ are accepted as energetic limits of the stable condition which exceed possible values of instability. Because values in this range can occur because of natural processes this step allowed exclusion of only the grossest mistakes in the vertical profiles of temperature and salinity. Stability mistakes were detected on 974 stations. Cases when the stations were excluded due to instability on all the levels were practically never observed.

The station headers excluded at this stage were placed on CD-ROM in a file named Data\Errors\Limit.csv.

Step 5. Elimination of Duplicates
The existing system of international sampling and exchange of information results in frequent inclusion of the same data into the files received from different sources. Besides, even in the data from one source, duplication is possible. For instance during the preparation of the CD-ROM *Climatic Atlas of the Barents Sea 1998: temperature, salinity,*

oxygen (Matishov et al., 1998), the NODC archives and information products were used. After that, a new CD-ROM *World Ocean Data Base Atlas - 1998* was included on the work. This CD-ROM is an enhanced but not identical version of the NODC information base collected earlier.

The matter is complicated by the fact that it is possible to keep identical information in different formats and data bases in different forms but with different omission of information and varying quality. For instance, in several data bases the information on the time of measurement was absent. In others the information on the attached meteorological and hydrochemical observations were omitted. Sometimes the geographical co-ordinates were given, not in degrees, minutes and seconds; but in degrees with a precision up to a hundredth degree that leads to additional mistakes connected with rounding off the co-ordinate values.

For these reasons, the search and exclusion of station duplicates were carried out as the final step of the work, after having fulfilled the main quality control procedures. Although this caused additional work, it allowed us to choose the data variant containing the most complete and most correct information.

The station data were compared for the concurrence of co-ordinates and station execution period (with permissible latitude/longitude differences of 0.5 minutes and permissible time differences of 10 minutes). For the stations where the time information was missing, the depth was compared if depth information of both stations was present. The depth and the levels were compared for agreement within 0.1m, the temperature within 0.001ºC, and the salinity within 0.001 psu. If the co-ordinates and the time at two stations coincided, or (when time data were missing) the information on the first level and the depth coincided, then the station containing the more useful information was selected for the subsequent processing and analysis. That is, the station giving time of observation, station depth, the greater number of parameters for the larger number of levels, including temperature and salinity measurements at the surface.

The results of this comparison and exclusion of the duplicates are given in Tables 2.5 and 2.6. In these tables the sources from which duplicate stations were excluded are enumerated in the column, and the sources where duplicate stations were found are enumerated in the line. It should be noted that in Table 2.5, all the excluded station are presented. In Table 2.6, only those duplicates which coincide for all the comparable parameters are present (in this case the choice of the source, from which data were excluded happens quite arbitrarily – we usually excluded the stations with the larger source number). Because duplicates are not searched globally in all data sets and the search is consecutive (a detected duplicate is excluded from the further calculations), the results for duplicated stations somewhat depend on the sequence of the choice.

From 510,885 oceanographic stations at the Valiability Limits Control stage, 206,300 stations were accepted for final processing after the exclusion of duplicates (Table 2.3). The analyses of Tables 2.3 and 2.5 reveal that from the 95,189 oceanographic station data received from NODC and included into the final processing (46% out of the total number of the stations), 42,046 stations (20%) were found in the NODC data set alone. These were all absent in other sources. Out of the 22,189 (11%) oceanographic stations from MMBI, only 5,026 (2.5%) were unique.

To explain the technique used for these calculations we choose the MMBI data set as an example. MMBI contributed 22,189 stations to the BarKode data base (Table 2.3). Table 2.5 shows that 17,049 common stations between MMBI and NODC were included as MMBI data in the final data base (excluded from NODC). In turn, 30,980 stations common with MMBI were included in the NODC data set (excluded from MMBI). Additional 94 stations also found in the US Navy data set, 17 from the UK Navy, and 3 from the NPI were included in the MMBI data set. As a result, the number of unique MMBI data sets entering the BarKode data base is 22,189 – 17,049 – 94 – 17 – 3 = 5,026 stations. The results of these calculations appear on the left side of Table 2.5 ("Test of crossings").

It is actually better to use Table 2.6 that takes into account the quality of the information in different data bases. In this case, NODC has given 56,356 unique oceanographic stations (27.3 %), and MMBI 6,384 (3.1 %) stations. Coincidences of the MMBI data stations with other sources are, as a rule, observations of the Murmansk Marine Biological Institute. Thus, for example, 52,049 stations (25%) from MMBI are included in the information base. The results of these calculations appear on the right side of Table 2.6 ("Test of complete concurrence").

Thus, in Table 2.7 the different data source contributions for the BarKode data base are shown. For example, the table shows that the use of the CD-ROM Eastern Arctic Ice, Ocean and Atmosphere Data, 1991 has not added new information to the data base. The general structure of the information base based on the input data sources is presented in Fig. 2.4. All sources having a contribution of less than 0.5 % were taken together.

Codes, which indicate the original name of the station, the country that made the observation and the ship used, have been preserved in the BarKode data base. Their inclusion provides the capability to analyze the data set source, although such an analysis was outside the framework of this project.

The station headers excluded at this stage were placed on CD-ROM in a file named Data\Errors\Dublicat.csv. The quality and redundancy-checked data for this step were placed on CD-ROM in the Data\Control folder.

Table 2.5: Number of Data Duplicates by Input Data Sources

Source No.	Source No. / Source code	1	2	3	4	5	6	7	8	9	10	11	Total excluded
		U	**M**	**C**	**K**	**D**	**P**	**E**	**I**	**F**	**N**	**B**	
1	**U**	163,460	17,049	30,103	14,100	13	174	1	1,895		217		**227,012**
2	**M**	30,980	15,278	111	40			10			184		**46,603**
3	**C**	7,557	94	466	3,530		76		38				**11,761**
4	**K**	13,250	17	3,046	1,287				8				**17,608**
5	**D**												**0**
6	**P**	37		4			1						**42**
7	**E**	4									51		**55**
8	**I**	1,289		49	1				66		49		**1,454**
9	**F**												**0**
10	**N**	26	3					8	4		9		**50**
11	**B**												**0**
Total coincident		**216,603**	**32,441**	**33,779**	**18,958**	**13**	**251**	**19**	**2,011**	**0**	**510**	**0**	**304,585**

Table 2.6: Number of Completely Congruent Data by Input Data Sources

Source No.	Source No. / Source code	1	2	3	4	5	6	7	8	9	10	11	Total excluded
		U	**M**	**C**	**K**	**D**	**P**	**E**	**I**	**F**	**N**	**B**	
1	**U**	117,837	15,786	13,040	12,930	2	113		642		45		**160,395**
2	**M**	29,798	14,069	39	16			10			23		**43,955**
3	**C**	4,713	13	111	3,249		46		31				**8,163**
4	**K**	4,103	4	166	257				7				**4,537**
5	**D**												**0**
6	**P**	14		3									**17**
7	**E**	1											**1**
8	**I**	179			1				26				**206**
9	**F**												**0**
10	**N**	25	2						1		8		**36**
11	**B**												**0**
Total coincident		**156,670**	**29,874**	**13,359**	**16,453**	**2**	**159**	**10**	**707**	**0**	**76**	**0**	**217,310**

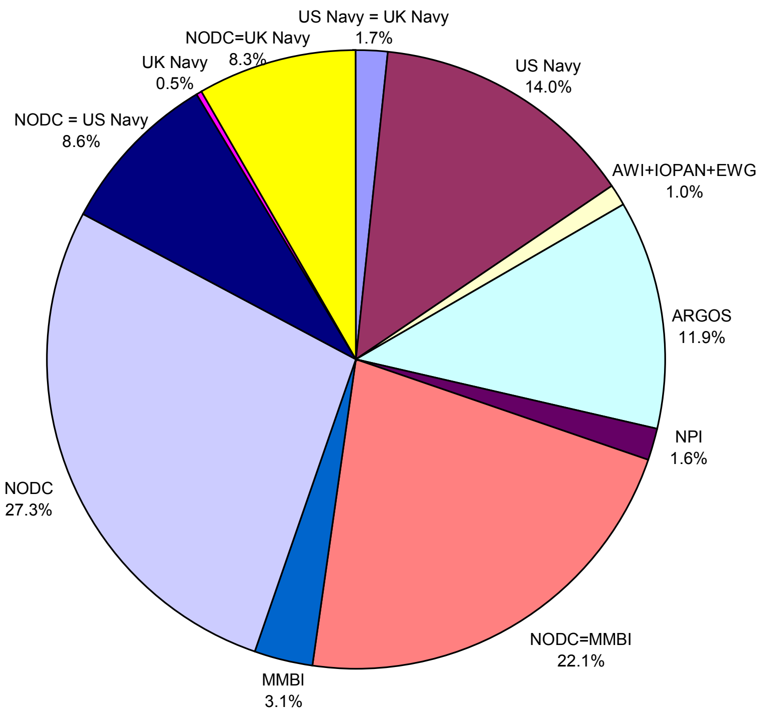

Fig. 2.4: Contributions of input data sources of the BarKode data base. In addition to unique sources, the relative contributions of data that existed in more than one source are shown

Table 2.7: Inter-comparison of Barkode Input Data Sets

Test of crossings				Test of complete concurrence			
Data source name	**Number of unique stations**	**Source for common stations**	**Number of common stations**	**Data source name**	**Number of unique stations**	**Data source for completely identical stations**	**Number of completely identical stations**
NODC	42046	NODC=MMBI	48029	NODC	56356	NODC=MMBI	45584
MMBI	5026	NODC=US Navy	37660	MMBI	6384	NODC=US Navy	17753
US Navy	8732	NODC=UK Navy	26885	US Navy	28797	NODC=UK Navy	17033
UK Navy	0	NODC=AWI	13	UK Navy	1010	NODC=AWI	2
AWI	192	NODC=IOPAN	211	AWI	203	NODC=IOPAN	127
IOPAN	156	NODC=EWG	5	IOPAN	247	NODC=EWG	1
EWG	213	NODC=CEAREX	1794	EWG	222	NODC=CEAREX	695
CEAREX	0	NODC=NPI	243	CEAREX	0	NODC=NPI	70
N Navy	309	MMBI=US Navy	205	N Navy	309	MMBI=US Navy	52
NPI	2835	MMBI=UK Navy	57	NPI	3268	MMBI=UK Navy	20
ARGOS	24628	MMBI=EWG	10	ARGOS	24628	MMBI=EWG	10
		MMBI=NPI	187			MMBI=NPI	25
		US Navy=UK Navy	6576			US Navy=UK Navy	3415
		US Navy=IOPAN	80			US Navy=IOPAN	49
		US Navy=CEAREX	87			US Navy=CEAREX	31
		UK Navy=CEAREX	9			UK Navy=CEAREX	8
		EWG=NPI	59			EWG=NPI	0
		CEAREX=NPI	53			CEAREX=NPI	1

Step 6. Interpolation on Standard Levels
For convenience, all the parameters observed in the observation base are interpolated to the following nine standard levels: *0, 25, 50, 100, 150, 200, 250, 300 m*, and the *bottom*. The distance between the bottom and the near-bottom level is assumed to be 5 m. Where the near-bottom level was absent, the data were interpolated to it.

The vertical interpolation of the parameters to the standard levels was carried out in accordance with the procedure accepted by the UNESCO (Reiniger and Ross, 1968; UNESCO, 1991; Levitus and Boyer, 1994).

A linear interpolation was used. If the distance between the level of the observation and that of the interpolation was less than 5% of the allowable distance for the interpolation (Appendix 3), the measured values were taken as the interpolated level. The interpolation was not done if the distance between the two levels used for the interpolation was larger than double the allowable distance. Extrapolation was also not done if the distance to the nearest level exceeded 95% of the allowable distance for the interpolation.

As the result of the processing, 206,300 stations (Table 2.3) were completed at this step. These stations are placed on CD-ROM in the folder named Data\Interpol.

3. DATA PLACEMENT ON CD-ROM

The data base on the CD-ROM created under this project contains temperature (ºC) and salinity profiles (in psu) for the period 1898–1998. The area covers the Barents, the Kara and the White Seas (see Fig. 2.2).

The data originate from all types of devices used to carry out the oceanographic observations during that period. These include the Nansen bathometer and various types of electronic and mechanical samplers. The precision of observations when a variety of methods and devices are applied during various time periods is described in numerous publications (i.e., Matishov et al., 1998; UNESCO, 1991). All data were tested for values within specified ranges of temperature (-2.00 to 35.00°C) and salinity (0.000 to 45.000 psu). Data outside the specified ranges were excluded. The data files were subject to additional control and processing (see chapter 2) and are available on the CD-ROM. The data that were rejected during the processing were also placed on the disc.

At every step of the process, the information was grouped into 12 monthly files (January to December). The files contain controlled and accepted observations from the entire period. The following file formats were used for the CD-ROMs:

1. csv – comma separated text format for MS Excel is used for hydrological information, reference and test (control) data;
2. doc - files WinWord 7.0, Windows 95;
3. txt - ASCII text files;
4. gif - Graphic files
5. grd - files in ASCII GRID format using SURFER software (Golden Software, Inc.). The fields of depths received from the US NGDC Data Base (5 min x 5 min), used for the depth control are in this format;

6. bna - used to draw the maps and visualise data: Co-ordinates of the boundaries of the coast's contours;
7. L48 - the guiding files of the exact contours of the coast;
8. cpp- programs text files for BC++ (Borland C++, version 5.0);
9. h- header programs text files for BC++;
10. rc- resource programs text files for BC++;
11. rh- header resource text files for BC++.
12. pdf – portable document format

3.1 CD-ROM Contents

1. The Root folder

Readme_eng.doc	-	Description of the disc's structure (English)
Readme_rus.doc	-	Description of the disc's structure (Russian)
Readme.txt	-	Description of the disc's structure

2. Folder Report – Contains the report plus reference documentation.

Report_rus.doc	-	BarKode Report - Russian text (Word document)
Report_eng.doc	-	BarKode Report - English text (Word document)
Report_rus.pdf		BarKode Report - Russian text (PDF document)
Report_eng.pdf		BarKode Report - English text (PDF document)

2.1 Appendices.pdf – Contains all referenced appendices in one PDF document

2.2 Contains single appendices in Microsoft Word format as listed:

APP01.doc	-	Codes of data processing stages
APP02.doc	-	Errors and condition codes
APP03.doc	-	Standard hydrological levels used at the control of the data
APP04_01.doc	-	Station distribution in January
APP04_02.doc	-	Station distribution in February
APP04_03.doc	-	Station distribution in March
APP04_04.doc	-	Station distribution in April
APP04_05.doc	-	Station distribution in May
APP04_06.doc	-	Station distribution in June
APP04_07.doc	-	Station distribution in July
APP04_08.doc	-	Station distribution in August
APP04_09.doc	-	Station distribution in September
APP04_10.doc	-	Station distribution in October
APP04_11.doc	-	Station distribution in November
APP04_12.doc	-	Station distribution in December
APP0413A.doc	-	Total station distribution
APP0413B.doc	-	Total station distribution (continued)
APP05.doc	-	Number of stations per year

APP06.doc	-	Number of stations per day
APP07.doc	-	Depth distribution US NGDC data base (5 min x 5 min)
APP08.doc	-	Results of data processing for the Norwegian Polar Institute
APP09.doc	-	Historical sea-surface temperature (SST) data - Observations from ships' log books, 1867-1912
DAY_APP.csv	-	ASCII table - number of stations per year
YEAR_APP.csv	-	ASCII table - number of stations per day of year

3. Folder Data - The data for the period 1898–1998.

3.1 Folder Data\Primary - data files after selection and primary testing

P01.csv	-	data file for January
P02.csv	-	data file for February
P03.csv	-	data file for March
P04.csv	-	data file for April
P05.csv	-	data file for May
P06.csv	-	data file for June
P07.csv	-	data file for July
P08.csv	-	data file for August
P09.csv	-	data file for September
P10.csv	-	data file for October
P11.csv	-	data file for November
P12.csv	-	data file for December

3.2 Folder Data\Control - data files after all controls

C01.csv	-	data file for January
C02.csv	-	data file for February
C03.csv	-	data file for March
C04.csv	-	data file for April
C05.csv	-	data file for May
C06.csv	-	data file for June
C07.csv	-	data file for July
C08.csv	-	data file for August
C09.csv	-	data file for September
C10.csv	-	data file for October
C11.csv	-	data file for November
C12.csv	-	data file for December

3.3 Folder Data\Interpol - data files on the standard levels

I01.csv	-	data file for January
I02.csv	-	data file for February
I03.csv	-	data file for March

I04.csv	-	data file for April
I05.csv	-	data file for May
I06.csv	-	data file for June
I07.csv	-	data file for July
I08.csv	-	data file for August
I09.csv	-	data file for September
I10.csv	-	data file for October
I11.csv	-	data file for November
I12.csv	-	data file for December

3.4 Folder Data\Errors - The headers of erroneous stations after control steps

Coast.csv	-	The headers of stations after the Coast Control
Depth.csv	-	The headers of stations after the Depth Control
Limit.csv	-	The headers of stations after the Limit Control
Dublicat.csv	-	The headers of the stations after the Duplicate Control

4. Folder Coastline - The co-ordinates of the coast's contour received from processing navigation maps and from the CD-ROM GEBCO-1997 (66 files of type bna).

5. Folder Bathymetry - depths fields received from the 5 min x 5 min US NGDC Data Base (144 files of type grd).

6. Folder Software - This catalogue contains the complete texts of the programs used in the given work for the formation of the BarKode data base. These programs are developed using the compiler Borland C ++, 5.0A (Borland International Inc., 1998). The texts of the programs are included only for research. Therefore, the authors have not included the managing and help information on the programs in this complete set. The authors are not responsible for consequences during compilation, performance and other non-authorized use of these programs.

6.1 Folder Software\ACSYS_98 - The program complex of the primary sampling and quick tests of the data from "World Ocean Data Base Atlas - 1998" (28 files of type cpp, h, rc, rh, txt).

6.2 Folder Software\ACSYS_99 - The program complex of the primary sampling and quick tests of the data from MMBI (27 files of type cpp, h, rc, rh, txt).

6.3 Folder Software\ACSYS_np - The program complex of the primary sampling and quick tests of the data from NPI (28 files of type cpp, h, rc, rh, txt).

6.4 Folder Software\ACSYS_c - The program complex of the primary sampling and quick tests of the data from ARGOS, AWI, CEAREX, EWG, IOPAN, N Navy, UK Navy and US Navy (28 files of type cpp, h, rc, rh, txt).

6.5 Folder Software\ACSYS_qc - The program complex of the complete control steps for the BarKode data base (28 files of type cpp, h, rc, rh, txt).

6.6 Folder Software\ACSYS_sl - The program complex for the division to months for the BarKode data base (28 files of type cpp, h, rc, rh, txt).

6.7 Folder Software\ACSYS_sr - The program complex for sorting after time and the exclusion of duplicates stations from the BarKode data base (28 files of type cpp, h, rc, rh, txt).

6.8 Folder Software\ACSYS_ll - The program complex for the interpolation on the standard and bottom levels for the BarKode data base (28 files of type cpp, h, rc, rh, txt).

6.9 Folder Software\ACSYS_tg - The program complex for the calculation of statistics from the BarKode data base (27 files of type cpp, h, rc, rh, txt).

7. Folder Www - Maps and diagrams of the station distribution by source for the BarKode data base in gif-pictures.

Region.gif	-	map of region boundaries and bathymetry
Bathymetry Grid.gif	-	map of depths distribution of the US NGDC Data Base (5 min x 5 min)

7.1 Folder Www\Diagrams - diagrams of the number of stations per year and of the number of day of year for the BarKode data base (36 pictures of type gif). The first letter of the filename corresponds to the code of the input data set (as in Tables 2.1 and 2.2).

7.2 Folder Www\Maps - maps of station distribution by data source for the BarKode data base (128 pictures of type gif).

7.3 Folder SSTlogs - Historical SST logs in 176 data files of type ASCII, 18*.dat, 19*.dat, sorted by year and expedition. A header with meta-data is included in the files, followed by the data themselves. Statistics are in a file nobsyear.dat.

3.2 Data Format

Each oceanographic station is written on one line which ends with the symbols of the transfer to the next new line as indicated (HEX-code 0D0A). The decimal point in the numerical data is clearly marked. The separators between the parameters are the comma symbol (HEX-code 2C). Before the first data recording in the file a line with the names of the parameters is written. The order of the parameter fields is fixed (Table 3.1). After the station name, the data on the depth levels follow in Group 3. The groups are written successively for increasing depth values. Not more than 101 groups of values at different levels are included. The presence of at least one parameter for each station is obligatory.

Table 3.1: File Format Description for the Oceanographic Station Profiles

Parameter	Number	Field Format	Parameter Description
Station Code	1.	11 symbols	Station's regime code • Position 1 - data source code (Table 2.1); • Position 2–3 - country code after the list of NODC (1993); • 4 and 5 - ship code after the list NODC (1993); • 6 to 10 - cruise number; if the cruise is unknown the line 'XXXXX' or '99999' is set; • 11 - type of measuring device after NODC (1993): 'B'- bathometer, thermometer; 'C', 'D', 'I' etc. - different probes; 'X', 'M'- detachable and mechanic bathythermographs
Processing step code	2.	integer	Shows the steps which the given station has passed during the data processing (Appendix 1)
State code	3.	integer, up to 4 symbols	Gives the results which were received during data processing at different steps (Appendix 2)
Year	4.	integer, 4 symbols	Year (YYYY)
Month	5.	integer, 2 symbols	Month (MM)
Day	6.	integer, 2 symbols	Day (DD)
Time	7.	float	The time of the observation in hours, Greenwich time (HH.HHH - with a precision of up to a thousandth of an hour)
Latitude	8.	float	Latitude is in degrees (GGGG.GGGGGG -with a precision of up to a millionth of a degree), northern latitude is positive, southern latitude is negative
Longitude	9.	float	Longitude of the station is in degrees (GGGG.GGGGGG with a precision of up to a millionth of a degree), east is positive, west is negative
Depth	10.	float	Depth of the station is in meters (DDDDD.D - with a precision of up to a tenths of a meter)
L^k	1.	float	The level of the observation is in meters (DDDDD.D - with a precision of up to a tenth of a meter).
T^k	2.	float	The water temperature is in degrees Celsius (GGG.GG - with a precision of up to a hundredth of a degree)
S^k	3.	float	The water salinity is in psu (GG.GGG - with a precision of up to a thousandth psu)

Note: * - here ^{k} - the ordinal number of the level is marked.

4. OVERVIEW OF RUSSIAN HYDROGRAPHIC DATA AND OUTLOOK

The geographical distribution of the data (Fig. 2.2) points out the fact that the Barents, Kara and White Seas comprise one of the areas of the world ocean that is best covered with observations. In this work, 206,300 oceanographic stations were assembled. However, these data do not cover all available information from the region.
The Russian sources for a possible update of this data base can be divided into a few larger data blocks:

1. historical data from all sources
2. data from the Hydrographic Service of the Russian Navy
3. data from the Hydrometeorological Services
4. data from the fishing and research divisions of the Fishing Ministry
5. data from the divisions of the Russian Academy of Sciences

4.1 Historical Data from all Sources

Many countries equipped expeditions to the Barents Sea for scientific purposes. In 1837 the expedition of the French vessel *La Recherche* recorded surface water temperature measurements in the Spitsbergen area. The expedition reached a latitude of 79°36'N. By 1870, several Russian ships carried out episodic oceanographic work in the Barents Sea, and since 1880 Russian naval and commercial ships have been used for work in this area on a yearly basis. At the end of 19th century, a new stage of government-organized large sea expeditions began. During this time, international standards and the first international system of oceanographic supervision in the Barents Sea were created.

During World War I, oceanographic work in the Barents Sea was suspended. Since 1917 the number of expeditions has risen sharply in connection with the organization of fishing and the necessity to develop the northern areas of Russia. Regular expeditions to the Kara Sea also began during this period.

Before World War II, practically all data were published in scientific reports and found in libraries and archives (the detailed bibliography of this period is given in the Climatic Atlas of the Barents Sea (Matishov et al., 1998))

The number of observations in Barents, Kara and White Seas for this period is estimated at about 10,000 stations. This work includes only about half of the existing information (5,141 stations) for this period. Most of the missing data can be found in libraries, but a large effort on search and digitization of this material is required.

4.2 Data from the Russian Naval Hydrographic Service

At the beginning of this century, scientific work in the Barents Sea was frequently carried out by the Russian Navy. After World War I, the Russian Naval Hydrographic Service became systematic in their efforts and continued with a variable degree of activity until the present day. The total number of observations in the Barents Sea is estimated at roughly 75,000 stations. From this, only part of the data from the last twenty years has been digitized. The Hydrographic Service and other research divisions of the Russian Navy participated only peripherally in the international exchange of data. Some exchange took place within the framework of international and interdepartmental expeditions. In this project, the quantity of observations of the Navies is of the order of 10–15% of all Russian data.

4.3 Hydrometeorological Service Data

Before World War II, various departments carried out research. The Murmansk Territorial Hydrometeorological Service (created in 1938) carried out monitoring of the Barents Sea and began collecting and accumulating all received data (including that from other departments) in the 1950s. In the White Sea, such work was carried out together with the Arkhangelsk Territorial Hydrometeorological Service. For the Kara Sea, the Arctic Territorial Hydrometeorological Services (Amderma and Dickson), and the Arctic and Antarctic Research Institute (St. Petersburg) were active. A small quantity of data from these areas is present in the State Oceanographical Institute (Moscow). The Hydrometeorological Service has for a long time been engaged in the creation of regional data banks. At the Murmansk Territorial Hydrometeorological Service alone, the total data quantity is estimated at more than 350,000 stations, of which more than 85% is already digitized. The establishment of a Hydrometeorological Service after 1992 has reduced the Murmansk Territorial Hydrometeorological Service activity in this area considerably, but the digitization of existing archives in Murmansk still proceeds. Until recently there was a rigid hierarchy in the Hydrometeorological Service. The information interchange was carried out only on-line through the Central Research Institute of the Hydrometeorological Information (VNIIGMI-MCD, World Data Centre-B, Obninsk). A significant part of the Russian data included in the BarKode project for the period after 1955 was received from the World Data Centre-A, USA, the Naval oceanographic centres of the USA and Great Britain, which again received it via Obninsk.

4.4 Fishing Ministry Data

Virtually from the very beginning, oceanographic research in the Barents and White Seas was carried out to aid the fishing industry. In 1921 the Floating Marine Scientific Institute was created, from which the Polar Research Institute of Marine Fishing and Oceanography (PINRO) was later founded. From 1921 to 1941, PINRO carried out more than 100 flights, and more 3000 deep-water stations were measured. The merit of PINRO in the establishment of systematic standard sections in the Barents Sea and the realization of systematic seasonal measurements and monthly supervision along the Kola meridian is significant. From April 1934 until now, studies in the Barents Sea were carried out following this unique system.

During the military period, the specialized Sevrybpromrazvedka division did a lot of work under the direction of MMBI scientists. Up to the end of the 1980s, PINRO gave data to the VNIIGMI-MCD and exchanged information with the Murmansk Territorial Hydrometeorological Service. The institute has worked on the creation of its own data base for long time and participated in an exchange with similar organizations abroad. The total number of stations available at PINRO is estimated at approximately 250,000. However, for international exchange, PINRO supplied data only in limited number and mainly only within the framework of international expeditions. Therefore, the quantity of these data in the Barents/Kara Seas Oceanographic Data Base is rather insignificant.

4.5 Russian Academy of Sciences Division Data

Oceanographic station data for the Arctic region from the Academy of Sciences division of the Murmansk Marine Biological Institute (MMBI) comprises about 25,000 stations. Beginning with the foundation of the institute in1937, the activities concentrated mainly in the coastal zone. Work began in the open sea after the first ships were equipped for open sea work (early 1970s). MMBI has since that time cooperated intensively with Russian and foreign partners, resulting in a data base containing about 75,000 stations. The institute continues its work in updating the data base (about 65 % of the accessible data are digitized). MMBI also continues to reference the exchange with other organizations and its own work at sea. All digitized data are accessible for international exchange and are included in the BarKode data base.

A minor amount of oceanographic data also resides at the Oceanographic Institute of the Russian Academy of Sciences (Moscow). These data were not used in this work.

Thus, the quantity of the accessible Russian data for the Barents, Kara and White Seas from all sources is more than 500,000 stations. This project can be viewed as the first step on the long path to the creation of a complete Barents/Kara Seas Oceanographic Data Base.

Russia's participation in the international exchange of data is increasing, and necessary state-level decisions have already been accepted. *(See article written by Admiral A. Komaritsyn, Chief of the Main Department of Navigation and Oceanography of the Military Ministry of Russia, "An Exchange of the Oceanographic data", Magazine "A Fishing Economy", 1999, # 3).*

5. ACKNOWLEDGMENT

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This data set is a contribution to the *Arctic Climate System Study* (ACSYS) of the *World Climate Research Programme* (WCRP).

6. CITATION REQUIREMENTS FOR USERS OF THIS CD-ROM

In reference lists or bibliographies, users should cite the SST data from historical logbooks as follows:

Sea surface temperature data from historical logbooks of the Norwegian Polar Institute, 1867-1912. In: The Barents and Kara Seas Oceanographic Data Base (BarKode) CD-ROM, 1999.

Available from the International ACSYS/CLIC Project Office, The Polar Environmental Centre, N-9296 Tromsø, Norway.

An example of a statement within a publication acknowledging data might read:

"The BarKode CD-ROM data provided by the International ACSYS/CLIC Project Office, Tromsø, Norway."

Please send one copy of each publication to the International ACSYS/CLIC Project Office.

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8. RUSSIAN LANGUAGE REPORT

Appendix 9
Приложение 9

SEA SURFACE TEMPERATURE DATA FROM HISTORICAL LOGBOOKS 1867-1912

ДАННЫЕ О ТЕМПЕРАТУРЕ ПОВЕРХНОСТИ ВОДЫ ИЗ ИСТОРИЧЕСКИХ БОРТОВЫХ ЖУРНАЛОВ

Appendix 9
Приложение 9

The Norwegian Polar Institute (NPI) possesses about 150 logbooks with information on sea surface temperature (SST) and other meteorological variables from ships that sailed the Nordic Seas, including the Barents and Kara Seas, since 1867. Henrik Mohn, the first director of the Norwegian Meteorological Institute (DNMI), initiated the observation series. The logbooks were delivered to NPI several years ago from DNMI.

In order to make this data set available it was necessary to digitize the logbooks. Nikolay Doronin at Ecoshelf, St. Petersburg undertook this work, with the help of Tanja Schrader for translation from Norwegian to English. Torgny Vinje and Jane O'Dwyer from NPI coordinated this project. The data set is only draft-controlled (October 1999) and may contain errors. More than 9000 observations where both information about latitude, longitude and SST exist are included on this CD-ROM for the BarKode area (Table 9.1 and Figure 9.1). The complete data set (more than 125,000 observations) for the North Atlantic may be obtained from NPI.

Today, this data set is potentially of great interest for climate study in the Polar Regions, for example within the Polar Climate Programme at NPI, and also in connection with the establishment of global and regional climate data series, as undertaken by ACSYS, NOAA, and at the Hadley Centre.

Норвежский Полярный Институт (NPI) обладает приблизительно 150 судовыми журналами с информацией о температуре поверхности моря (SST) и других метеорологических параметрах от судов, которые находились в Северных морях, включая Баренцево и Карское моря, начиная с 1867. Сбор этих наблюдений был начат Хенриком Мохуном (Henrik Mohn), первым директором Норвежского Метеорологического Института (DNMI). Бортовые журналы DNMI предоставил NPI несколько лет назад.

Чтобы сделать эти данные доступными, было необходимо перенести информацию из судовых журналов на технические носители. Эта работа была предпринята Николаем Дорониным (Nikolay Doronin) в Экошельф, Санкт-Петербурге, с помощью Татьяны Шредер (Tanja Schrader), переводившей журналы с Норвежского на Английский язык. Торгни Винье (Torgny Vinje) и Джейн О'Двиер (Jane O'Dwyer) координировали этот проект от NPI. Работа с этим набором данных только что закончена (октябрь 1999) и может содержать ошибки. Больше чем 9000 наблюдений, где есть информация относительно координат и SST наблюдений для BarKode региона, включено в этот CD-ROM (Таблица 9.1 И рис. 9.1). Полный набор данных (содержащий более 125,000 наблюдений) для Северной Атлантики может быть получен от NPI.

Сегодня этот набор данных может быть очень интересен для изучения климата в полярных областей, например, в рамках Полярной Климатической Программы NPI и также для формирования глобальных и региональных климатических рядов данных, например, по проектам ACSYS, NOAA и Центра Хадли (Hadley Centre).

Appendix 9
Приложение 9

Table 9.1: Number of observations from ship's logbooks per year.
Таблица 9.1: Количество SST наблюдений в год, найденных в судовых журналах.

The second column shows all observations, the third one shows those with latitude, longitude and SST available, while the last column shows the SST observations for the BarKode geographical area.

Первая колонка показывает все наблюдения, вторая, с координатами и SST доступный, и третья, - только SST наблюдения для географической области BarKode.

Year	All	Lat+Lon+SST available	BarKode area Lat+Lon+SST
1867	5914	156	26
1868	1803	0	0
1869	1558	11	0
1870	5196	451	334
1871	7607	1525	1053
1872	6393	1011	772
1873	3027	1218	276
1874	6948	822	262
1875	2100	311	127
1876	3687	375	190
1877	3168	159	138
1878	1191	188	169
1879	1665	270	0
1880	900	7	0
1881	792	6	0
1882	816	0	0
1883	2010	178	9
1884	2586	213	27
1885	864	63	0
1886	1128	81	81
1887	2010	239	10
1888	5402	639	400
1889	4338	380	265
1890	4842	713	696
1891	1800	282	154
1892	1320	70	68
1893	1824	58	0
1894	2844	340	228
1895	2904	288	174
1896	1704	230	205
1897	1722	365	201
1898	4032	489	346
1899	4560	474	346
1900	3960	397	344
1901	6147	792	578
1902	4521	350	253
1903	1500	159	157
1904	1986	165	159
1905	2094	155	113
1906	1362	58	58
1907	102	0	0
1908	756	110	103
1909	1560	237	237
1910	1236	331	252
1911	804	106	106
1912	702	107	107
Total	**125385**	**14579**	**9024**

Appendix 9
Приложение 9

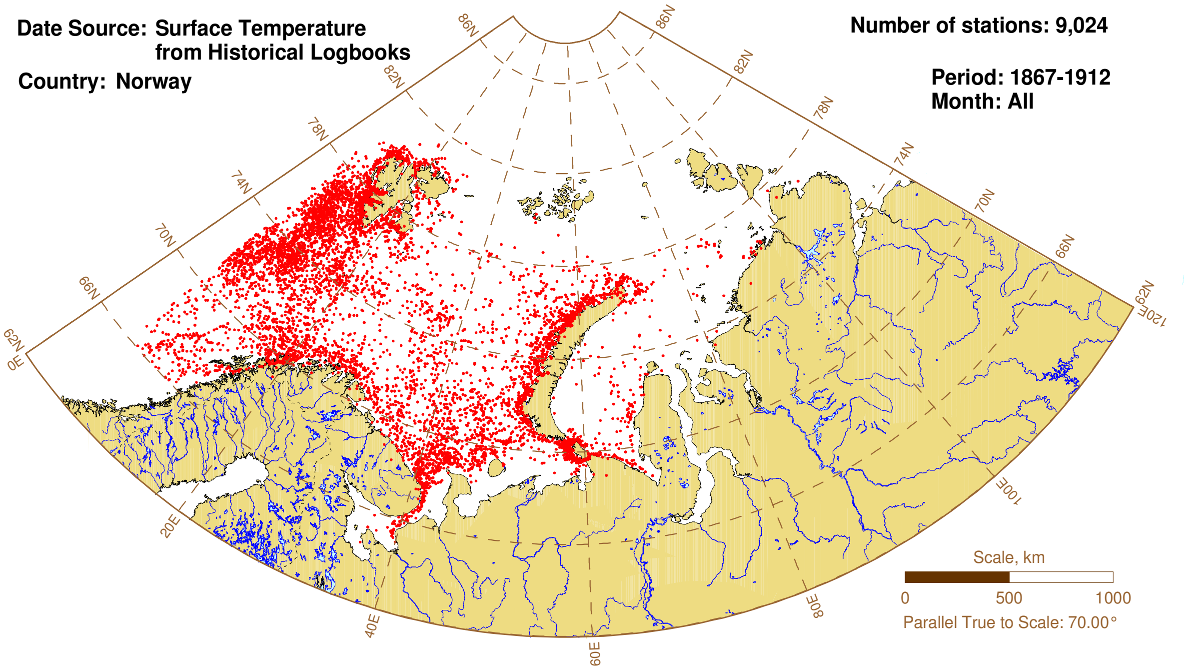

Figure 9.1: Geographical distribution of 9024 SST observations within the BarKode area (1867 to 1912).

Рис. 9.1: Распределение 9024 SST наблюдений в пределах Географического района BarKode (с 1867 до 1912 год).