



Coordinated Eastern Arctic Experiment (CEAREX) Data, Version 1

USER GUIDE

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1 DETAILED DATA DESCRIPTION

The Coordinated Eastern Arctic Experiment (CEAREX) was a multinational, multi-platform field program conducted in the Norwegian and Greenland Seas north to Svalbard from September 1988 through May 1989. Canada, Denmark, France, Norway and the United States participated in the experiment. Bathymetry, biophysical, hydrography, meteorology, noise, sample position, and sea ice data were collected in four phases:

- Polarbjorn Drift Phase
- Whaler's Bay/SIZEX Phase
- Oceanography Camp (O-Camp) Phase
- Acoustic Camp (A-Camp) Phase

1.1 Detailed Project Description

The CEAREX began with the drift of the R/V POLARBJORN on 17 September 1988 and ended on 19 May 1989 when the POLARBJORN docked in Longyearbyen, Spitsbergen. In addition to the POLARBJORN, the R/V HAAKON MOSBY and two ice camps were also used to collect data.

1.1.1 POLARBJORN Drift Phase (September 1988 - January 1989)

The CEAREX drift operations used the ship POLARBJORN as a scientific base. During early September 1988, the POLARBJORN made its way into a region of multiyear pack ice north of Svalbard with icebreaker support from the U.S. Coast Guard NORTHWIND. The POLARBJORN was allowed to freeze into the ice on September 16 at 82 degrees 41 minutes north, 32 degrees 26 minutes east. The ship was relatively immobile and drifted slowly southeastward with the ice pack toward Viktoriya Island, then southwestward past Kvitoya Island, and finally into the Barents Sea.

The large ice floe (Alpha Floe) to which the POLARBJORN was moored was used as a drifting data collection platform until 15 November, when strong northwesterly winds destroyed the ice floe just northwest of Kvitoya. At this time, equipment was brought aboard and an attempt was made to return to Tromso, Norway. After several days of limited progress, 16 of the 20 scientists were airlifted to Spitsbergen on December 12. A strong storm in early January allowed the POLARBJORN to break free and return to Tromso on 9 January 1989. All drift operations were completed by mid-January 1989, and the ship operated in the Fram Strait and Barents Sea areas from late January until May 1989.

For a complete description of the POLARBJORN drift phase of CEAREX, please refer to:

Pritchard, R. S. et al. 1990 CEAREX Drift Experiment. EOS, Transactions of the American Geophysical Union 71(40):1115-1118.

1.1.2 Whaler's Bay/SIZEX Phase (January 1989 - May 1989)

The Seasonal Ice Zone Experiment (SIZEX) phase began on 13 January when the POLARBJORN sailed from Tromso en route to operations in Fram Strait. This phase of CEAREX consisted of two separate cruises. The first cruise lasted from 9 February until 5 March 1989, and the second one from 8 March until 2 April 1989. Biophysical oceanographic operations commenced 4 April and concluded 17 May 1989. The first SIZEX cruise concentrated on conditions in the vicinity of Bjornoya, south of Svalbard; all subsequent cruises were located in the Fram Strait region west of Svalbard.

The HAAKON MOSBY's (University of Bergen, Norway) participation in the SIZEX phase began on 25 February 1989, when the ship left Tromso, Norway, bound for regions in the Barents Sea. From 26 February to 7 March 1989 the ship operated in the general area between the Svalbard and the northern coast of Norway. On 7 March the HAAKON MOSBY headed northwest toward regions in the Fram Strait west and southwest of Svalbard, where the ship cruised seaward of the pack ice edge from 11 March to 19 March 1989. The HAAKON MOSBY then headed southeast into the Barents Sea, finally returning to port on 23 March 1989.

Johannessen and Sandven (1989) describe SIZEX in more detail and provide a list of participants in the experiment.

1.1.3 Camp Operations Phase (March 1989 - April 1989)

The oceanography ice camp (O-Camp) and acoustic ice camp (A-Camp) operations were located on the pack ice in the Fram Strait. Most of the studies conducted at O-Camp were related to processes in the upper boundary layer of the ocean. The A-Camp focus was acoustics in the ocean. The O-Camp was active from 30 March until 24 April 1989. The A-Camp operated from 30 March until 20 April 1989.

1.2 Detailed Data Description

Bathymetry, biophysical, hydrography, meteorology, noise, sample position, and sea ice data collected during the Coordinated Eastern Arctic Experiment (CEAREX) are available in ASCII format. The data were collected in the Norwegian and Greenland Seas north to Svalbard from September 1988 through May 1989. To bring together related Eastern Arctic data sets and facilitate research use of the CEAREX data, some data from the Marginal Ice Zone Experiment (MIZEX), the Eurasian Basin Experiment (EUBEX), and the Seasonal Ice Zone Experiment (SIZEX) are included. In addition to more than 200 data files and 16 program files, the CEAREX data set contains documentation files that describe each type of data collected.

- Bathymetry data include gridded trackline data collected from the two ice floe operation camps, digital bottom bathymetry, and continental topography data compiled for the Fram Strait region and a portion of the Arctic Ocean.
- Biophysical data include bottle sample, zooplankton sample, bioluminescence, and optics profile data.
- Hydrography data consist of Conductivity-Temperature-Depth (CTD), Salinity-Temperature-Depth (STD), and bottle data collected from the operations camps, the drifting ship POLARBJORN, and data archives. Hydrography data also include data from the MIZEX, the EUBEX, NODC archives, and a merged set of data from five other cruises
- Meteorology data from CEAREX and the MIZEX (1983, 1984, 1987) include near-surface time series and rawinsonde upper-air sounding measurements of wind, pressure, temperature, and humidity collected on ship platforms, ice floe stations, and the operation camps.
- Noise data consist of acoustic measurements from a variety of hydrophone and geophone arrays and ambient noise observations made from a drifting ship using omni-directional hydrophones tethered beneath the ice cover.
- Sample Position data consist of hourly listings of position and velocity for both manned stations and unmanned drifting buoys.
- Sea ice data consist of ice accelerometer data for movements associated with the deformation of multi-year ice floes, and sea ice compressive stress measurements made in a multi-year floe.

Production of the data set was supported by the Arctic Program of the Office of Naval Research (ONR). The Direct Research Funding Program at the Naval Post graduate School (NPS) and the Naval Oceanographic and Atmospheric Research Laboratory (NOARL), now a part of the Naval Research Laboratory, supported the NPS scientific effort that acquired much of the meteorology data.

1.3 Format

All data are in ASCII text format and tabular form so that they can be used on a variety of computer platforms. The data files were converted to STREAM format in which each line ends with the carriage return and line feed characters. The files can be read using any editor or word processor. TYPE or PRINT commands can be used directly; because many of the files are quite large, these commands should be used with caution. The data files may be read using FORTRAN, C or another high-level programming language.

The files contain no special formatting characters. Because tabs are interpreted differently by different text processors, tabs have been converted to blank spaces in order to align the columns (fields).

Some of the files may appear to be double-spaced when displayed on a screen. Whether this happens depends on how your computer or terminal handles records that are longer than 80 characters. These double-spaced files display as single-spaced when read with a word processor.

Each documentation file describes these tables by giving the column or field width and the type of data in the field. One blank is between each field, unless otherwise specified in the documentation files.

The formats for each data type—bathymetry, biophysical, hydrography, meteorology, noise, position, and sea ice—are described in the Appendix.

1.4 File and Directory Structure

The CEAREX data set contains 217 data files and 16 program files in eight directories and 20 sub-directories. Please read the file README.1ST. It is located in the DOCUMENT/ sub-directory.

Table 1. Data Directories and Contents

Directory	Subdirectory	Subdirectory	Contents
\BATHYMET			documentation file, 6 data files
\BIOPHYS			documentation file, 6 data files
\DOCUMENT			15 files including README.1ST
\HYDROG			documentation file, 9 sub-directories
	\BIOCTD		7 data files
	\BOTTLE		1 data file
	\EUBEX		2 data files
	\FRAM		26 data files
	\HELO		2 data files
	\LAMONT		3 data files
	\OCAMP		1 data file
	\SHIP		5 data files
	\SIZEX		2 data files
\METEOR			documentation file, 2 sub-directories
	\SURFACE		12 data files (CEAREX and MIZEX data)
	\UPPER		10 data files (CEAREX and MIZEX data)
\NOISE			2 sub-directories:
	\ACOUSTIC		documentation file and 3 data files
	\AMBIENT		documentation file and 1 data file
\POSITION			documentation file and 2 sub-directories:

Directory	Subdirectory	Subdirectory	Contents
	\POSDAT		27 data files
	\POSPRG		16 program files (source code in C)
\SEAICE			3 sub-directories
	\ACCEL		documentation file and 77 data files
	\DEFORM		documentation file and 6 data files
	\STRESS		2 sub-directories:
		\BDM	documentation file and 14 data files
		\CRREL	documentation file and 6 data files

1.5 Spatial Coverage

CEAREX data were collected in the Greenland and Norwegian Seas near Svalbard, north of Norway. Figure 1 shows an area map adapted from the CEAREX Operations Plan. The map shows the intended areas of CEAREX operations and data collection. Thus, the key shows the proposed dates of operation, not the actual dates. The map is used here to illustrate the general coverage of the CEAREX operations in the eastern Arctic.

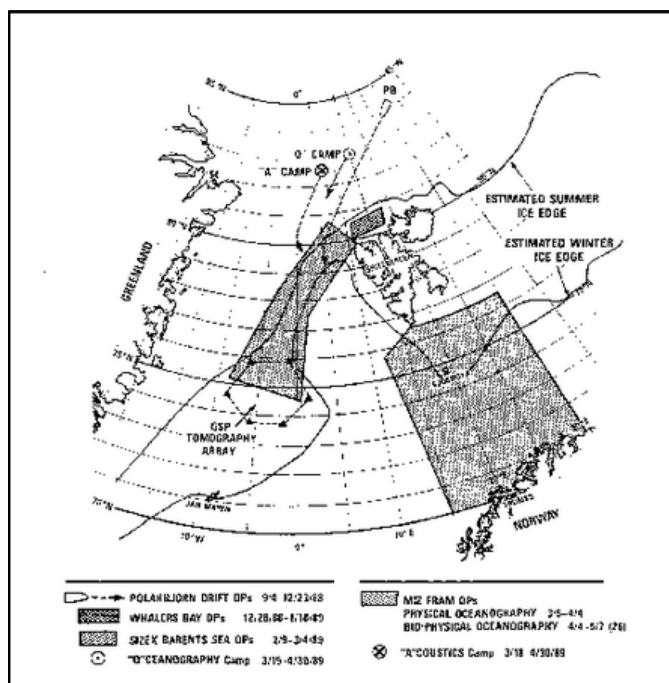


Figure 1. General CEAREX Coverage in the Eastern Arctic

1.5.1 Projection

Scattered digital bathymetry data were converted from latitude/longitude to an X-Y Cartesian system using a Lambert's Conic Conformal transformation.

1.5.2 Grid Description

The digital bathymetry topography data are gridded to a 10 m by 10 m grid that extends from roughly 73 degrees north to 90 degrees north and from 60 degrees west to 60 degrees east. The trackline bathymetry data are not gridded.

1.6 Temporal Coverage

Data were collected between September 1988 and April 1989.

1.7 Parameter or Variable

- Air Temperature
- Alkalinity
- Ambient Noise
- Altitude
- benthic Habitat
- Bioluminescence
- Carbon Dioxide
- Chlorophyll
- Conductivity
- Fluorescence

2 SOFTWARE AND TOOLS

The source code was written in C and is provided for use without support from NSIDC. The programs are located in the directory with the sampling position data. For a special note about the file names of the C programs, please refer to the FTP directory documentation file.

3 DATA ACQUISITION AND PROCESSING

For information about data acquisition, processing methods, and potential error sources, please refer to the Appendix (no data acquisition information is available for the position data).

3.1 Sensor or Instrument Description

CEAREX data were collected from various sensors and platforms including accelerometers, aircraft, anemometers, barometers, bathyphotometers, CTD and STD, buoys and drifting buoys, geophones, ground stations, hydrophones, hygrometers, Nansen Bottles, rawinsondes, thermometers, ships, stress sensors, thermistors, and transponders.

4 REFERENCES AND RELATED PUBLICATIONS

Items marked with an asterisk (*) relate directly to CEAREX; other items are cited by the authors either as references for techniques or to point data users in the direction of more information about a discipline or procedure.

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4.1 Related Data Collections

[Sea Ice Data](#)

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6 DOCUMENT INFORMATION

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6.2 Date Last Updated

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APPENDIX A – BATHYMETRY DATA

Data Description:

Trackline Data

- Bathymetry tracklines for CEAREX are from three sources:
- The ship NORTHWIND while it was enroute to the CEAREX area near Svalbard
- The Acoustics Camp (A-Camp) located on an ice floe
- A group of tracks collected during the drift phase of CEAREX

Digital Data

The digital bathymetry data file consists of both bottom bathymetry and continental topography data for the region of Fram Strait and for a portion of the Arctic Ocean. Specifically, the digital bathymetry data covers a region between 74 degrees north and 88 degrees north over the centrally deep regions of Fram Strait and the Arctic Ocean as well as the East Greenland continental shelf; it covers a region 1650 km by 1650 km with data values every 10 km in both the horizontal and vertical directions. Within the Arctic Ocean, the zonal extent is 60 degrees west to 60 degrees east. The data includes only the fringes of the Barents Sea that border the deeper regions. Surface topography is also included for some realism but should not be relied on.

The bathymetry includes Fram Strait topography on a 10 m by 10 m grid that covers an area extending roughly from 73 degrees north to 90 degrees north and from 60 degrees west to 60 degrees east. Latitude and longitude are given in decimal degrees.

Data Acquisition:

Trackline Data

A 12 kHz EDO transducer, a GIFFT transceiver and an oscilloscope were used to periodically measure the depth of the water column at the Oceanography Camp (O-Camp). A mean sound speed of 1492 m/s is assumed in order to convert the travel time of the acoustic signal (echo) to depth. Camp navigation is interpolated from approximately hourly satellite fixes.

Digital Data

The digital bathymetry was created by melding three different data sets, incorporating data for a given region based on the following priority:

1. A higher spatial-resolving, hand-digitized map of 1983 bathymetry that extended from 76 degrees north to 83 degrees north and from 17.5 degrees west to 15.0 degrees east (taken from a contour map provided by K. Aagaard)
2. Digital coastline data
3. Lower resolution DBDB5 data, used only in areas outside the hand-digitized region.

Data Processing:

Trackline Data

The investigators provided the data to the Naval Research Laboratory. The Naval Research Laboratory formatted the data for submission to the marine geophysical data base maintained by the NOAA National Geophysical Data Center (NGDC) Marine Geology and Geophysics Division (MGG).

Digital Data

The scattered data were converted from latitude/longitude to an X-Y Cartesian system using a Lambert's Conic Conformal transformation, gridded using a minimum tension algorithm, and then contoured to check for accuracy. If specific regions were not modeled accurately enough, additional data were employed and the process was repeated.

Since the 1983 bathymetry did not show the Belgica Bank and its associated troughs located on the northeast Greenland Shelf (Bourke et al. 1987), the resulting bathymetry was **graphically edited** to include this feature for completeness. The graphical editing of the bathymetry within the region of the Belgica Bank is by its very nature not exact, but provides a fair degree of realism. Separate files do exist for the continental coastlines of Greenland, Svalbard, and many of the smaller islands.

Data Organization:

The bathymetry trackline data and digital bathymetry data are presented in separate subdirectories for CEAREX. The bathymetry trackline data are presented in six ASCII data files, and the digital bathymetry data are presented in a single data file.

Data Format:

Trackline Data

Because no other "standard" format was available, the Marine Geophysical Data Exchange Format (MGD77) was used to present the tracklines. The user community is invited to comment on the utility of this format for data analysis. It appears that a gridded format may be more useful; as the set of available tracklines for the Eastern Arctic grows, the feasibility of gridding the data for the future will be investigated.

The description of the MGD77 format in this document is extracted from MGD77 Task Group (1989), which is available on request from:

NOAA/National Geophysical Data Center, 325 Broadway, Boulder, CO 80303 USA

MGD77 uses 16 header records composed of 80-character "sequences" to describe the data. A sequence is a logical record that ends with its sequence number in positions 79-80. The 120-character physical records are composed of 1.5 sequences each. The header sequences are defined in a **header record table** in the CD-ROM documentation file. Data records are 120-character records with contents and format described in a **data record table** in the CD-ROM documentation file. To use the data in a program, read consecutive strings of 80 characters in the order described in the tables.

Digital Data

Data are presented in 54-character ASCII records containing five columns, one each for latitude, longitude, Z, X and Y, where:

Z is elevation in meters, 0 being sea level

if Z is less than 0 => bottom bathymetry,

if Z is greater than 0 => continental topography (crude)

X (km) is the resulting transform of the latitude and longitude pair using Lambert Conic Conformal (LCC) mapping

Y (km) is the resulting transform of the latitude and longitude pair using LCC mapping

The Lambert transformation used a latitude-longitude origin of 74 degrees north and 25 degrees west, a central meridian of 0 degrees, a central parallel of 79 degrees north, minimum and maximum parallels of 76 degrees north and 82 degrees north and a scale factor of 1:10000. A

conversion factor of 0.25423619 was used to convert LCC output to true distance in kilometers determined from great circle distance.

The first twelve records in the file are shown here as sample data. The first and second records are informative headers.

```

Filename:  \BATHY\MANLEY.BTH
Latitude  Longitude      Z          Y          X
73.0026  -25.1198         14        -100       -50
73.0396  -24.8420        -21        -100       -40
73.0763  -24.5631        -20        -100       -30
73.1125  -24.2829        -11        -100       -20
73.1484  -24.0016         -5        -100       -10
73.1839  -23.7191         0         -100         0
73.2190  -23.4354         11        -100        10
73.2537  -23.1505        -49        -100        20
73.2880  -22.8644        -68        -100        30
73.3218  -22.5772        -29        -100        40

```

Notes:

Trackline Data

The header for the file `ACAMP.BTH` was added at NSIDC and may contain more information after it has been ingested by MGG.

The file `\BATHY\OCAMP.BTH`, contains data from the O-Camp provided by D. Menemenlis of the Institute of Ocean Sciences, Sidney, British Columbia. These data were intended for inclusion in the MGD77 format files; however, it is not certain that they were actually included. To ensure their availability, the data are provided separately in a file containing descriptive text and in a **text file** in the CD-ROM documentation file. These data will be incorporated into the bathymetry data set on the next version or volume of the Eastern Arctic CD-ROM series. NSIDC apologizes for any inconvenience this may cause.

The surface topography data should not be relied on.

Digital Data

As of December 1990, there were many useful maps but no acceptable digital data of bottom bathymetry in the region of Fram Strait. For example, DBDB5 omitted or poorly represented the Molloy Deep. In an attempt to address this problem until such time as sufficient observations in the Arctic are obtained to provide a complete, high-resolution digital bathymetry, Thomas Manley created the digital data presented early in 1990 for his own research purposes.

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A.M. Hittelman, NOAA, National Geophysical Data Center - MGD77 format

Digital Data

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APPENDIX B – BIOPHYSICAL DATA

Data Description:

The Biological-Physical-Optical cruise was carried out aboard RV POLARBJORN during April and May 1989. The bio-physical data variables and their accompanying definitions are listed in the data processing section of the CD-ROM documentation file.

The meteorology data consist of hourly averaged observations of wind speed, wind direction, air temperature, relative humidity and sea level pressure made from the CEAREX biophysical stations. All optics profile data are in units per meter. The variable 'k' for all fields is the diffuse attenuation coefficient for the designated wavelength. All bioluminescence data values are in photons (*E10) per cubic meter. Values in the zooplankton data file are the mean densities for replicate tows. The phytoplankton and particulate matter variables from the biological analyses include:

- chlorophyll concentration (ug/l)
- phaeophytin concentration (ug/l)
- particulate organic carbon (ug/l)
- particulate organic nitrogen (ug/l)
- primary productivity (ug C/l/d)

Data Acquisition:

Biological Analyses - Bioluminescence

Vertical profiles of mechanically stimuable bioluminescence were obtained using a High Input Defined Excitation (HIDEX) type bathyphotometer. Please refer to the CD-ROM documentation file for details of the instrumentation and sampling.

The design was based on the NORDA HIDEX. A 220 volt stainless steel well (Crown) pump was used to pump 100 gallons per minute through a detection chamber. Bioluminescence was stimulated by the shear created as the flow of seawater passed through a 1-cm x 1-cm grid at the intake to the detection chamber. The walls of the detection chamber were lined with optical fibers that collect light from the entire detection chamber and direct it to the photomultiplier tube (PMT) in the MER-2050 profiling bioluminescence photometer (BP) (Biospherical Instruments, Inc.). This instrument samples voltages at the photomultiplier tube at a sampling interval of 1 microsecond. Through a shipboard computer, the instrument is directed to sample the PMT a specified number of times, and then to sample any other sensors. In this case, the only other parameters sampled were voltage to the PMT and depth. Typically, these parameters were sampled at 1-second intervals. The MER-2050 allows for the high voltage to the PMT to be set at four levels: off (0 volts), low (500

volts), medium (700 volts) and high (900 volts), with higher voltages resulting in increased sensitivity. The BP was usually operated at its highest sensitivity, except in highly bioluminescent waters where bioluminescence was too bright to be accurately measured at the highest sensitivity.

One bioluminescence data file contains data averaged at 5 m intervals. Data from the top 5 meters were discarded. Values are in photons (*E10) per cubic meter. Another data file contains data from four stations (66, 69, 71 and 73) at which the BP was stopped at 10 m intervals and the pump was run for five minutes at each depth. The **variables** in these files are defined in the CD-ROM documentation file.

Biological Analyses - Phytoplankton and Particulate Matter

Pigments: Chlorophyll and phaeophytin were determined fluorometrically on a Turner Designs Fluorometer Model 10 (Holm-Hansen et al. 1967; Parsons et al. 1984), which had been calibrated with commercially purified chlorophyll-a (Sigma Chemical). Filters were extracted in 90 percent acetone, sonicated for ten minutes, and the fluorescence was assayed before and after acidification.

Particulate carbon and nitrogen: Particulate matter concentrations were determined by pyrolysis of filtered samples in a Perkin Elmer Model 240B elemental analyzer. Samples (approximately 0.3-1.1 l) were filtered through precombusted (450 C for four hours) GF/F filters, rinsed with a few ml of weak (0.01 N) HCl, placed in precombusted glass vials and covered with aluminum foil, and dried at 60 C. Blanks were filters placed under another filter and processed as above (Nelson et al. 1989).

Primary productivity: Rates of primary productivity were determined using simulated in situ ¹⁴C-incorporation experiments (Smith and Nelson 1990). Samples were collected from depths which corresponded to known percentages of surface irradiance and placed in bottles covered with neutral density screens. The samples were inoculated with approximately 20 uCi of HCO₃ and incubated on deck for approximately 24 hours. Incubations were terminated by filtering the samples through GF/F filters, which were rinsed with 5 ml 0.1N HCl just prior to the completion of the filtration (Goldman and Dennett 1985). All samples were counted on a liquid scintillation counter, and counting efficiencies determined by the external standard method. Total added isotope was determined by counting 0.5 ml of unfiltered sample directly.

Integration was from the surface to the depth at which 0.1 percent of surface irradiance penetrated. This depth varies for each station.

Biological Analyses - Zooplankton

The results of enumeration of zooplankton obtained by net tows are contained in a separate data file. The samples were collected with oblique tows with a 0.5 m diameter 153 um mesh net hauled between the surface and 150 meters. Numbers included in the database are the mean densities for replicate tows. Each field represents the results for a species, a species developmental stage, or an aggregate of organisms not identified to the species level. All **variable symbols** are defined in the CD-ROM documentation file.

Nutrient Chemistry - Major Dissolved Nutrients

All major dissolved nutrient observations were taken in Fram Strait between April 10 and May 17, 1989. Nutrient observation samples whose concentrations are reported in the data file were obtained during the biological Niskin bottle casts. The nutrient analyses were performed using a six-channel Alpkem Rapid Flow Analyzer "mated" to a computer-controlled (HP Vectra ES/12) data acquisition system. The methods used for the ammonium, nitrate, nitrite, phosphate and silicate analyses were slight modifications of the methods described by Sakamoto et al. (1990).

Please refer to the CD-ROM documentation file for discussions of the continuous vertical **nutrient profiles** obtained, ammonium method problems encountered, and nutrient data errors detected.

Nutrient Chemistry - Biogenic and Lithogenic Silica

Biogenic silica was determined by filtering seawater through 0.6 um Nuclepore filters, drying them and returning them to Oregon State University for analysis. Back in the lab, the filters were digested in hot NaOH to dissolve the biogenic silica (Paasche 1973, Krausse et al. 1983) and the resulting solution was analyzed for reactive silicate by the acid-molybdate method of Strickland and Parsons (1972). These same filters were subsequently digested in 0.2 ml of 2.9M HF acid in order to dissolve the lithogenic silica (Eggimann and Betzer 1976). This solution was diluted to an HF concentration of less than 8 mm and analyzed by the above acid-molybdate method.

Optics

A bio-optical-physical profiler was deployed at approximately 25 percent of the CEAREX stations. The system is an integrated in situ profiler capable of measuring the **variables** in continuous profile mode that are identified in the CD-ROM documentation file.

Marine particulate absorption and fluorescence excitation spectra were determined according to the methods of Mitchell and Kiefer (1984) and Mitchell (1990). Briefly, from 0.5 to 2.0 liters of seawater collected in rosette Niskin bottles were filtered through Whatman GF/F filters. The particles concentrated on the filters were then analyzed in a spectrophotometer and

spectrofluorometer. An analysis using the spectrophotometer provided the raw absorbance, which was then corrected according to Mitchell (1990) to determine the absorption coefficient of the particles in the sea water suspension. The method is considered to have an accuracy of +/- 15 percent. Absorption coefficients at selected wavelengths corresponding to the channels of the optical profiler are included in the data files. The spectral fluorescence data are not included in the data base.

Station Observational Log

Notes on sea ice, sea state, cloud state and station type were recorded by a watch person at each station. The data were entered into a personal computer file for subsequent qualitative assessment of each station.

Data Processing:

Bioluminescence Data

Data were averaged at 5 m intervals. Data from the top 5 meters were discarded. Values are in photons (*E10) per cubic meter. There were no CEAREX conductivity-temperature-depth (CTD) stations numbered bp1700 and bp2300 for the second and third casts during the second drift. These station numbers in the data set refer to times when the BP and nets were deployed but no CTD was operating. At four stations, the BP was stopped at 10 m intervals and the pump was run for five minutes at each depth. Data from these four stations are provided in a separate file because the significantly shorter record length was difficult to integrate with the larger records in the other bioluminescence data file.

Physical Oceanography Data

CTD data were collected and processed by Tom Manley. Comparison data used in quality control were extracted from a file on the CEAREX CD-ROM and integrated into the bio-physical data for the discrete depths sampled. The data were extracted at depths decimated at 1 meter, smoothed, and interpolated as described in the physical oceanography data processing section of the CD-ROM documentation file. Please read it in its entirety to better understand what can and cannot be 'obtained' from the data set.

For the biophysical data files, ONLY CTD DATA FOR THE DEPTHS OF THE WATER SAMPLES ARE INCLUDED. The final CTD data set for the bio-physical cruise is included in the hydrography data files.

The quality control file used on the final data file is available in the CD-ROM documentation file. The file compares the trip log information obtained as each bottle was tripped and reported and bottle salinities with the final processed CTD/fluorescence profiles. The contents of the physical oceanography data files are also discussed in CD-ROM documentation file. For a discussion of the errors associated with the physical oceanography data, please refer to the data processing section of the CD-ROM documentation file.

Meteorology Data

The hourly averaged values were calculated from ten minute averaged values. Wind data were converted into u and v components, averaged, and then converted back into speed and direction. Missing values were coded as -9, except AIRTEMP, which was coded as -99 if missing. There are gaps in the data records where observations are missing, and there is no entry for one or more date/time group.

Only bio-physical station data from the POLARBJORN Cruise were extracted and are included. A PC diskette containing the CEAREX hourly meteorological data is available from NSIDC User Services. The complete CEAREX ten minute meteorological data are contained on the CEAREX CD-ROM.

Optics Data

All data from the deck PAR sensor and the bio-optical-physical profiler deployed at CEAREX stations were integrated using a Biospherical Instruments multiplexing deck box. The digitized signal was transferred by RS-232 interface to an IBM-AT compatible computer. A complete description of the profiler, data sampling and data processing can be found in Mitchell and Holm-Hansen (1991) or Mitchell (1991).

Data Organization:

The bio-physical cruise data are presented in six ASCII data files on the CEAREX CD-ROM including:

- two bioluminescence data files
- a data file of all bottle samples and bottle depths
- a zooplankton sampling data file
- an optics profiles data file
- a station log data file

Tables describing the data files are provided in the CD-ROM documentation file. Each table includes variable names, formats, and a brief variable description.

Data Format:

Null values are provided in data file fields that may in some cases contain no data. The null value varies depending on the field. The null value for each field is given in the tables in the CEAREX CD-ROM documentation files. Formats are specified for each field. At least one blank separates each field, but there may be more than one blank between some fields.

In the larger **bioluminescence** data file, the first three header records have the FORTRAN format 21(A7,1X). The FORTRAN format for the fourth header record is A7,161X. The data record FORTRAN format is 21(F6.1,1X). "1X" indicates one blank between each field in the headers and data records. For the smaller bioluminescence data file, the format of the first three header records is 4(A7,1X), the format of the fourth header record is A7,25X, and the data record format is 4(F6.1,1X).

Heading titles in the **zooplankton** data file correspond to categories in a table in the documentation files on the CEAREX CD-ROM that shows all values in floating point format. The FORTRAN format of the header record is 29(A10,1X). The format of the data records is 29(F10.2,1X). Values are number of observations of zooplankton groups per cubic meter.

Investigators:

The following Principal Investigators (PIs) provided the data file/methods and/or references description for the CD-ROM documentation files (and this document):

Edward Buskey, University of Texas at Austin - biological analyses zooplankton and bioluminescence

Louis Codispoti, Monterey Bay Aquarium Research Institute (MBARI) - nutrient chemistry, dissolved nutrients

Kenneth Davidson, Naval Postgraduate School - meteorological data

Peter Guest, Naval Postgraduate School - meteorological data

Thomas O. Manley, Marine Research Corporation - meteorological data

R. Greg Mitchell, Scripps Institution of Oceanography - optical profiling and particle optics

David Nelson, Oregon State University - nutrient chemistry, biogenic and lithogenic silica

H. J. Niebauer, University of Alaska - station log observations

Walker O. Smith, Jr., University of Tennessee - biological analyses, phytoplankton and particulates

APPENDIX C – HYDROGRAPHY DATA

The CEAREX hydrography data include conductivity-temperature-depth (CTD) data collected during two cruises and from two camps, and data obtained during the Seasonal Ice Zone Experiment (SIZEX) and the Eurasian Basin Experiment (EUBEX). The hydrography data files also include data taken from the Fram Strait 11-Year CTD Data Set, bottle data obtained from a National Oceanographic Data Center data base, and ship data acquired from a merged data set of 300 Norwegian and Greenland Seas stations.

Information in this document has been derived from documentation files on NSIDC's CD-ROM titled *Eastern Arctic Ice, Ocean and Atmosphere Data, Volume 1: CEAREX-1, version 1.0, 8/91*.

Data Description

Described here are the SIZEX data, the Fram Strait data, the bottle and ship data, and the data processed at the Lamont-Doherty Geological Observatory.

Lamont

The Lamont data were collected during the POLARBJORN drift phase. Three data files contain 208 calibrated, decimated CTD hydrographic stations. Time is in GMT; all latitudes are in degrees north; all longitudes are in degrees east; temperature is in degrees Celsius; pressure is in decibars; salinity is in parts per thousand (PSS78 units); conductivity is in millimohs.

SIZEX

The SIZEX data include remote sensing, oceanographical, ocean acoustical, meteorological, and sea ice data.

Fram Strait

The Fram Strait data consists of all readily available hydrographic information obtained from salinity-temperature-depth (STD) or conductivity-temperature-depth (CTD) profiling instruments north of 76 degrees north and within the region of Fram Strait. Data from 4,114 stations comprise the Fram Strait data file. The data consists mostly of spring, summer and fall measurements. A table in the CD-ROM documentation file identifies the 26 experiments undertaken between 1977 and 1987 whose data have been collected into the Fram Strait data file.

Bottle and Ship

The bottle data represents 1549 stations obtained through a search of a copy of the NOAA/National Oceanographic Data Center (NODC) data base. No quality control measures were applied to the data after selection. The original investigators' and/or institutions' quality control measures are documented at NODC. Examination of the data shows very few stations with the quality, resolution, or range of parameters expected from modern observations.

The ship data files comprise a special merged data set of Norwegian Sea and Greenland Sea stations from 1980 through 1984, having relatively good data quality. Data are in five files. All station times are missing from the data files.

Data Acquisition and Equipment

Described here are the data acquisition methods and equipment for the Lamont, Acoustics Camp (A-Camp), Oceanography Camp (O-Camp), EUBEX, SIZEX (including the Seasoar Program), and the bottle and ship data.

Lamont

The Lamont data were collected during the first three legs of CEAREX (PB1, PB2, and PB3) aboard the ship POLARBJORN:

LEG	Dates of Stations	Chief Scientist
PB1	10/17/88 - 12/14/88	R. Pritchard
PB1	12/15/89 - 01/08/89	J. Ar dai
PB2	01/14/89 - 02/01/89	E. D'Asaro
PB3	02/09/89 - 03/01/89	O. Johannesse

Bottom depths for the hydrographic stations are from the ship-mounted echo sounder. The values are in uncorrected meters and should be used as estimates. When the echo sounder was inoperable the following alternative methods were used:

Leg	Stations	Source of Depth Data
PB1	1, 2	General Bathymetric Chart of the Oceans
PB2	5-7	(GEBCO), 5th edition (corrected meters)
PB1	60-104	Ship's charts and winch wire counter
PB3	10-11, 52, 45-60	ADCP

Raw CTD data were collected while the CTD unit was lowered (downtrace) and raised (uptrace). The data values presented here are from the downtrace except occasionally when the downtrace values were contaminated and unusable; in these cases the uptrace values were processed. At the

following stations, uptrace data were used at 12 PB1 stations, 17 PB2 stations, and 14 PB3 stations. Uptrace data tend to be lower quality than downtrace data.

The navigation available when this data set was assembled was the original navigation collected on the POLARBJORN by ERIM. Logging mistakes and gross navigational errors in station positions have been corrected using this raw navigation and the CTD log sheets. All station locations should be re-evaluated if the navigation is processed further.

A Neil Brown IIIB CTD underwater unit (serial number 01-2276-01) was used to collect the Lamont data. The instrument was calibrated before the start of CEAREX on March 22, 1988 by the Naval Oceanographic Office. A total of 208 stations were collected between October 10, 1988 and March 1, 1989 (PB1 through PB3). No post-cruise processing by the Naval Oceanographic Office was possible because of damage to the conductivity cell at the start of PB4. A post-cruise calibration of pressure only was run for the instrument on August 22, 1989 at Lamont-Doherty Geological Observatory.

Continuous cruise calibration of the conductivity cell was possible using Autosal salinity measurements from water samples collected by Niskin water bottles. The conductivity data were calibrated separately for each leg of the cruise. The reversing thermometers provided to calibrate the CTD thermometer were of poor quality and their results were not used in the temperature calibration. A total of 234 bottles were available for use with the 208 stations. The lack of bottle data has caused the calibration errors to be larger than is desirable. Data values within approximately 5 meters of the surface are to be used with caution. The upper water layer was often contaminated by the ship. In some cases the surface values have been extrapolated to allow all stations to start at zero meters.

Please refer to the lists of calibration results (Appendix E) and equations contained in the CD-ROM documentation file.

A-Camp

The CTD data were acquired from a drifting ice camp (A-Camp) and from a helicopter that was also based out of the ice camps. Muench et al. (1991) describe the helicopter CTD data. The data from the A-Camp (cruise designator ICE) and the helicopter (cruise designator CX2) were obtained using SeaCat portable, self-contained CTD systems. Some salinity spiking was encountered with the SeaCat systems in regions of strong vertical temperature gradient, and this was most pronounced in portions of the A-Camp data (cruise ICE), where lowering rates were maintained at 0.5 m/s (a slow rate) in an effort to minimize the problem. Each of the CTD systems was calibrated prior to and following the field program.

Two SeaCats used at the A-Camp (ICE) were intercalibrated through simultaneous casts during the program, though loss of one of the two instruments precluded such intercalibration later in the program. The helicopter-borne SeaCat (CX2) systems were intercalibrated periodically at the O-Camp. Except where severe spiking was present, accuracy of the observations is +/- 0.01 degree C and 0.02 psu.

O-Camp

The O-Camp daily cast data were collected from the Oceanography Camp via a "yoyo" CTD system. The yoyo CTD system was cycled nearly continuously down to 400 meters. Typically a single cast was made each day to 600 meters. Near the very end, the continuous casts went deeper than 400 meters.

Data were also obtained from a helicopter (cruise designator CX3) using a SeaBird model SBE/11 CTD system, which had a pumped conductivity cell and was not subject to salinity spiking. The CX3 data constitute a small subset of the total volume of CTD data obtained from O-Camp, and is integrated with that data on the CEAREX CD-ROM.

EUBEX

EUBEX data were collected from 35 CTD stations near Spitsbergen between March 8 and April 17, 1981. The surveys were conducted using aircraft and from the sea ice surface, and extended down to 1 km where the water was deep enough to allow this. A table in the CD-ROM documentation file provides location information for each of the stations.

Three CTD casts taken off Greenland are included in a separate EUBEX data file. For more complete information on the EUBEX CTD data, please refer to Lewis and Perkin (1983) and Perkin and Lewis (1984).

SIZEX

The SIZEX and related MIZEX data were collected using various observational platforms such as ice-strengthened ships, open ocean ships, drifting buoys, bottom-moored buoys, helicopters, and satellites. SIZEX data were collected in the Barents Sea and the Greenland Sea in February and March 1989.

On February 8, the POLARBJORN departed Tromso heading towards the Barents Sea. Between Fugloya and Bjornoya, 12 CTD stations were obtained. The ice edge east of Bjornoya was encountered on February 11 when one acoustic buoy was deployed in ice-covered area at 75 degrees 04 minutes north, 23 degrees 00 minutes east. The next day one current meter rig and a

second acoustic buoy were deployed in open water at 74 degrees 57 minutes north, 29 degrees 15 minutes east. Then the POLARBJORN headed northeastward towards the Hopen area.

Between February 13 and February 15, ten Argos buoys were deployed on ice floes in an area approximately 100 km by 100 km. Five of these buoys were toroids with current meter strings. The deployment area west of Hopen was selected because the expected drift of the array was southwestward towards Bjornoya where the array could be recovered later. In this period the ship had to plow through fairly heavy ice, much of it was multiyear up to four or five meters thick, and she could move only a few miles per day. Weather conditions were good with four to six hours of daylight, and the helicopter could be used almost every day for ice reconnaissance and buoy deployment.

Between February 17 and February 24, the ship drifted southwestward with the pack ice, or moved only slightly, while the different groups collected data. Every time the ship was towed to a floe, radar and in situ measurements of snow and ice were made, sessions of ADCP data and wave data were obtained, and vertical and horizontal acoustic arrays were deployed. Ice photographs were obtained using helicopter, and other in situ measurements for SAR calibration were carefully coordinated with the SAR flights. Sonobuoy deployments were also coordinated with the Norwegian P3 flights from Andoya on February 18 and February 27. One iceberg, which was approximately 200 m by 100 m and grounded at 50 m depth, was visited for in situ measurements. Meteorological and remote sensing data were collected regularly throughout the experiment.

From February 24 through February 27, all the toroids were recovered, partly by use of helicopter since the ship could make only slow progress in the pack ice. Three small Argos buoys were left in the area to continue monitoring the ice drift. On February 27, wave/acoustic studies had first priority with one dedicated SAR flight, deployment of a vertical acoustic array, and a wave buoy near open water.

Barents Sea operations were very successful. In ice-covered areas, the weather was very good most of the time. All important instruments were recovered, and a lot of interesting data were collected. The POLARBJORN arrived in Tromso on March 4. After repair in a shipyard in Harstad and a cargo outhaul to Longyearbyen, the POLARBJORN was ready for the Greenland Sea operations. On March 11, she left Longyearbyen and headed southwestward to occupy deep CTDs in the acoustic tomography array in the Greenland Basin in cooperation with the HAKON MOSBY. Between March 13 and March 16, only four deep CTD casts were obtained in this area because there were problems with both the winch and the CTD sonde. The HAKON MOSBY had to be called for technical assistance before the program could be continued.

Between March 17 and March 28, the weather conditions were quiet and operations were carried out in the Boreas Basin at about 78 degrees north. The CTD system functioned normally after the

repair and 70 CTD stations were obtained in this period. Only two toroid buoys with current meters and four other Argos buoys were deployed. The study of eddies, deep convection and chimneys using the CTD and water samples was emphasized. Therefore, less time was spent on buoy deployment and more on CTD work compared to the Barents Sea. Meteorological and remote sensing data were collected regularly, and snow/ice measurements and acoustic data were obtained in between the CTD casts. A dedicated acoustic experiment was carried out on March 27 and March 28. Seven SAR flights over the area by NADC P-3 were completed in this period.

From March 28 through April 1, two strong storms passed the area and weather conditions changed from moderate to rough. Of highest priority in this period was the recovery of the last toroid, which had five current meters and one thermistor chain. It had been deployed from a multiyear floe at about 78 degrees 25 minutes north, and during a seven day period it drifted southward with the East Greenland current. Fortunately, the toroid survived the storms and was successfully recovered at 76 degrees 30 minutes north on March 31. After one more deep CTD cast in the Greenland Basin, the POLARBJORN headed back to Tromso where she arrived on April 2.

Two of the drifting Argos buoys were caught by eddies and circulated in the Boreas Basin for about three weeks after the ship left the area. One buoy drifted south to about 73 degrees north where data transmission stopped on May 18.

The Greenland Sea leg was successfully completed and much interesting data were obtained. Ice conditions, ocean conditions and weather are different in the Greenland Sea compared to the Barents Sea. Therefore, the data sets from these two areas complement each other.

SIZEX CTD and Seasoar Program

In the Barents Sea, a total of 55 CTD stations were completed. The water masses in the shallow area between Bjornoya and Hopen (40 m to 60 m depth) are dominated by homogeneous cold polar water with temperature around -1.8 degrees C and salinity of 34.7 parts per thousand. In the western part of the experiment area, some intrusion of warm and saltier Atlantic water below 50 m was observed. In the Greenland Sea, 75 CTD stations were obtained, 13 of which were deeper than 2000 m. The deep CTD casts were made in cooperation with the HAKON MOSBY to study deep convection and bottom water formation. The shallow casts (500 m) were made to map eddies and upper ocean chimneys in the Boreas Basin. (Johannessen et al. 1991).

Bottle and Ship

The bottle data were obtained by searching a copy of the NOAA/National Oceanographic Data Center (NODC) data base, June 1990 version, held by Joe Reid. The search was performed using the following coincident criteria:

- maximum observed (sampling) depths greater than or equal to 200 meters
- latitudes above 80 degrees north, or latitudes between 70 degrees north and 80 degrees north
- with longitudes between 120 degrees west and 180 degrees or 180 and 100 east
- both temperature and salinity data at the same station
- salinity values reported to at least two decimal places
- the YMER 1980 Fram Strait and northern Barents Sea slope expedition
- the KNORR 1981 expedition for the North Atlantic Study of the Transient Tracers in the Ocean(TTO-NAS)
- the HUDSON 1982 winter expedition
- the METEOR 1982 spring expedition
- the POLARSTERN 1984 post-MIZEX expedition in and near Fram Strait

Data Processing

Due to the predominance of interleaving of the various water masses within this region, virtually all of the profiles displayed density inversions and spiking over a rather wide range of amplitudes (1 m through 10 m). Since these characteristics were undesirable for the intended use of the data, a variable-knot cubic-spline smoothing algorithm was used to remove all density inversions and spikes from the data while still preserving structure having vertical amplitudes greater than 20 meters. This algorithm consecutively fit a series of cubic splines with continuous first and second derivatives over the entire profile. More splines were used at the beginning of the profile to insure better fit of the thermal layering. Subsequent verification procedures were incorporated into the processing to ensure a closeness of fit to the original profile and to insure that no inversions were present. Additionally, the mixed layer was removed from the smoothing process since it was important that the data maintain the original observational values as well as prevent the modification (smearing) of the base of the mixed layer. Data were subsampled every 5 meters and then truncated at a maximum depth of 800 m to produce the final data. The Lamont CTD data were processed at Lamont-Doherty Geological Observatory. All data were filtered with a median filter using a window of five scans after which the correction coefficients were applied for each sensor and a 0.25-second lag in temperature/pressure was applied to account for response time. The final data set was then averaged into 1 m bins.

Data Organization

The hydrography data are presented in 49 data files in nine subdirectories on the CEAREX CD-ROM, one each for:

Lamont data

Bio-physical Cruise data

Acoustics Camp data

Oceanography O-Camp daily cast data

EUBEX data

SIZEX data

Fram Strait data

Bottle data

Ship data

Data Format

At the Scripps Institution of Oceanography, Oceanographic Data Facility, all CTD files were converted to the "S87" standard CTD data format. The S87 format data files were then provided to the National Snow and Ice Data Center (NSIDC), converted to fixed-length records, and written to magnetic tape for CD-ROM mastering. Each record contains 64 characters; the end of each data record is padded to 64 characters with blanks, and the 64th character is a "newline."

The S87 data format was developed at the Lamont-Doherty Geological Observatory as a standard format for ASCII station data. The main parts of the S87 format file are the header line(s) optional identification line(s) describing the data lines.

```

0          1          2          3          4          5          6          { column
1234567890123456789012345678901234567890123456789012345678901234 { counter

TPPCC SSSS CC SDD.DDDD SDDD.DDDD YY/MM/DD JUL HH:MM CRUISE_ID { data fields

```

where:

```

T          = data type (C: ctd, B: bottle, A: axbt, X: xbt)
PP         = NODC platform code
CC         = NODC country code of the platform
SSSS      = station number
CC        = cast number
SDD.DDDD  = latitude in decimal degrees
SDDD.DDDD = longitude in decimal degrees
YY/MM/DD  = date (including "/")
JUL       = year-day for year of collection (also called "Julian Day")
HH:MM     = time (including ":")
CRUISE_ID = optional cruise identifier.

```

Following the header line is an optional secondary header line for end-of-cast information. There may also be another line describing important physical characteristics at the station location. This line must begin with the character "&" in the first column. For a list of physical characteristics mnemonics in use when the data set was assembled, please refer to the CD-ROM documentation file.

A sample optional "&" line is as follows:

```
&ZZ=4766   TA=-4.2   PA=0990   WS=0.6   WD=122
```

Comment lines follow this optional "&" line; they may not begin with "&" or "@". Use these comment lines to note the name of the program used to write the data file, the date the file was written, and the name of the programmer.

A column identification line contains mnemonics of at least two unique characters that identify the data types. This line must start with the character "@" in the first column. For a list of data type mnemonics in use when the data set was assembled, please refer to the CD-ROM documentation file.

The following is an example of data that illustrates all parts of the S87 format:

```

CPB32  55  1  74.4490  19.5095 89/03/01  60 17:56 PB3
&ZZ=4766  TA=-4.2  PA=0990  WS=0.6  WD=122
90/02/01  sohara  program: s87interp -i 1

```

```
@PR TE CO SA PT S0 0 -1.877 27.375 34.912 -1.877 28.112 1 -1.877 27.375 34.912 -1.877 28.112 2 -
1.877 27.375 34.911 -1.877 28.111 3 -1.877 27.375 34.910 -1.877 28.110 4 -1.877 27.375 34.910 -
1.877 28.110 5 -1.877 27.375 34.909 -1.877 28.109 6 -1.877 27.375 34.908 -1.877 28.109 7 -1.878
27.383 34.920 -1.878 28.118 8 -1.876 27.384 34.919 -1.876 28.118 9 -1.873 27.385 34.916 -1.873
28.115
```

All Fram Strait files are named *.jms, where the "*" represents the name and year of the platform, and the ".jms" extension tags the files as relating to Manley et al. (1991). To avoid duplicate filenames, the name and year of the experiment were used instead in some cases. Please refer to

the CD-ROM documentation file for a table of Fram Strait filenames and the associated "Cruise_id" value found in positions 54 through 62 of each file's header records.

The CEAREX hydrography data are also archived in the original format (as provided to Scripps by each investigator) and are available on magnetic media from NSIDC User Services. Please inquire for current distribution format(s) and cost.

Notes

Data accuracy varies with experimental program and the types of sensors used, but for the data set as a whole, the accuracy estimates are +/- 0.02 degree C and +/- 0.02 psu for temperature and salinity, respectively. Residual (smoothed - original) standard errors were used as an indication of the quality of fit between the smoothed and original profiles of temperature, salinity and density. Less than 10 percent of the station data had residuals greater than +/- 0.01, but they were still within the limits of the data set reliability (i.e., +/- 0.02).

Errors related to the hydrography CTD data have been identified.

SIZEX data descriptions in this document were extracted from the SIZEX portion of the CD-ROM documentation file, which was taken from Johannessen and Sandven (1989). Lamont data descriptions in this document were derived from the Lamont section of the CD-ROM documentation file, which was taken from O'Hara (1990).

Please refer to the CD-ROM documentation file for the abstract from:

Manley, T. O., R. H. Bourke and K. L. Hunkins. 1991. Near-surface circulation over the Yermak Plateau in northern Fram Strait. *Journal of Marine Systems* 3(1/2):107-125.

Investigators

Roger Andersen, University of Washington - O-Camp data

Ola Johannessen, Nansen Remote Sensing Center - SIZEX data

Thomas Manley, Marine Research Corporation - Bio-Physical Cruise data, Fram Strait data Set

James Morison, University of Washington - O-Camp data

Robin Muench, Science Applications International Corporation - A-Camp data

Suzanne O'Hara, Lamont-Doherty Geological Observatory - Lamont data

Ronald Perkin, Institute of Ocean Sciences - EUBEX data

James Swift, Scripps Institution of Oceanography - bottle and ship data

APPENDIX D – HYDROGRAPHY DATA: CTD

CEAREX Hydrography Data: CTDs

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1. Introduction

Hydrography data files on this CD-ROM were provided to Dr. James Swift, Scripps Institution of Oceanography, Oceanographic Data Facility, by the original CEAREX investigators. At Scripps, the files were converted to a standard format. The standard format selected is "S87", developed by the Physical Oceanography Group at Lamont-Doherty Geological Observatory; S87 is described in detail in Section 2 of this documentation file. The S87 format data files were then provided to the National Snow and Ice Data Center (NSIDC), converted to fixed-length records, and written to magnetic tape for CD-ROM mastering.

The CEAREX hydrography data sets on this CD-ROM are also archived in the original format, as provided to Scripps by each investigator. The original format data are available on magnetic media from the National Snow and Ice Data Center, CIRES, University of Colorado, Boulder, Colorado 80309-0449, USA. Please inquire for current distribution format(s) and cost.

2. "S87" Standard CTD Data Format

The S87 data format was developed as a standard format for ASCII station data. The main parts of the S87 format file are the header line containing all pertinent station information, an id line containing mnemonics of at least two unique characters describing the data in the columns that follow, and the data lines themselves.

Please note that all CTD data files on this CD-ROM are in S87 format, and each record contains 64 characters. The end of each data record is padded to 64 characters with blanks; the 64th character is a "newline".

The first line of S87 data files is the header line, containing all the information needed to identify the station. This line may be repeated within a single file, when the file contains data for more than one station.


```

0          1          2          3          4          5          6      { column
1234567890123456789012345678901234567890123456789012345678901234 { counter

TPPCC SSSS CC SDD.DDDD SDDD.DDDD YY/MM/DD JUL HH:MM CRUISE_ID { data fields
    
```

where:

```

T          = data type (C: ctd, B: bottle, A: axbt, X: xbt)
PP         = NODC platform code
CC         = NODC country code of the platform
SSSS      = station number
CC        = cast number
SDD.DDDD  = latitude in decimal degrees
SDDD.DDDD = longitude in decimal degrees
YY/MM/DD  = date (including "/")
JUL       = year-day for year of collection (sometimes called
           "julian day")
HH:MM     = time (including ":")
CRUISE_ID = optional cruise identifier.
    
```

Following the header line is an optional secondary header line for end-of-cast information. There may also be another line describing important physical characteristics at the station location. This line must begin with the character '&' in the first column. As of September 1989 there are eleven physical characteristics mnemonics used in this optional '&' line:

```

CS = PCO2 in situ
CL = PCO2 at lab T (15 degrees C)
TC = total CO2
TK = total alkalinity
ZZ = bottom depth in meters
SS = bucket surface salinity
TA = air temperature in degrees C
PA = air pressure in millibars (hectopascals)
TS = bucket surface temperature in degrees C
WS = wind speed in meters per second
WD = wind direction in degrees
    
```

A sample optional '&' line is as follows:

```
&ZZ=4766 TA=-4.2 PA=0990 WS=0.6 WD=122
```

Comment lines follow this optional '&' line; they may not begin with '&' or '@'. It is recommended that these comment lines be used to note the name of the program used to write the data file, the date the file was written, and the name of the programmer.

The column identification line contains mnemonics of at least two unique characters that identify the data types in the columns below. This line must start with the character '@' in the first column. A list of data type mnemonics in use when the data set was assembled is given here:

```

AG  adiabatic temperature
AN  specific volume anomaly
BV  Brunt Vaisalla frequency
C3  delta C-13
C4  delta C-14
CA  chlorophyll a
CC  total CO2 by gas chromatograph
CL  pCO2 @ lab temperature
CO  conductivity
CS  pCO2 @ in situ temperature
DE  depth
DF  density flux
DR  density ratio
    
```

F1 freon 11
 F2 freon 12
 FL flags (from ctd78 format)
 FR freon ratio
 FS freon saturation
 GV geostrophic velocity
 HZ dynamic height
 IT ice thickness (cm)
 LT percent of light transmitted through water
 N2 nitrite (stability)
 N3 nitrate
 NH ammonia
 OC oxygen current
 OS % oxygen saturation
 OT oxygen temperature
 OX oxygen (ml/l)
 PA air pressure
 PH pH
 PO phosphate
 PR pressure
 PT potential temperature
 RN record number (bottle number)
 RT rosette temperature
 RS rosette salinity
 RO rosette oxygen
 SE sea state
 S0 sigma theta
 S1 sigma 1
 S2 sigma 2
 S3 sigma 3
 S4 sigma 4
 SA salinity
 SI silicate
 ST sigma t
 SV sound velocity
 SW swell
 T1 tritium (TU)
 T2 tritium (TU-81)
 TA air temperature
 TC total CO2 by titration
 TE temperature
 TF temperature above freezing
 TG temperature gradient
 TI time
 TK total alkalinity (titration)
 VE sound velocity
 WD wind direction
 WE weather
 WS wind speed (m/s)

Here is an example of data, illustrating all parts of the S87 format:

```
CPB32 55 1 74.4490 19.5095 89/03/01 60 17:56 PB3
&ZZ=4766 TA=-4.2 PA=0990 WS=0.6 WD=122
90/02/01 sohara program: s87interp -i 1
@PR TE CO SA PT S0
0 -1.877 27.375 34.912 -1.877 28.112
1 -1.877 27.375 34.912 -1.877 28.112
2 -1.877 27.375 34.911 -1.877 28.111
3 -1.877 27.375 34.910 -1.877 28.110
4 -1.877 27.375 34.910 -1.877 28.110
5 -1.877 27.375 34.909 -1.877 28.109
6 -1.877 27.375 34.908 -1.877 28.109
7 -1.878 27.383 34.920 -1.878 28.118
8 -1.876 27.384 34.919 -1.876 28.118
```

9 -1.873 27.385 34.916 -1.873 28.115

3. Lamont CTD Data (PB1, PB2, PB3) - S. O'Hara
 These data are in the CD-ROM subdirectory \HYDROG\LAMONT.

The files LMTPB1.CTD, LMTPB2.CTD and LMTPB3.CTD contain the 208 calibrated, decimated CTD hydrographic stations collected during the first three legs of CEAREX aboard the ship POLARBJORN.

LEG	Dates of Stations	Chief Scientist
===	=====	=====
PB1	17 Oct - 14 Dec 1988	R. Pritchard
PB1	15 Dec - 08 Jan 1989	J. Ardai
PB2	14 Jan - 01 Feb 1989	E. D'Asaro
PB3	09 Feb - 01 Mar 1989	O. Johannessen

The navigation available when this data set was assembled was the original navigation collected on the POLARBJORN by ERIM. Logging mistakes and gross navigational errors in station positions have been corrected using this raw navigation and the CTD log sheets. All station locations should be re-evaluated if the navigation is processed further.

Bottom depths for the hydrographic stations are from the ship-mounted echo sounder. The values are in uncorrected meters and should be used as estimates. When the echo sounder was inoperable the following alternative methods were used:

Leg	Stations	Source of Depth Data
----	-----	-----
PB1	1, 2	General Bathymetric Chart of the Oceans (GEBCO), 5th edition (corrected meters)
PB2	5-7	
PB1	60-104	ship's charts and winch wire counter
PB3	10, 11, 52, 45-60	ADCP

Raw CTD data were collected while the CTD unit was lowered (downtrace) and raised (uptrace). The data values presented here are from the downtrace except occasionally when the downtrace values were contaminated and unusable; in these cases the uptrace values were processed. At the following stations, uptrace data were used:

PB1	Stations 13,16,18,30,32,34,36,38,41,44,92,99
PB2	Stations 2,8,12,13,15-19,21,22,24,25,30,36,45,47
PB3	Stations 1,7,13,16-18,22,24,25,29,32,34,36,43

Note that uptrace data tend to be lower quality than downtrace data.

The instrument used to collect data was a Neil Brown IIIB CTD underwater unit, serial number 01-2276-01. The instrument was calibrated before the start of CEAREX on 22 March 1988 by the Naval Oceanographic Office. A total of 208 stations were collected between 10 October 1988 and 1 March 1989 (PB1-PB3). No post-cruise processing by the Naval Oceanographic Office was possible because of damage to the conductivity cell at the start of PB4. A post-cruise calibration of pressure only was run for the instrument on 22 August 1989 at Lamont-Doherty Geological Observatory.

Continuous cruise calibration of the conductivity cell was possible using Autosal salinity measurements from water samples collected by Niskin water bottles. The conductivity data were calibrated separately for each leg of the cruise. The reversing thermometers provided to calibrate the CTD thermometer were of poor quality and their results were not used in the temperature calibration. A total of 234 bottles were available for use with the 208 stations. The lack of bottle data has caused the calibration errors to be larger than is desirable. Data values within approximately five meters of the

surface are to be used with caution. The upper water layer was often contaminated by the ship. In some cases the surface values have been extrapolated to allow all stations to start at zero meters.

The final calibration results, with range, accuracy and resolution statistics supplied by the Neil Brown CTD, are as follows:

Sensor	Range	Accuracy	Resolution	StDev*
Pressure (db)	0 to 6500	0.1%**	0.0015%**	0.80
Temperature (deg C)	-3 to 32	0.005	0.0005	0.0039
Conductivity (mmohs)	1 to 65	0.005	0.001	PB1 = 0.0316
	1 to 65	0.005		PB2 = 0.0193
	1 to 65	0.005		PB3 = 0.0102

* StDev - Standard deviation of fit used for correction to calibration data.
 ** Values are in percent of frequency-shift.

Calibration Equations:

Pressure:

$$PR = (3.8 \times 10^{-9}) \times PR^{**3} - (1.154 \times 10^{-5}) \times PR^{**2} + 1.00834123 \times PR + .45067954$$

Temperature:

$$TE = .99996436 \times TE + .00133419$$

Conductivity:

PB1:

$$CO = .9858689 \times CO + (4.136 \times 10^{-5}) \times TE + .29824006$$

PB2:

$$CO = (8.7285 \times 10^{-4}) \times CO^{**2} + .94209108 \times CO + (4.136 \times 10^{-5}) \times TE + .94666183$$

PB3:

$$CO = (1.151 \times 10^{-5}) \times CO^{**3} - (1.01464 \times 10^{-3}) \times CO^{**2} + 1.0224569 \times CO + (4.136 \times 10^{-5}) \times TE - .07029152$$

The CTD data were processed at Lamont-Doherty Geological Observatory. All data were filtered with a median filter using a window of five scans after which the correction coefficients were applied for each sensor and a 0.25 second lag in temperature/pressure was applied to account for response time. The final data set was then averaged into one meter bins.

Time is in GMT; all latitudes are North; all longitudes are East. Temperature is in degrees Celsius; pressure is in decibars; salinity is in parts per thousand (PSS78 units); conductivity is in millimohs.

[Documentation text taken from O'Hara, 1990 "Coordinated Eastern Arctic Experiment (CEAREX) CTD Data for PB1, PB2 & PB3, October 17 1988 - March 1, 1989." Palisades, NY: Lamont-Doherty Geological Observatory.]

4. Physical Oceanography During the Bio-Physical Cruise (PB5)- T. Manley
 These data are in the CD-ROM subdirectory \HYDROG\BIOCTD.

4.1. CTD Data Processing - Tom Manley

Although this may appear to be a long document on how things were done, I would strongly recommend that you read it in its ENTIRETY. If you are knowledgeable about how the data were processed, you will better understand what can and can not be 'obtained' from the data set.

4.1.1. Contents of the Data Set

4.1.1.1. All of the CEAREX bio-ctd stations are labeled XXX.BIO, where XXX ranges from 002 to 212. Station 1 was not even considered since it was an exceptionally bad TEST station.

4.1.1.2. The updated edition (26 December 1989) of the tagfile is called TAGNEW.DAT. This file is on the CD-ROM with the pathname \HYDROG\BIOCTD\TAGNEW.DAT.

4.1.1.3. The file COMPAR.LOG was used as one of the quality control steps. This file may be of more use to you than TAGNEW.DAT in that it incorporates the final data and compares it with the record tag (bottle trip) information. COMPAR.LOG is on this CD-ROM with the pathname \HYDROG\BIOCTD\COMPAR.LOG.

4.1.1.4. A station listing file called BIOSTA.LOG that lists all of the positions and times of the stations, is more or less useful for quick reference. The file is on this CD-ROM with the pathname \HYDROG\BIOCTD\BIOSTA.LOG.

4.2. Documentation for Tom Manley's file COMPAR.LOG

The file COMPAR.LOG intercompares the trip log information (obtained as each bottle was tripped and reported in the file TAGNEW.DAT) and bottle salinities with that of the final processed CTD/fluorescence profiles. This file was used as a form of quality control on the final data and did indeed reveal important information for the user. The notes that follow are important to understanding and using the data.

4.2.1. Station 165 shows a trip-final temperature difference of 0.651 degrees C. This has NOT been modified for the following reasons. Although the original log sheet and the trip file do confirm the 1.88 degree C temperature, the uptrace file shows no indication of such temperatures. Looking at the original plot, it appears that the 1.8 degree C water is almost the last depth level plotted. All other temperatures shown in the original plot are in the 1.2 degree C range and agree with the Neil Brown final temperatures (NB_TE). This is not a confusion of stations since the profiles (original and final) match except for this upper level temperature of 1.8 degree C. I concede that the high temperature was there, however, it must obviously be slightly above where the uptrace profile was terminated by the software. Further, one may want to show how different the surface trips can be (perhaps due to the proximity of the ship and its engine coolant outlets, on the same side as was used to lower the CTD) by looking at station 168 results which had two duplicate trips at 2 db with differences between the RECORD_TAG information of 0.4 degree C!!!!

4.2.2. Stations 197 to 199 show the small but noticeable effect of a broken thermistor in the differences (DEL_TE) between the record tag observations (TF_TE) and the final data (NB_TE) when temperatures were positive. This resulted in an offset of about 0.08 degree C that was later corrected for in the final data.

4.2.3. When the thermistor was replaced after station 198, stations 199 to 212 show a rather obvious temperature mismatch of approximately 0.4 degree C between the record tag observations (TF_TE) and the final data (NB_TE) when temperatures were positive. These varying offsets were later corrected for in the final data.

4.3. Data Processing Steps

4.3.1. Downtrace processing was rejected due to too many unexplainable hysteresis problems between the down and up traces. Uptraces were chosen because they could be calibrated to much higher standards since bottles were taken on these profiles.

4.3.2. Bulk salinity calibration was abandoned because of strong variations between stations and because of the exceptional stability of the temperature-salinity curve generated using calibrated Neil Brown temperatures and BOTTLE salinities.

4.3.3. Temperature was entirely bulk-calibrated, since there was no direct evidence of time variation, except when the first response thermistor was replaced at station 197. A very small correction was used for stations 2 through 196.

4.3.4. Pressure calibration equations were generated for both uptrace and downtrace using a bulk processing method. However, pressure offsets were calculated individually for each station to get the best near surface information for the biological work as well as to provide the best intercomparison with the MER (G. Mitchell's bio-physical sensor; see BIOPHYS.DOC Section 6) observations. Station 196, due to its depth of approximately 2500 db, had its own pressure calibration.

4.3.5. University of Rhode Island (URI) provided a week of programming time and two weeks of microVAX time (at no cost) to reprocess all of the up and downtraces from the original digital data. The reprocessing included temperature and pressure calibrations. Salinity was then derived with the newly-calculated p, t and c. Nothing was done to fluorometry or conductivity.

4.3.6. Station 151 was re-derived from audio data and was later reprocessed by URI.

4.3.7. Processed uptraces were still quite noisy due to dragging instrumentation through the water column (i.e. the sensors reading some of the more nasty turbulent wake effects.) Filtering was done to smooth out these turbulent effects.

4.3.8. Both the top and bottom of the profiles were inspected to make sure that the data seemed reasonable. In several stations, a bad point was included that would make a mess of the filtering process. If bad data were observed, they were replaced with data along a similar trend using the original plotted data and the uptrace plot and/or, very rarely, the downtrace as a framework.

4.3.9. Two uptrace profiles were deemed unusable: station 117 and station 164. Station 127 had a repairable section of data missing and was salvaged using the downtrace information.

4.3.10. Initially, a median filter of 20 points and then a Gaussian filter of 30 points was used. This turned out to be too 'heavy-handed' and a better method of 4 successive 10-point Gaussian passes was used. Glen Cota and I agreed on this as the best compromise for fluorescence as well as CTD work. Additionally, this provided a reasonable fluorometry profile, as opposed to some of the original profiles that looked more like a 'shotgun' pattern. By the very nature of filtering, top and bottom parts of the profile (if in high gradient regions) will be off from the original characteristic conditions of the uptrace. Deviations of this kind were checked at the very end of the

processing phase of quality control using the COMPAR.LOG file (i.e. comparing final data against original record tag trips). Please read the introduction to the COMPAR.LOG file to get an appreciation for these errors (Section 4.2, above). In short, these errors were minimal especially compared to the variability of the data within the record tag file itself (see the FT_VAR column in the COMPAR.LOG file.) With respect to the other high gradient regions such as the thermo/halo/pycnoclines, there will be deviations. This is not totally desirable, however it was a trade-off that I was willing to make to get the hydrographic information into a more intelligible form. The deviations in the 'clines' can be also seen in the COMPAR.LOG file.

4.3.11. The correction of the 'broken thermistor' data at Stations 197 through 212 was completed.

4.3.12. T,S, density and FL profiles were plotted for all of the stations. Since many of the stations have very little density variation in them, inversions, obviously a major source of problems, were easily detected. Many of the inversions were created solely because of a temperature/conductivity lagging mismatch. We did not have time to investigate this at URI, so the data were processed using generic lagging concepts. The lagging mismatch, the noisy nature of the data, and the potential for bio-fouling (Phaeocystis) gumming up the conductivity cell in certain high biomass regions, lead me to believe that the density inversions were an artifact of the above-mentioned problems and therefore COULD NOT BE CONSIDERED AS REAL PHYSICAL PROCESSES occurring in the ocean. For this reason, all density inversions were removed BY HAND to ensure the proper gradient characteristics of the original density field were preserved.

4.3.13. A major problem was then discovered: There was an obvious and CONSISTENT density inversion (approximately 0.006 sigma-0 units) observed at the transition from positive to negative temperatures (i.e. at 0 degrees C.) This problem should have been detected at the beginning and corrected BEFORE all of the filtering since the 0 degree density shift was subsequently 'smeared' by the filtering process. Instead of starting from scratch, an attempt was made to fix the 'generic' problems with some creative software. Surprisingly, the program worked better than had been expected, and all of the stations were realigned. Only stations 2 through 196 were done this way. Stations 197 through 212 had already been (unwittingly) corrected for this problem since it had manifested itself to extreme proportions because of the broken thermistor. It should also be noted that the temperature error that caused this 0.006 density inversion problem was on the order of 0.005 degrees C, which upon recalculation of salinity and then density (like a positive feedback loop) caused the observed density problem. The opposite effect was also observed (i.e. - a positive increase in density of 0.006 during the transition from negative to positive temperatures). These were more difficult to find since this transition was typically masked by the high gradient in the thermocline/pycnocline but in several profiles where this was not the case, it was observable. All positive temperatures were too warm by 0.005 degree C so their salinity profiles, etc., were also off. The program took all this into account so that ALL of the profiles can be considered similar in their makeup.

4.3.14. After verification of acceptable density structure at both the top and bottom of the profile, three techniques were tried for salinity calibrations. These were: 1) calibrating the purely independent channel of conductivity through the bottle salinity; 2) calibrating salinity as a function of the bottle

salinity; 3) calibration of salinity as a function of pressure. Both 1 and 2 proved to be completely unsatisfactory while 3 proved to be the most acceptable. Additionally, the clean nature of the bottle salinity plotted against corrected Neil Brown temperature on a T-S curve gave exceptionally high credibility to the calibration of salinity on a per station basis. Of the DEEP bottles that fell off of the tight T-S curve, all had justification for being that way oceanographically (at virtually all points there was indication of deep water ventilation - chimneys, cold pool survey, and the like). So they remained as part of the calibration. Calibration for most of the stations was calculated using linear regression of the difference between the bottle salinity and the filtered and corrected Neil Brown data against their respective pressures, which of course provides a perfect fit given two x,y pairs. Only Station 196 had three salinity bottles taken. Using this station as a test case, a linear equation was generated with only the top and bottom information. The intermediate value was then solved for and compared with the actual value. The resulting error of 0.005 psu (see COMPAR.LOG Station 196 for this result) confirmed the linear method and additionally gave the best indication of accuracy of the data, this being less than 0.006 psu. Note that the 0.006 psu accuracy is ONLY for those stations that had both bottom and top bottle salinities available. About 82% of the data fall within these conditions. Those stations that have only one bottle or no bottles were provided extra information from the bounding stations (in time) to come up with the required equation. For those stations that had one bottle, accuracy is estimated to be on the order of 0.015 psu. For stations that had no bottles, accuracy would be on the order of 0.025 psu.

The stations that fall into the 0.015 psu accuracy are 19, 46, 47, 57, 73, 102, 105, 106, 107, 114, 127, 129, 152, 153, 154, 155, 156, 165, 168, 190, 195, 201, and 202.

The stations that fall into the 0.025 psu accuracy are 2, 3, 11, 15, 29, 30, 40, 49, 60, 67, 82, 92, 94, 103, and 104.

All remaining stations have the higher 0.006 psu accuracy.

4.3.15. After salinity calibration was applied, plots were then made to verify the validity of the equation for each station. Several stations were found to have bad (primarily surface) bottle data when compared to the bounding station information and were therefore discarded. New equations were then made and retried. This iterative method was only used on about 8 stations and each was correctly calibrated on the second pass.

4.3.16. All profiles went through visual editing to insure the removal of all density inversions. If I don't believe them, I won't let other people suffer through them! New salinities were then 'back-solved' from the corrected density and unaltered pressure and temperature values.

4.3.17. T-S plots of all of the stations proved to be another quality control technique. Station 212 was found to be in error serendipitously. An autosal typographical error was found that gave the low salinity that in turn made the delta S look like all of the other 'normal' stations. This was taken care of. Freezing temperature quality control also proved to be exceptionally useful in that no data values fell below the freezing point.

4.3.18. All of the station headers were redone to reflect the

start time and position of the uptrace (or downtrace where applicable.) This was done on the basis of the original log sheets. Uptrace position was defined to be the average of the beginning and ending latitude and longitude.

4.3.19. The COMPAR.LOG file was the last quality control check (see the file for details) which also turned up one station, or I should say the lack of one station, in error. Station 151 was actually Station 150! Since Station 151 was the audio tape station and was difficult to get reprocessed (and I didn't want to hold the data back any more - at least not for one station), I decided to use the downtrace version and apply salinity calibration to the data based on the uptrace tag file information. This also proved to be acceptable. As it turns out, Station 151 did not have that large a deviation from the uptrace.

4.3.20. The parameters of potential temperature and dynamic height were added to each station.

4.3.21. The station file headers are explained below. The example shown here is for Station 002.BIO, with the actual data values at the beginning of the station given in the example.

```
CPB32  2  2  78.5403  9.3690 89/04/10 100 12:29  PB5
PR      TE      SA      FL      PT      S0      HZ
7.0     0.140    34.214   1.206   0.140   27.464   0.004
8.0     0.145    34.216   1.271   0.145   27.466   0.005
9.0     0.150    34.218   1.339   0.150   27.467   0.005
```

The first line (a traditional file header) can be broken down as:

```
CPB32  - ship id code
2      - station number
2      - uptrace cast used; if value is 1, a downtrace was
        used
78.5403 - decimal latitude
9.3690  - decimal longitude (East is positive, West is
        negative)
89/04/10 - year/month/day
100     - relative Julian day (year-day)
12:29   - recorded log sheet time at beginning of uptrace or
        downtrace
PB5     - CEAREX cruise number id for the bio/phys/oceanog
        phase.
```

The second line (data column headers) can be broken down as:

```
PR - pressure in db
TE - temperature in degrees C
SA - salinity in psu
FL - uncalibrated, but very close to correct, according to
    Glen Cota; units are mg/l
PT - potential temperature in degrees C
S0 - Sigma-0 or potential density
HZ - dynamic height anomaly in dyn. m. using the surface (0 db)
    as the reference level; the first value in the data (if not
    at 0 db) is used to represent the surface parameters.
```

4.4. Conclusion

Time, and use of the data, will find any remaining errors. Please let me [T. Manley] know of any problems that are encountered so they can be investigated and corrected in later versions of the data set.

5. Oceanography Camp (O Camp) Daily CTD Casts - J. Morison, R. Andersen
These data are in the CD-ROM subdirectory \HYDROG\OCAMP.

At O Camp during CEAREX 1989, a yoyo CTD system was cycled nearly continuously down to 400 meters. Typically a single cast was made each day to 600 meters. Near the very end, the continuous yoyo-ing went deeper than 400 meters.

Plots of individual daily deep casts, Day 088 - Day 117, are shown in a printed data report, "CEAREX 89 O-Camp Daily CTD Casts" (Morison, J. and R. Anderson, 1990, Seattle: University of Washington, Polar Science Center, 32 pp.) available from the authors at the address given in Section 12, "Contact Information". The plots offer a quick summary of the state of the water column during the experimental period.

The plots show down casts. The alignment of temperature and conductivity sensors is adjusted to minimize salinity spiking and a correction for the thermal anomaly of the conductivity cell is applied, then the data are averaged into one-meter bins.

Data obtained from a helicopter (cruise designator CX3) were obtained using a SeaBird model SBE/11 CTD system which had a pumped conductivity cell and was not subject to salinity spiking. The CX3 data is a small subset of the total volume of CTD data obtained from O-Camp, and is integrated with that data in the subdirectory \HYDROG\OCAMP.

Data are described in the following publications:

Muench, R.D.; M.G. McPhee; C.A. Paulson; and J.H. Morison (1991) Winter oceanographic conditions in the Fram Strait-Yermak Plateau region. Journal of Geophysical Research, submitted April 1991.

6. Helicopter and Acoustics Camp (A-Camp) CTD Data - R. Muench
These data are on the CD-ROM in the files \HYDROG\HELO\CX2HELO.CTD and \HYDROG\HELO\ICEHELO.CTD.

The CTD data on this CD-ROM were acquired from a drifting ice camp (A-Camp) and from a helicopter which was also based out of the ice camps. The CTD data from the A-Camp (cruise designator ICE) and from the helicopter (cruise designator CX2) were obtained using SeaCat portable, self-contained CTD systems. Some salinity spiking was encountered with the SeaCat systems in regions of strong vertical T gradient, and this was most pronounced in portions of the A-Camp data (cruise ICE), where lowering rates were maintained at 0.5 m/s (a slow rate) in an effort to minimize the problem. Each of the CTD systems was calibrated prior to and following the field program.

Two SeaCats used at the A-Camp (ICE) were intercalibrated through simultaneous casts during the program, though loss of one of the two instruments precluded such intercalibration later in the program. The helicopter-borne SeaCat (CX2) systems were intercalibrated periodically at the O-Camp. Except where severe spiking was present, accuracy of the observations is +/- 0.01 degree C in T and 0.02 psu in salinity.

The helicopter CTD data are described in the following journal article:

Muench, R.D.; M.G. McPhee; C.A. Paulson; and J.H. Morison (1991) Winter oceanographic conditions in the Fram Strait-Yermak Plateau region. Journal of Geophysical Research, submitted April 1991.

7. Seasonal Ice Zone Experiment (SIZEX 89) - O.M. Johannessen
These data are in the CD-ROM subdirectory \HYDROG\SIZEX.

7.1. Introduction

SIZEX 89 (The Seasonal Ice Zone Experiment 1989) is an official pre-ERS-1 program where the main objective is to perform ERS-1 type sensor signature studies of different ice types in order to develop SAR algorithms for ice variables such as ice types, ice concentration and ice kinematics. When ERS-1 is launched, these variables in conjunction with other atmospheric and oceanic variables will be used as input to a mesoscale coupled ice-ocean forecasting model for the Barents Sea, Fram Strait and Greenland Sea. Furthermore the long term objective is to use radar satellites such as ERS-1 and the planned Polar Platforms to monitor the global ice cover as a climate indicator. The SIZEX program consists of pre- and post-launch experiments. The 1987 and 1989 experiments were pre-launch, while a post-launch experiment is planned for 1992. The main objective of the program can be separated into three groups:

- 1: Remote sensing science
- 2: Geophysical science
- 3: Application of remote sensing data in process studies and ice forecasting.

SIZEX 89 was a multidisciplinary, international winter experiment carried out in the Barents Sea and the Greenland Sea in February and March 1989. During the field experiment remote sensing, oceanographical, ocean acoustical, meteorological, and sea ice data were collected. SIZEX is a continuation of the MIZEX summer experiments in 1983 and 1984 (O.M. Johannessen, 1987, "Introduction: Summer marginal ice zone experiments during 1983 and 1984 in Fram Strait and the Greenland Sea", JGR 92(C7), p. 6716-6718) and the winter experiment in 1987 (MIZEX Group, 1989, "MIZEX East 1987. Winter marginal ice zone program in the Fram Strait and Greenland Sea", EOS, 70(17), p. 545-555). All these experiments employed various observational platforms such as ice-strengthened ships, open ocean ships, drifting buoys, bottom-moored buoys, helicopter, aircraft and satellites.

7.2. R/V "POLARBJORN" Operations

On 8 February at 2300 Z the POLARBJORN departed Tromso heading towards the Barents Sea. Between Fugloya and Bjornoya 12 CTD stations were obtained. The ice edge east of Bjornoya was encountered on 11 February when one acoustic buoy was deployed in ice-covered area at 75 degrees 04 minutes N, 23 degrees 00 minutes E. The next day one current meter rig and a second acoustic buoy were deployed in open water at 74 degrees 57 minutes N, 29 degrees 15 minutes E. Then the POLARBJORN headed northeastward towards the Hopen area.

Between 13-15 February a total of ten Argos buoys were deployed on ice floes in an area of approximately 100 by 100 km. Five of these buoys were toroids with current meter strings. The deployment area west of Hopen was selected because the expected drift of the array was southwestward towards Bjornoya where the array could be recovered later. In this period the ship had to plow through fairly heavy ice, much of it was multiyear up to 4-5 m thick, and she could move only a few miles per day. Weather conditions were good with 4-6 hours daylight and the helicopter could be used almost every day for ice reconnaissance and buoy deployment.

Between 17-24 February the ship drifted southwestward with the packice, or moved only slightly, while the different groups collected data. Every time the ship was towed to a floe, radar and in situ measurements of snow and ice were made, sessions of ADCP data and wave data were obtained, and vertical and horizontal acoustic arrays were deployed. Ice photographs were obtained using helicopter, and other in situ measurements for SAR calibration were carefully coordinated with the SAR flights. Sonobuoy deployments were also coordinated with the two Norwegian P3 flights from Andoya on 18 and 27 February. One iceberg, which was approximately 200 by 100 m large and grounded at 50 m depth, was visited for in situ measurements.

Meteorological and remote sensing data were collected regularly throughout the experiment.

From 24-27 February all the toroids were recovered, partly by use of helicopter since the ship could make only slow progress in the packice. Three small Argos buoys were left in the area to continue monitoring of the ice drift. On 27 February wave/acoustic studies had first priority with one dedicated SAR flight, deployment of a vertical acoustic array and a wave buoy near open water.

Barents Sea operations had been very successful; in ice-covered areas the weather was very good most of the time, all important instruments were recovered, and a lot of interesting data were collected. Entertainment was provided by polar bears almost daily, and at the end of the experiment Bjornoya was called. In the morning of 4 March the POLARBJORN arrived in Tromso.

After repair in a shipyard in Harstad and a cargo outhaul to Longyearbyen, the POLARBJORN was ready for the Greenland Sea operations. On 11 March she left Longyearbyen and headed southwestward to occupy deep CTDs in the acoustic tomography array in the Greenland Basin in cooperation with the HAKON MOSBY. Between 13-16 March only four deep CTD casts were obtained in this area because there were problems with both the winch and the CTD sonde. We had to call the HAKON MOSBY for technical assistance before the program could be continued.

Between 17-28 March the weather conditions were quiet and operations were carried out in the Boreas Basin at about 78 degrees N. The CTD system functioned normally after the repair and 70 CTD stations were obtained in this period. Only two toroid buoys with current meters and four other Argos buoys were deployed. Emphasis was put on the study of eddies, deep convection and chimneys using the CTD and water samples. Therefore less time was spent on buoy deployment and more on CTD work compared to the Barents Sea. Meteorological and remote sensing data were collected regularly, and snow/ice measurements and acoustic data were obtained in between the CTD casts. A dedicated acoustic experiment was carried out on 27-28 March. Seven SAR flights over the area by NADC P-3 were completed in this period.

From 28 March to 1 April weather conditions changed from moderate to rough, since two moderate strong storms passed the area. Of highest priority in this period was the recovery of the last toroid, 5064, which had five current meters and one thermistor chain. It had been deployed from a multiyear floe at about 78 degrees 25 minutes N, and during a seven day period it drifted southward with the East Greenland current. Fortunately, the toroid survived the storms and was successfully recovered at 76 degrees 30 minutes N on 31 March. After one more deep CTD cast in the Greenland Basin the POLARBJORN headed back to Tromso where she arrived on 2 April.

Two of the drifting Argos buoys were caught by eddies and circulated in the Boreas Basin for about three weeks after the ship had left the area. One buoy drifted south to about 73 degrees N where data transmission stopped on 18 May.

The Greenland Sea leg was successfully completed, with a lot of interesting data. Both ice conditions, ocean conditions and weather are different in the Greenland Sea compared to the Barents Sea. Therefore the data sets from these two areas complement each other.

7.3 CTD and Seasoar Program

In the Barents Sea a total of 55 CTD stations were completed. The water masses in the shallow area between Bjornoya and Hopen (40-60m depth) are dominated by homogeneous cold polar water with temperature around -1.8 degrees C and salinity of 34.7 parts per thousand. In the western part of the experiment area some intrusion of warm and saltier Atlantic water below

50 m was observed. In the Greenland Sea 75 CTD stations were obtained, 13 of which were deeper than 2000 m. The deep CTD casts were made in cooperation with the HAKON MOSBY to study deep convection and bottom water formation. The shallow casts (500m) were made to map eddies and upper ocean chimneys in the Boreas Basin. [Johannessen, O.M., et al., 1991, "Eddy-related winter convection in the Boreas Basin", In Deep Convection and Deep Water Formation in the Oceans, ed. by J.-C. Gascard, et al., Elsevier pp. 87-105].

7.3.1 Data Report

Nansen Remote Sensing Center plans to produce a data report on the CTD and Seasoar data sets. Inquire for availability at the address shown in Section 13, "Contact Information".

[Documentation text taken from Johannessen and Sandven, "SIZEX 89: A Prelaunch ERS-1 Experiment. Experiment Report". Nansen Remote Sensing Center. Technical Report no. 23, 1989.]

8. EUBEX CTD documentation - R. Perkin

These data are in the CD-ROM subdirectory \HYDROG\EUBEX.

The 37 EUBEX (Eurasian Basin Experiment) CTD stations included in the file EUBEX.CTD on this CD-ROM were taken near Spitsbergen, during the period 8 March - 17 April 1981. The surveys were conducted using aircraft and from the sea ice surface, and extended down to 1 km where the water was deep enough to allow this. There are no data for stations 3503 or 3506. The following table provides location information for each of the stations:

Area	Stn	Lat		Lon		Date			Max-P	Tch-P	Instr	Consec	
		Deg	Min	Deg	Min	Yr	Mo	Dy					Hr
SPITSBERGEN	404	80	19.20	29	27.30	81	3	15	12	244.	237.X	XCTD	3504
SPITSBERGEN	407	78	33.60	16	36.40	81	3	15	15	109.	104.X	XCTD	3505
SPITSBERGEN	316	81	41.30	23	18.90	81	3	21	12	1002.	-999.X	XCTD	3507
SPITSBERGEN	211	83	30.00	13	.40	81	3	23	15	998.	-999.X	XCTD	3508
SPITSBERGEN	206	84	.10	1	31.50	81	2	24	15	1001.	-999.X	XCTD	3509
SPITSBERGEN	207	83	46.40	3	32.10	81	3	24	16	1002.	-999.X	XCTD	3510
SPITSBERGEN	215	81	25.50	16	30.50	81	3	25	11	1002.	-999.X	XCTD	3511
SPITSBERGEN	213	81	47.00	14	40.10	81	3	25	12	1006.	-999.X	XCTD	3512
SPITSBERGEN	212	82	16.90	13	2.20	81	3	25	14	1004.	-999.X	XCTD	3513
SPITSBERGEN	208	83	27.90	5	57.10	81	3	25	17	1004.	-999.X	XCTD	3514
SPITSBERGEN	210	82	39.20	11	29.50	81	3	26	10	1003.	-999.X	XCTD	3515
SPITSBERGEN	209	82	58.70	8	42.80	81	3	26	12	1003.	-999.X	XCTD	3516
SPITSBERGEN	308	84	29.10	17	12.70	81	3	26	15	1004.	-999.X	XCTD	3517
SPITSBERGEN	309	84	6.50	17	34.00	81	3	26	16	1004.	-999.X	XCTD	3518
SPITSBERGEN	315	81	59.60	22	49.20	81	3	27	11	1004.	-999.X	XCTD	3519
SPITSBERGEN	314	82	23.00	23	.00	81	3	27	12	1004.	-999.X	XCTD	3520
SPITSBERGEN	313	82	40.40	21	45.80	81	3	27	14	1004.	-999.X	XCTD	3521
SPITSBERGEN	310	83	41.60	18	49.40	81	3	27	17	727.	-999.X	XCTD	3522
SPITSBERGEN	516	81	59.50	31	40.30	81	3	28	11	1048.	-999.X	XCTD	3523
SPITSBERGEN	311	83	22.00	19	57.00	81	3	28	13	1003.	-999.X	XCTD	3524
SPITSBERGEN	512	83	24.50	30	42.30	81	3	28	16	1007.	-999.X	XCTD	3525
SPITSBERGEN	514	82	44.80	31	58.20	81	3	29	11	1004.	-999.X	XCTD	3526
SPITSBERGEN	312	83	9.90	19	35.70	81	3	29	13	1004.	-999.X	XCTD	3527
SPITSBERGEN	517	81	41.40	32	57.20	81	3	30	16	1003.	-999.X	XCTD	3528
SPITSBERGEN	401	81	15.90	29	22.40	81	3	31	11	331.	320.X	XCTD	3529
SPITSBERGEN	317	81	22.30	24	45.00	81	3	31	12	136.	125.X	XCTD	3530
SPITSBERGEN	211	83	9.80	12	17.40	81	3	31	17	106.	-999.X	XCTD	3531
SPITSBERGEN	508	84	33.50	30	44.30	81	4	1	13	1004.	-999.X	XCTD	3532
SPITSBERGEN	402	80	43.70	28	43.50	81	4	4	11	395.	-999.X	XCTD	3533
SPITSBERGEN	216	81	5.60	16	28.60	81	4	12	10	999.	-999.X	XCTD	3534
SPITSBERGEN	702	77	49.20	15	27.20	81	4	14	9	87.	75.X	XCTD	3535
SPITSBERGEN	701	77	51.30	16	40.60	81	4	14	10	68.	56.X	XCTD	3536
SPITSBERGEN	703	77	47.50	15	8.30	81	4	14	11	112.	99.X	XCTD	3537

SPITSBERGEN 105 80 33.10 0 .10 81 4 17 11 1010. -999.X XCTD 3538

Three CTD casts taken off Greenland by Knut Aagaard are also included, in the file GREEN.CTD.

See Lewis and Perkin, "Supercooling and energy exchange near the Arctic Ocean surface," JGR, 88(C12), p. 7681-7685, 1983, and Perkin and Lewis, "Mixing in the West Spitsbergen Current," Journal of Physical Oceanography, 14(8), p. 1315-1325, 1984 for more complete information on the EUBEX CTD data.

9. The Fram Strait 11-Year CTD Data Base - T. Manley, R. Bourke and K. Hunkins. These data are in the CD-ROM subdirectory \HYDROG\FRAM.

9.1. Abstract

Using hydrographic data collected over an 11-year period, a view of the circulation pattern existing in the upper 40 meters over the Yermak Plateau of northern Fram Strait is presented. Past work has indicated that the primary influx of Atlantic water into the central Arctic Ocean is accomplished via a single narrow current that borders the northern coast of Svalbard. Volumetric analysis of the available hydrographic data has shown the presence of a shallow, previously undocumented plume of Atlantic-derived water entering the Arctic Ocean directly over the Litke Trough. This plume represents one part of a large, near-surface (predominant in the upper 20 m) mushroom-shaped salinity-defined dipole structure that has a lateral extent of some 450 km. The eastern vortex of this dipole is poorly documented due to a lack of data-coverage, but the better documented western limb of the dipole, which is the central topic of this paper, represents a recirculated filament of modified Atlantic water that moves cyclonically around the periphery of the Yermak Plateau. T-S analysis of the original data and the use of a simplified model depicting the evolving T-S properties of Atlantic water as it interacts with the atmosphere and ice cover support this view. Additionally, over the larger-scale distribution fields of salinity (which primarily defines density) and dynamic height, a well defined front in both salinity and dynamic height is observed 200-500 km north of Svalbard trending east northeast.

[Abstract from Manley, Bourke and Hunkins, 1991, "Near-surface circulation over the Yermak Plateau in Northern Fram Strait." The data set presented here is the basis for this paper.]

9.2. Data Base Description

All readily available hydrographic information obtained from STD or CTD profiling instruments north of 76 degrees North and within the region of Fram Strait were combined into a single data base comprising 4,114 stations. Bottle data available from earlier cruises within this region, although gathered into a separate data base, were not used because of the large vertical spacing between samples and the initial requirement that the data base provide a vertical resolution on the order of 5 m. Table 1 lists the 26 experiments spanning 11 years (1977-1987) whose data have been collected into this data base. Primarily, the data base is comprised of spring, summer and fall measurements although there are three experiments (POLARCIRCLE 1977, HUDSON 1982 and MIZEX 1987) that do provide wintertime observations.

TABLE 1 - Data Base Contents (In Chronological Order)

Filename	Experiment	Platform	Stations	Dates
=====	=====	=====	=====	=====
SVALB77.JMS	--	POLARCIRCLE	123	20 Nov - 5 Dec 1977
NORSEX79.JMS	NORSEX	POLARCIRCLE	238	17 Sep - 4 Oct 1979
ODEC79.JMS	Fram-I	helicopter	100	24 Mar - 1 May 1979
FRAM79.JMS	Fram-I	ice-camp	88	29 Mar - 6 May 1979
WWIND79.JMS	--	WESTWIND	154	19 Aug - 25 Sep 1979
YMER80.JMS	--	YMER	113	13 Aug - 19 Sep 1980
EUBEX81.JMS	EUBEX	Twin Otter	34	15 Mar - 17 Apr 1981
FRAM81.JMS	Fram-III	ice-camp/helo	191	30 Mar - 7 May 1981
NWIND81.JMS	MIZLANT	NORTHWIND	114	18 Oct - 15 Nov 1981
LANCE81.JMS	--	LANCE	63	28 Jul - 12 Aug 1981
METEOR82.JMS		METEOR	19	19 Jun - 23 Jun 1982
HUDSON82.JMS	--	HUDSON	32	5 Mar - 15 Mar 1982
LANCE82.JMS	--	LANCE	97	19 Jul - 3 Aug 1982
PBJORN83.JMS	MIZEX-83	POLARBJORN	225	19 Jun - 9 Jul 1983
MIZEX83.JMS	MIZEX-83	helicopter	119	21 Jun - 31 Jul 1983
LANCE83.JMS	--	LANCE	61	21 Jul - 31 Jul 1983
LYNCH84.JMS	MIZEX-84	LYNCH	26	21 May - 21 Jun 1984
HMOBY84.JMS	MIZEX-84	HAKON MOSBY	449	17 Jun - 17 Jul 1984
KBJORN84.JMS	MIZEX-84	KVITBJORN	309	12 Jun - 22 Jul 1984
NWIND84.JMS	MIZLANT	NORTHWIND	313	22 Aug - 15 Sep 1984
QUEEN84.JMS	MIZEX-84	POLARQUEEN	46	12 Jun - 17 Jul 1984
PSTERN05.JMS	MIZEX-84	POLARSTERN	170	15 Jun - 18 Jul 1984
PSTERN07.JMS	Arktis 7/84	POLARSTERN	33	20 Jul - 5 Aug 1984
MIZEX84.JMS	MIZEX-84	helicopter	222	12 Jun - 17 Jul 1984
NWIND85.JMS	MIZLANT	NORTHWIND	147	5 Aug - 26 Sep 1985
HMOBY87.JMS	MIZEX-87	HAKON MOSBY	628	27 Mar - 9 Apr 1987

9.3. Data Format Description

The 26 files in the CD-ROM directory \HYDROG\FRAM are named *.jms, where * represents the name and year of the platform, and jms tags the files as relating to Manley, Bourke and Hunkins in the *Journal of Marine Systems* 3 (March 1992): 107-125. In some cases, the name and year of the experiment was used instead to avoid duplicate filenames. The files are in the "s87" standard CTD data format, having 64 character records.

Table 2 presents the filenames and the associated "Cruise_id" value found in positions 54-62 of each file's header records. See Section 2 of this file for a complete description of the "s87" standard CTD data format, developed at Lamont-Doherty Geological Observatory, and in which format all the CTD files on this CD-ROM are presented.

TABLE 2 - Filenames (In CD-ROM Directory Order) With Associated Cruise_id

Filename	Cruise_id	Dates
=====	=====	=====
EUBEX81.JMS	Eubex-81	15 Mar - 17 Apr 1981
FRAM79.JMS	Fram1-79	29 Mar - 6 May 1979
FRAM81.JMS	Fram3-81	30 Mar - 7 May 1981
HMOBY84.JMS	Hknmosby	17 Jun - 17 Jul 1984
HMOBY87.JMS	Mizex-87	27 Mar - 9 Apr 1987
HUDSON82.JMS	Hudson-82	5 Mar - 15 Mar 1982
KBJORN84.JMS	Kvtbjorn	12 Jun - 22 Jul 1984
LANCE81.JMS	Lance-81	28 Jul - 12 Aug 1981
LANCE82.JMS	Lance-82	19 Jul - 3 Aug 1982
LANCE83.JMS	Lance-83	21 Jul - 31 Jul 1983
LYNCH84.JMS	Lynch-84	21 May - 21 Jun 1984
METEOR82.JMS	Meteor-82	19 Jun - 23 Jun 1982
MIZEX83.JMS	Mizex-83	21 Jun - 31 Jul 1983
MIZEX84.JMS	Mizex-84	12 Jun - 17 Jul 1984
NORSEX79.JMS	Norsx-79	17 Sep - 4 Oct 1979
NWIND81.JMS	Nwind-81	18 Oct - 15 Nov 1981
NWIND84.JMS	Nwind-84	22 Aug - 15 Sep 1984
NWIND85.JMS	Nwind-85	5 Aug - 26 Sep 1985
ODEC79.JMS	Odec-Fr1	24 Mar - 1 May 1979
PBJORN83.JMS	Plrbjorn	19 Jun - 9 Jul 1983
PSTERN05.JMS	Ps-05-84	15 Jun - 18 Jul 1984
PSTERN07.JMS	Ps-07-84	20 Jul - 5 Aug 1984
QUEEN84.JMS	Queen-84	12 Jun - 17 Jul 1984
SVALB77.JMS	Svalb-77	20 Nov - 5 Dec 1977
WWIND79.JMS	Westwind	19 Aug - 25 Sep 1979
YMER80.JMS	Ymer1980	13 Aug - 19 Sep 1980

9.4. Data Processing Description

Due to the predominance of interleaving of the various water masses within this region, virtually all of the profiles displayed density inversions and spiking over a rather wide range of amplitudes (1 - 10 m). In that these characteristics were undesirable for the intended use of the data, a variable-knot cubic-spline smoothing algorithm was used to remove all density inversions and spikes from the data while still preserving structure having vertical amplitudes greater than 20 m. This algorithm consecutively fit a series of cubic splines with continuous first and second derivatives over the entire profile. More splines were used at the beginning of the profile to insure better fit of the thermal layering. Subsequent verification procedures were incorporated into the processing to insure a closeness of fit to the original profile and to insure that no inversions were present. Additionally, the mixed layer was removed from the smoothing process since it was important that the data maintain the original observational values as well as prevent the modification (smearing) of the base of the mixed layer. Data were subsampled every 5 m and then truncated at a maximum depth of 800 m to produce the final data set. The accuracy of the data varies with experimental program and the types of sensors used, but for the data set as a whole, the accuracy estimates are +/- 0.02 degree C and +/- 0.02 PSU for temperature and salinity, respectively. Residual (smoothed - original) standard-errors were used as an indication of the quality of fit between the smoothed and original profiles of temperature, salinity and density. Less than 10% of the station data had residuals greater than +/- 0.01, but they were still within the limits of the dataset reliability (i.e., +/- 0.02).

9.5. Reference

Manley, T.O., R.H. Bourke, and K.L. Hunkins. "Near-surface circulation over the Yermak Plateau in northern Fram Strait," *Journal of Marine Systems* (1992).

10. Bottle and Ship Data - J. Swift

10.1. Bottle Data

These data are in the CD-ROM subdirectory \HYDROG\BOTTLE.

The bottle data stations in the file BOTTLE.DAT were obtained by searching a copy of the NOAA/National Oceanographic Data Center (NODC) data base, June 1990 version, held by Joe Reid. The search was performed using the following coincident criteria:

- maximum observed (sampling) depths greater than or equal to 200 meters;
- latitudes above 80 N, or latitudes between 70 N and 80 N with longitudes between 120 W and 180 or 180 and 100 E;
- both temperature and salinity data at the same station;
- salinity values reported to at least two decimal places.

The search resulted in 1549 stations. No quality control measures were applied to the data after selection. The original investigators' and/or institutions' quality control measures are documented at NODC. Examination of the data shows very few stations with the quality, resolution, or range of parameters expected from modern observations.

10.2. Ship Data

These data are in the CD-ROM subdirectory \HYDROG\SHIP.

The ship data files are a special merged data set of 300 Norwegian Sea and Greenland Sea stations from 1980-1984, having relatively good data quality. Cruises included on the CD-ROM are the YMER 1980 Fram Strait and northern Barents Sea slope expedition, the KNORR 1981 expedition for the North Atlantic Study of the Transient Tracers in the Ocean (TTO-NAS), the HUDSON 1982 winter expedition, the METEOR 1982 spring expedition, and the POLARSTERN 1984 post-MIZEX expedition in and near Fram Strait.

Data are in five files: HUDSON.CTD, KNORR.CTD, METEOR.CTD, STERN.CTD (POLARSTERN data), and YMER.CTD. When there was overlap among stations, HUDSON data were used. All station times are missing from the data files. The ship code for the KNORR is 5N instead of 6N as shown in the NODC ship code list.

11. References

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O'Hara, S.H. (1990) Coordinated Eastern Arctic Experiment (CEAREX) CTD Data for PB1, PB2 & PB3, October 17, 1988 - March 1, 1989. Palisades, NY: Lamont-Doherty Geological Observatory, unpagged. [LAMONT]

Perkin, R.G. and E.L. Lewis. 1984. Mixing in the West Spitsbergen Current. *Journal of Physical Oceanography* 14: 1315-1325. [EUBEX]

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August 1991

APPENDIX E – HYDROGRAPHY CTD ERRORS

Errors associated with CTD data are identified below. Duplications of depth readings and missing header line spaces caused the errors in the hydrography data files, which are in the /HYDROG subdirectory.

The following files contain profiles with first header lines that are missing a space. This results in an error when trying to read in date and position of profiles.

File Name	Profiles with Missing Space
BOTTLE/BOTTLE.DAT	527
SHIP/HUDSON.CTD	129
SHIP/KNORR.CTD	13
SHIP/METEOR.CTD	106
SHIP/STERN.CTD	32
SHIP/YMER.CTD	20

The following profiles contain duplications of depth readings or (in one case) depth inversions. Because the list contains the actual depths and profile numbers of the errors, it can be used to pinpoint the errors.

File: BOTTLE/BOTTLE.DAT
 Profile: 677
 Readings 7 and 8 are both 100 meters

File: EUBEX/EUBEX.CTD
 Profile: 18
 Readings 500 and 501 are both 1004 m

File: FRAM/EUBEX81.JMS
 Profile: 6
 Readings 2 and 3 are both 5 m

File: FRAM/EUBEX81.JMS
 Profile: 7
 Readings 2 and 3 are both 5 m

File: HELO/ICEHELO.CTD
 Profile: 13
 Readings 12 and 13 are both 13 m

File: HELO/ICEHELO.CTD
 Profile: 13
 Readings 13 and 14 are both 14 m

File: HELO/ICEHELO.CTD
 Profile: 13
 Readings 14 and 15 are both 15 m

File: HELO/ICEHELO.CTD
 Profile: 13
 Readings 15 and 16 are both 16 m

File: HELO/ICEHELO.CTD
 Profile: 13
 Readings 16 and 17 are both 17 m

File: HELO/ICEHELO.CTD
Profile: 13
Readings 17 and 18 are both 18 m

File: HELO/ICEHELO.CTD
Profile: 13
Readings 18 and 19 are both 19 m

File: HELO/ICEHELO.CTD
Profile: 13
Readings 19 and 20 are both 20 m

File: HELO/ICEHELO.CTD
Profile: 13
Readings 20 and 21 are both 21 m

File: HELO/ICEHELO.CTD
Profile: 13
Readings 21 and 22 are both 22 m

File: HELO/ICEHELO.CTD
Profile: 13
Readings 22 and 23 are both 23 m

File: HELO/ICEHELO.CTD
Profile: 13
Readings 23 and 24 are both 24 m

File: HELO/ICEHELO.CTD
Profile: 13
Readings 24 and 25 are both 25 m

File: HELO/ICEHELO.CTD

APPENDIX F – METEOROLOGY DATA

The CEAREX meteorology data include surface data and rawinsonde profile data obtained during CEAREX and three Marginal Ice Zone Experiment (MIZEX) components, and from ship platforms and ice floe stations.

Data Description:

Near-surface (also called surface) time series data and rawinsonde (also called upper-air or sounding) profiles data are included on the CEAREX CD-ROM. For both data types, wind, pressure, temperature, and humidity data were collected during CEAREX and three components of the Marginal Ice Zone Experiment (MIZEX), which all took place during various seasons in the seas around the Svalbard archipelago.

MIZEX-83 Data

The MIZEX-83 data files contain values of surface meteorological parameters from the POLARBJORN. Data collection began when the ship left the port of Tromso on July 14, 1983. With the exception of two breaks, the ship operated within the marginal ice zone from July 18 through July 30. From June 27 to July 8, the POLARBJORN remained moored to the same large floe. After July 13, the ship made stops at six ice floes for periods of several hours. The rest of the time the ship was usually in motion or undertaking oceanographic conductivity-temperature-depth (CTD) measurements.

MIZEX-84 Data

The MIZEX-84 meteorological program was much more extensive than MIZEX-83. During the summer of 1984, surface and upper-air data were obtained using four ships. The field program commenced on June 3 when the ice-strengthened POLAR QUEEN left port and was completed on July 21. The POLAR QUEEN was usually within the ice pack, tens of kilometers from the edge. The normal-hulled HAAKON MOSBY generally remained a few kilometers seaward of the ice edge. The normal-hulled VALDIVIA operated in the open ocean, usually tens of kilometers from the edge. The ice-breaker POLARSTERN operated deep within the pack ice, along the ice edge and in the open ocean. From July 9 through 13, there was intensive meteorological measurement activity and rawinsondes were launched every three hours from each ship. The ships remained in the same position to form a diamond-shaped pattern across the ice edge during this period.

MIZEX-87 Data

MIZEX-87 was the third and final of the MIZEX experiments. The field program occurred March 19 to April 9 in the Greenland Sea and from April 10 to April 11 in the Barents Sea

near Bear Island. Surface and upper-air data were obtained from three ships. The ice-strengthened POLAR CIRCLE was usually within the ice a few kilometers from the ice edge. The HAAKON MOSBY operated just seaward of the ice edge. The VALDIVIA operated in the open ocean near the ice edge to tens of kilometers from the edge.

CEAREX Data

CEAREX began with the drift of the R/V POLARBJORN on September 17, 1988 and ended on May 19, 1989. In addition to the POLARBJORN, the R/V HAAKON MOSBY and two ice camps were also used to collect meteorological data. The CEAREX field program consisted of three phases:

- the Drift Phase
- the Whaler's Bay/SIZEX Phase
- a Camp Operations Phase

Data Acquisition

The accuracies noted in this section represent 95 percent confidence intervals based on manufacturer's claims, field experience, and knowledge of instrument location. In general, the instrument sensitivity was at least one order of magnitude greater than the accuracy. Although considerable effort was made to remove erroneous data, a few bad data points likely remain.

Platform movement was vector subtracted from the measured wind velocity (relative wind) to give the true wind speed and direction. The velocities of the ship platforms were determined from bridge heading and speed instruments.

MIZEX-83 Measurements

During MIZEX-83, both surface data and upper-air measurements were taken from the POLARBJORN.

Surface Measurements

The surface data represent averages from consecutive ten-minute periods. The instruments were located on a bow mast, 16 meters above sea level. The relative wind speed and direction were measured with a cup anemometer and a vane. Temperature was obtained from an aspirated, radiation-shielded, platinum-resistance thermometer (PRT). Humidity was obtained from a cooled-mirror hygrometer. Pressure was not measured.

The temperature was accurate to within 0.5 degrees C and the humidity to within 3 percent relative humidity. Wind speed and direction were usually accurate to 0.3 m/s and 10 degrees respectively.

There were some brief periods when the wind measurements were less accurate because of ship-induced air flow distortion.

Upper-air Measurements

Rawinsonde measurements were obtained and are summarized in Lindsay (1984) but are not included on the CEAREX CD-ROM. Please contact NSIDC User Services for current availability of these data.

MIZEX-84 Measurements

During MIZEX-84, surface and upper-air data were obtained using four ships:

- POLAR QUEEN
- HAAKON MOSBY
- POLARSTERN
- VALDIVIA

Identical Vaisala Upper Air Sounding systems on all four ships measured upper-air parameters several times a day.

POLAR QUEEN Surface Measurements

During most of MIZEX-84, the POLAR QUEEN was moored to a large ice floe. Near-surface wind speed and air temperature were measured at four levels from a 6.7 meter profile mast located on the floe 60 meters from the ship. The profile enabled the wind speed to be measured with an accuracy of 0.1 m/s. Temperature was accurate to 0.1 degree C.

When the profile mast was not deployed, during transit periods, or when the profile mast had an upwind obstruction, the wind and temperature was measured at 16 meters elevation from a bow mast on the ship. During these times, the accuracies for wind speed and temperature were estimated to be 0.3 m/s and 0.5 degree C. In all cases, the wind speed was adjusted to the 10 meter value using standard flux-profile relationships. Both the ice tower and bow mast locations had cup anemometers and radiation-shielded aspirated platinum-resistance thermometers.

Wind direction was measured with a vane on the bow mast with an accuracy of 5 degrees. The wind vane was not operational before June 11, therefore wind direction and wind speed were not available when the ship was moving. Humidity was measured with a cooled-mirror hygrometer on the bow mast and was accurate to 3 percent relative humidity. Pressure was measured in the ship's laboratory with an accuracy of 2 mb. All values are ten-minute averages.

Data described in section II.B of Lindsay (1985) contains extra variables that flag suspect values of wind speed, wind direction, temperature and humidity. These data are not included on the CEAREX CD-ROM. Please contact NSIDC User Services for information about its availability.

POLAR QUEEN Upper-air Measurements

Rawinsondes were launched from the ship at least twice a day using a Vaisala Upper Air Sounding system. The rawinsondes and initial processing of the data were provided by the Alfred Wegener Institute for Polar Research (AWI).

The accuracy of the temperature and dewpoint temperature was 0.2 degree C and 1.0 degree C respectively, while height was accurate to 30 meters. Vector wind was accurate to 2.0 m/s. Because rawinsonde measurements are instantaneous, they do not necessarily represent average conditions, particularly if strong secondary circulations are present.

HAAKON MOSBY Measurements

The surface data from the HAAKON MOSBY were obtained using instruments similar to those on the POLAR QUEEN. The wind, air temperature and humidity probes were mounted on a platform extending forward of the HAAKON MOSBY's main mast at a height of 15 meters above sea level. Pressure was measured in the ship's laboratory. The accuracies were: wind speed, 0.3 m/s; wind direction, 10 degrees; air temperature, 0.5 degree C; relative humidity, 3 percent; pressure, 2 mb. All observations were averaged over ten-minute intervals. The accuracy of the wind measurements was worse when the winds were directly from the stern. Rawinsondes were launched four times a day or more. The accuracies were identical to those for the POLAR QUEEN measurements.

POLARSTERN Measurements

The POLARSTERN had two anemometers, wind vanes, and temperature sensors. The set of sensors on the side of the ship from which the wind was blowing was used. If the two wind vanes could not agree on which side that was, the side with the higher wind speed was used. The humidity was calculated from an Li-Cl sensor. The values represent ten-minute averages. The accuracies are similar to those indicated above for the HAAKON MOSBY data.

The rawinsondes were usually launched every three hours. The estimated accuracies were identical to the POLAR QUEEN data.

VALDIVIA Measurements

The data were based on manually recorded observations of the permanent ship instruments. The observations were usually made every three hours and are based on averages over a few seconds. Sometimes the wind speed was estimated from sea state. Pressure was obtained from a

barometer on the bridge. Humidity was not measured. The accuracies were: wind speed, 2.0 m/s; wind direction, 15 degrees; air temperature, 1.0 degree C; pressure, 2 mb.

The rawinsondes were usually launched every six hours. The processing of the data and the estimated accuracies were identical to the POLAR QUEEN data.

MIZEX-87 Measurements

Surface and upper-air data were obtained from three ships:

- POLAR CIRCLE
- HAAKON MOSBY
- VALDIVIA

POLAR CIRCLE Measurements

The POLAR CIRCLE collected data from March 22 through April 11. A Coastal Climate WeatherPak (see "Section 11.5 | Notes") meteorological station (met station) was located on a platform extending forward of the POLAR CIRCLE's bow mast at a height of 16 meters above sea level. This instrument measured wind speed and direction, temperature, and relative humidity. There was a bug in the WeatherPak software in the wind speed calculation when the wind speed was greater than 9 m/s. During these periods, wind speed was measured from sonic anemometers at the same location. There was excellent agreement (within 0.3 m/s) between these sensors at lower wind speeds; therefore, reported speeds should be accurate to at least this amount. The errors associated with distortion of airflow by the ship were believed to be less than 5 percent because the anemometer locations were well away from blocking structures. An exception was when the wind was directly from the stern, when errors may have been as great as 20 percent. The temperature was accurate to 1.0 degree C and the relative humidity to within 5 percent.

All the wind speed and direction values for all the ships were corrected for ship motion based on the ship's speed and heading. On the POLAR CIRCLE, the ship's heading was obtained from a compass on the WeatherPak and was routinely checked against the ship's gyroscope. Unfortunately, the ship caused extreme magnetic distortion for certain headings so that there were occasionally considerable errors in the true wind directions between the times when the gyroscope heading was recorded. When the POLAR CIRCLE was near the HAAKON MOSBY, the wind direction from the latter should be used. Most of the time the wind directions from the POLAR CIRCLE were accurate to within 20 degrees. This problem did not affect the true wind speed calculations. The data were averaged over ten-minute periods.

Vertical profiles of temperature, humidity and winds were obtained nominally every six hours using a rawinsonde system manufactured by the VIZ Corporation. The vector winds were determined

from an Omega navigation system on the rawinsondes and were usually accurate to 1.0 m/s. In regions of strong vertical shear, errors may increase to 2.0 m/s. The temperature and dewpoint temperature were accurate to 0.2 degree C and 1.0 degree C respectively, while the heights were accurate to 30 meters. Because rawinsonde measurements are instantaneous, they do not necessarily represent the average conditions, particularly when strong secondary circulations are present.

HAAKON MOSBY Measurements

The HAAKON MOSBY had a Coastal Climate WeatherPak (see “Section 11.5 | Notes”) meteorological station at 18 meters elevation with the same instruments and similar accuracies as the POLAR CIRCLE for all parameters except wind direction. Because the WeatherPak software had a bug in the calculation of these wind speeds, a miniature cup anemometer was used to measure wind speeds above 11 m/s. Unlike the POLAR CIRCLE, there was no magnetic distortion of the compass; therefore wind directions were usually accurate to 5 degrees. During a few periods when air flow was from the stern of the ship, flow distortion may have caused 20 percent errors in wind speed and direction. Ten-minute averages were recorded.

The rawinsondes launched from the HAAKON MOSBY were manufactured by the Vaisala Corporation using a system developed by R. Helvey of the Pacific Missile Test Center. The rawinsondes were usually launched every six hours. The temperature data obtained from these rawinsondes have an accuracy of 0.2 degree C and the dewpoint temperatures are accurate to within 1.5 degrees C. Wind data were obtained using an Omega navigation tracking system on each rawinsonde. The vector wind speeds were usually accurate to 2 m/s. Winds in the lower 500 meters of the rawinsonde flights had to be interpolated from surface and upper-level measurements and therefore are likely to have larger errors. The heights are accurate to within 30 meters.

VALDIVIA Measurements

Instruments on the VALDIVIA measured all the basic parameters except humidity. Because of a problem recording the correct time, only data collected only during standard observation periods (when the time was known) are included on the CEAREX CD-ROM. This was usually every three hours. The accuracies of the values were the same as those from the HAAKON MOSBY.

The rawinsonde system on the VALDIVIA was virtually identical to the POLAR CIRCLE system and had the same accuracies. Launches were usually performed every six hours.

CEAREX Measurements

CEAREX data were obtained using:

- the POLAR QUEEN
- the HAAKON MOSBY
- two operations camps

POLARBJORN Surface Measurements

A Coastal Climate WeatherPak (see “Section 11.5 | Notes”) meteorological station was located on a platform extending forward of the POLARBJORN's bow mast at a height of 14 meters above sea level. This instrument measured wind speed and direction, temperature, and relative humidity. Temperature data are accurate to within 1.0 degree C and humidity to within 5 percent. Accuracy of wind speed and direction depended on wind direction relative to the ship; a "sheltering" effect was observed with winds directly from the stern. This situation seldom occurred during the drift phase because of the ship's slowly varying heading and persistent northerly winds. Wind speeds are accurate to within 0.3 m/s and direction to within 10 degrees, although during periods of unfavorable wind direction, errors may have been larger.

All winds were corrected for ship motion based on ship speed and heading. Throughout most of the drift, ship and ice relative winds were within 0.5 m/s. However, after November 15 when the POLARBJORN was mobile, this correction was important.

POLARBJORN Upper-air Measurements

Vertical profiles of temperature, humidity, and wind speed and direction were obtained twice daily throughout the experiment, with additional launches during periods of extreme or unusual weather. The system used rawinsondes and software developed by the VIZ Corporation. The rawinsondes were equipped with thermistors that measured temperatures to within 0.2 degree C. The humidity sensor consisted of a specially coated glass plate, the resistance across which varies with humidity. Humidity measurements generally agreed quite well with Coastal Climate WeatherPak (see “Section 11.5 | Notes”) readings, although some overestimation was evident. Winds were measured using Omega tracking and were therefore unavailable during periods of high solar flare activity.

A systematic underestimation of low-level winds occurred because of the necessary three-minute averaging of all wind data. Underestimation resulted from inclusion of lighter inversion-layer winds in the average. Rawinsonde wind directions were generally accurate to within 20 degrees. This data set includes virtually all rawinsonde data with very little editing. Spurious wind data take the form of shallow (100 meter) jets; data users should be skeptical of any soundings exhibiting large vertical shear in the absence of a temperature inversion.

Altitude was measured with a baroswitch, occasionally yielding spurious contacts, particularly at low levels. An effort was made to remove spurious contacts, but success in this difficult task is a

function of operator experience, therefore inaccuracies may exist in some soundings. Errors of this type are always largest at higher levels because of the cumulative effect of erroneous contacts during the rawinsonde's ascent.

HAAKON MOSBY Surface Measurements

A Coastal Climate WeatherPak (see "Section 11.5 | Notes") meteorological station was used on board the HAAKON MOSBY to measure air temperature, relative humidity, atmospheric pressure, and wind speed and direction. This station was mounted on a platform extending forward of the HAAKON MOSBY's bow mast at a height of 15 meters above sea level. All observations were averaged over ten-minute intervals. The temperature data obtained from this instrument were accurate to within 1.0 degree C and the relative humidity data to within 5 percent.

The accuracy of the wind measurements depended on the wind direction relative to the ship; a "sheltering" effect was observed with winds blowing directly from the stern. Wind speeds are accurate to within 0.3 m/s and direction to within 10 degrees, although when winds were from the stern the errors are likely to be larger. All wind data have been corrected for ship motion based on ship speed and heading. The measurements of atmospheric pressure are accurate to within 2 millibars.

HAAKON MOSBY Upper-air Measurements

Vertical soundings of the atmosphere were routinely obtained roughly every six hours, with rawinsonde flights at approximately 0000, 0600, 1200 and 1800 UTC every day, depending upon equipment or environmental difficulties. During periods of unusual or exceptional weather conditions soundings were made more frequently. The number of soundings made in a single day varied from zero to as many as nine.

The vertical profiles of temperature, dew point temperature and wind speed and direction were measured using rawinsondes manufactured by the Vaisala Corporation and software developed by Roger Helvey. The temperature data obtained from these rawinsondes have an accuracy of 0.2 degree C and the dewpoint temperatures are accurate to within 1.5 degrees C. Wind data were obtained using an Omega navigation tracking system on each rawinsonde. The vector wind speeds are considered to be accurate to within 1 m/s. Winds in the lower 500 meters of the rawinsonde flights had to be interpolated from surface and upper-level measurements and therefore are likely to have larger errors. The heights are accurate to within 30 meters. Obvious errors in the profile data were removed but the data are otherwise unedited.

Oceanography Camp (O-Camp) Surface Measurements

Wind speed, wind direction, temperature, humidity and pressure were obtained from a **Coastal Climate WeatherPak** (see “Section 11.5 | Notes”) meteorological station and recorded on Hewlett-Packard 200 series computers. The data were averaged over ten-minute periods. The winds were measured at a height of 2.82 m above the ice surface. Temperature, humidity and pressure were measured at 2.24 m. The temperature was accurate to 0.5 degree C; relative humidity, 8.0 percent; wind speed, 0.2 m/s; wind direction, 5.0 degrees; and pressure, 2.0 mb. The pressure data show some high frequency fluctuations that are not believed to be real.

Computer and met station malfunctions created periods when data were missing or obtained from other instruments. Considerable post-experiment editing was required to provide the best estimates of the basic meteorological parameters. The periods and substitution measurements made when problems occurred are described in the following paragraphs.

Computer malfunction between March 27 and March 30 required that the met station data be manually recorded. For some parts of these days, the values of all parameters are based on ten-second average measurements with irregular intervals ranging from 4 to 90 minutes between recorded measurements. For other periods of time, no data were recorded.

On March 30, a sonic anemometer was deployed at a height of 3.33 m. It measured average wind speed and direction, with an accuracy of 0.3 m/s and 10 degrees, respectively, every ten minutes. Twice on March 30, air temperature was recorded manually using an unshielded alcohol thermometer located beside the hut 0.7 m above the surface. From March 31 through April 1, the alcohol thermometer was located in a homemade box shield located 1.7 m above the surface. During this period, the temperature was manually recorded hourly during waking hours, and was accurate to within 1.5 degrees C.

Beginning March 31, pressure from an altimeter in the camp manager's hut was recorded two or three times a day. Starting April 2, the sonic anemometer was used to determine ten-minute average temperature.

The pressure and temperature sensors described in the previous two paragraphs were calibrated later in the experiment when a replacement met station was available for comparison. After adjusting for bias, the above sensors compared very well with the met station and the accuracies were estimated to be at least as good as the met station accuracies, (2.0 mb and 0.5 degree C, respectively). Although temperature as measured by a sonic anemometer is affected by humidity, the effect in the Arctic is too small to alter the accuracy stated above.

On April 9, a replacement met station was deployed and recorded average pressure, temperature, humidity and winds every ten minutes. The heights and accuracies were the same as described

earlier for the met station. The values recorded by this instrument were used for presentation in the atlas for the rest of the experiment, although the other sensors were still operational and provided intercomparisons for the post-calibrations described above.

Therefore, with the exception of the gap from March 28 to 30, all basic meteorological parameters were obtained by at least one sensor throughout the experiment at the O-Camp. Humidity was the one exception; it was available only when the met station was operational.

O-Camp Upper-air Measurements

Upper-air measurements of the basic meteorological parameters were obtained from rawinsondes launched from the O-Camp. The rawinsondes were launched two or more times each day. This system was manufactured by the VIZ Corporation. The winds were measured by an Omega navigation tracking system on each rawinsonde.

The accuracy of the temperature and dewpoint temperature was 0.2 degree C and 1.0 degree C respectively, while height was accurate to 30 m. Vector wind speed was usually accurate to 1.0 m/s, although in shear regions and near the surface errors may increase to 2.0 m/s. Sometimes, the Omega tracking system had problems and errors were extreme. These bad periods have not been removed from the data and can be identified by spikes or false jets in the sounding data. A comparison of data obtained from two profiles made within an hour confirmed the above accuracy estimates. Because rawinsonde measurements are instantaneous, they do not necessarily represent the average conditions, particularly if strong secondary circulations are present.

Acoustics Camp (A-Camp) Surface Measurements

Wind speed, wind direction, temperature, humidity and pressure were obtained from a **Coastal Climate WeatherPak** (see "Section 11.5 | Notes") meteorological station (met station) and recorded on Hewlett-Packard 200 series computers. The data were averaged over ten-minute periods. The winds were measured at a height of 2.82 m above the ice surface. Temperature, humidity, and pressure were measured at 2.24 m. The temperature was accurate to 0.5 degree C; relative humidity, 8.0 percent; wind speed, 0.2 m/s; wind direction, 5.0 degrees; and pressure, 2.0 mb. The pressure data show some high frequency fluctuations that are not believed to be real.

The A-Camp data were obtained entirely from the met station and contain no gaps larger than one-half hour. No editing of the data was needed and the above accuracies and heights apply throughout the measurement period.

A-Camp Upper-air Measurements

There were no upper-air measurements taken at A-Camp.

Data Organization

The meteorology data are presented in 22 files in two subdirectories on the CEAREX CD-ROM. One subdirectory contains 12 surface data files and another holds 10 upper-air sounding data files.

Data Format

The surface data files are ASCII coded 80 character records and the upper-air sounding data files are ASCII coded 81 character records. The final character in each record is a carriage-return. The variables within each record are separated by at least one space.

Surface Data Files

The **surface data files** contain time series of surface wind speed, wind direction, air temperature, relative humidity and pressure values. Every surface data record has the same format. Except for the VALDIVIA measurements noted above, the time on each record represents the start of a ten-minute averaging period. Missing data have the value -99.0 for surface data. A **FORTTRAN** program presented in the CD-ROM documentation file will read any of the surface data files.

Rawinsonde Profile Data

The **rawinsonde profile data files** contain two types of records: a single header record at the beginning of each sounding, followed by several data records with the profile information collected as the balloon goes up.

The header record contains:

1. LOC platform label , e.g. MIZEX84HM, CEAREXPB, etc.
2. XLAT latitude (degrees north)
3. XLON longitude (degrees east are positive, degrees west are negative)
4. IDATE date (YYMMDD; i.e. year, month of year, day of month)
5. ITIME time at start of sounding (HHMM); i.e. hour, minute
6. IMAX number of records in the sounding

The profile data records contain:

1. RCOUNT record counter for sounding = 1.0 to IMAX
2. TA air temperature (degrees C)
3. TD dewpoint temperature (degrees C)
4. RH relative humidity (percent)
5. PR pressure (mb)
6. WD wind direction (azimuthal)
7. WS wind speed (m/s)
8. Z height (m)

If one of the above variables has a value of -999.0, the value of that quantity was not available or was invalid. A FORTRAN program presented in the CD-ROM documentation file will read any of the upper-air files.

Notes

The humidity measurements from the **Coastal Climate WeatherPak meteorological stations** (met stations) are highly suspect during cold conditions. Therefore, the humidity values from the MIZEX-87 and CEAREX surface data files should all be considered suspect when the air temperature is below -10 degrees C. The upper-air humidities are not affected.

Additional information and graphical plots of the data are contained in hard-copy meteorological atlases (Lindsay 1984, 1985, 1986; Guest and Davidson 1988; Lackmann et al. 1989; Guest and Davidson 1989). In some cases, maps of sea level pressure analyses, maps of platform and ice edge positions, and radiation information are not presented on the CEAREX CD-ROM but are contained in the atlases.

All times in the data set and documentation are Universal Time Convention (UTC).

Investigator

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APPENDIX G – NOISE DATA

The CEAREX noise data include acoustic noise measurements made from a large horizontal hydrophone array, multiple vertical hydrophone arrays, and geophone arrays, and ambient noise observations made from the POLARBJORN using omni-directional hydrophones tethered beneath the ice cover.

Information in this document has been derived from documentation files on NSIDC's CD-ROM titled Eastern Arctic Ice, Ocean and Atmosphere Data, Volume 1: CEAREX-1, version 1.0, 8/91.

Data Description

Acoustic data descriptions are included in the following papers and reports that resulted from analysis of the acoustic data: Fricke (1991), Gerstoft and Schmidt (1991), Miller and Schmidt (1991), Peal (1990), and Seong (1991.) The ambient noise measurements are described in Pritchard (1989).

Data Acquisition and Equipment

Acoustic Noise Data

Direct acoustic measurements were made at the CEAREX Acoustics Camp (A-Camp) using a large horizontal hydrophone array, multiple vertical hydrophone arrays and geophone arrays.

Acoustic data were recorded by a multichannel digital acquisition system, capable of greater than 120 dB dynamic range, developed at Woods Hole Oceanographic Institution (WHOI) and described in von der Heydt (1991). The MIT/WHOI digital data set consisted of 40 channels devoted to hydrophone sensors of the horizontal array and 12 channels from four 3-axis geophones. Channels were selectively recorded on a 14-channel FM tape recorder. All data included on the CEAREX CD-ROM were acquired on the digital system.

In support of coherent processing techniques for the low frequency data (1 to 250 Hz) recorded from the hydrophone arrays, an independent system operating in the 10 kHz region was used to continuously measure delays between six tone burst sources and the array sensors, all at a common depth. These travel times were later used to estimate relative locations of sensors. Nominal location estimates are tabulated as supporting data on the CEAREX CD-ROM.

Ambient Noise Data

Ambient noise was measured using omni-directional hydrophones tethered beneath the ice cover, (Pritchard 1989). Two omni-directional, calibrated hydrophones were deployed at 60 and 90 meters beneath the pack ice at two sites roughly 1 km away from the ship and from each other. A few ambient noise observations began September 27; nearly continuous measurements began October 10, and observations ended November 18 near 81 degrees north 32 minutes east when severe ice deformations made it impossible to maintain instrumentation cable continuity. A PC-based LOFAR system measured the hydrophone output (Prada 1986).

Shielded instrumentation cable carried amplified hydrophone output into a Frequency Devices low-pass Butterworth filter with adjustable corner frequency (Model 901). Data were filtered by an RC circuit to minimize signals below 1 Hz. The acquisition system was a Compaq 386/20 computer on the ship. Data were entered through a Metrabyte A/D interface board (Model DAS-16G). Computer peripherals included VGA monitor, 80387 numeric co-processor, 130 Mb hard disk and 135 Mb tape cartridge backup, and NEC color printer.

The LOFAR computer program provided interactive control of data acquisition. Digitized input signals were sampled at the chosen maximum frequency. The anti-aliasing filter corner frequency was set between half and two-thirds of the Nyquist frequency. After collecting 1024 data points, an FFT was performed, and the power spectral density estimated. One hundred twenty-eight individual spectral densities were averaged, and the averages were recorded. Narrow-band harmonics were removed, data were calibrated, and the resulting power spectral densities collected into one-third octave bands. The first output bin was discarded from all spectra because of possible contamination by DC and other low frequency signals.

For a frequency bandwidth of 512 Hz, data were entered about 50 percent of time and FFT calculations required about 50 percent of time. For these parameters, an average spectral estimate was obtained at roughly 2-minute intervals. For all frequency bandwidths, the number of data points in the FFT was held constant at 1024. The time required to enter data decreased inversely with bandwidth. The average spectral estimate was obtained at roughly 1-minute intervals at a bandwidth greater than 2000 Hz. Since 1024 data values were used in each FFT, resolution decreased as bandwidth increased. For a maximum frequency of 512 Hz, frequency bins were 1 Hz but for a frequency maximum of 8192 Hz, frequency bins were 16 Hz.

The system "noise floor" was estimated by removing the hydrophone from the system and connecting all cables at the hydrophone location. The system contained the shielded instrumentation cable, anti-aliasing filter, A/D interface board, and acquisition computer. The noise floor was about 72 dB re: 1 microPa²/Hz across the spectrum, a threshold that remained rather steady throughout the experiment. This noise floor probably resulted from the 12-bit A/D interface

board, which limited the dynamic range to about 39 dB. All observed values are included on the CD-ROM. The user must eliminate those values contaminated by the noise floor.

Data were recorded from only one hydrophone at a time. The hydrophone indicated by H1 was tethered at 90 m depth. Its location appears on the cover photograph presented by Pritchard and twenty-eight others (1990). The hydrophone indicated by H2 was tethered at 60 m depth. It was located near the upper left corner of the same photograph.

Data Organization

The noise data are presented in four data files in two subdirectories on the CEAREX CD-ROM. One subdirectory contains acoustic noise data and one holds ambient noise data.

Data Format:

Acoustic Noise Data

Each file begins with an ASCII header of 512 bytes with information concerning the experiment, the number of sensors, and the number of data values in the file. A data stream for the first sensor follows this header. The stream end is indicated by a "new line" character. Second sensor data follows in the same way, with the sequence repeated for all sensors. The last record in the file may be padded to 512 characters with blanks. All data were sampled at 1 kHz. A listing of sensor locations relative to the nominal origin at sensor 9 is given in the description of file 3.

The FORTRAN data format is E8.6; the C language format is 13.6e.

Ambient Noise Data File

This file contains 700416 data values (700.416 seconds) from each of four sensors. These data were acquired as an ambient noise experiment during a particularly windy day in which the wind speed exceeded twenty knots. The initial start time of the data is 1534 GMT, April 11. In order, the sensors recorded on the file are NE320, NW7000, G4Y, and G4Z. The first two are hydrophones with a sensitivity of -160 dB re: 1 volt per micropascal. The first hydrophone was "hard wired" to the acquisition equipment at base camp. The second hydrophone, NW7000, communicated with base camp via a radio link with 10dB of gain. A gain normalization was applied to the data from this sensor to make the hydrophone gains consistent. The last two sensors, G4Y and G4Z, include the horizontal and the vertical component, respectively, of geophone G4.

Total file size is 39223813 bytes, consisting of a 512-character header, four groups of 700416 values each (14 characters per value), a new line (0D hexadecimal) following each group and an

additional new line at the end of the file. For the CD-ROM, the files were converted into 512-character records.

For cross-referencing with original data held by the investigators, this file contains data copied from WHOI optical disk CRX22.dat. Seventy-two records starting at record 157 are included for channels 24, 36, 50, and 51. Channel 36 is scaled by 0.31623 to normalize for preamp gain, as described above.

Plate Wave Experiment Data Files

This file contains 450001 values (450.001 seconds) from each of six sensors: NW20, APEX, NE40, G1X, G1Y, and G1Z. The data were acquired during a "Plate Wave Experiment" in which primer cord and SUS explosives were set off near the A-Camp. The data were collected at 1631 GMT, April 16, 1989.

Three shot events are recorded in this file: a primer cord shot at 32 feet depth; a second one at 64 feet depth; and finally, a SUS shot at 800 feet. The first three sensors in the file are ordinary hardwired hydrophones with sensitivity of -160 dB re: 1V/uPa. The latter three include both horizontal components and the vertical component of geophone G1.

Total file size is 37800603 bytes. This consists of a 512-character header, four groups of 450001 values each (14 characters per value), a new line following each group and an additional new line at the end of the file.

For cross-referencing with original data held by the investigators, this file contains data copied from WHOI optical disk CRX52.dat. Fifty-four records starting at record 556 are included for channels 5, 9, 11, 40, 41 and 42.

Remote Air Guns/Ambient Noise Data File

This file contains 55001 data values from 50 sensors, collected at 0848 GMT, April 17, 1989. Because of the large number of sensors, only 55 seconds of data are included. During this interval, an air gun was fired at 48-minute intervals from the Oceanography Camp (O-Camp), approximately 300 km to the northeast. With signal processing, it is possible to detect these signals. Otherwise, the data can also serve as a sample of ambient noise on a fairly quiet day in the Arctic.

The first 38 channels are hydrophones with a sensitivity of -160 dB re: one volt per micropascal. The last twelve channels are geophones. The last eight hydrophones on the file were radio-linked phones with an extra 10 dB of gain, for which no normalization is made.

A list of "X-Y" sensor position estimates is available in the CD-ROM documentation file. The estimates are in meters relative to a Y-axis baseline between the apex sensor, channel 9 and channel 7.

Total file size is 38501263 bytes. This consists of a 512-character header, 50 groups of 55001 values each (14 characters per value), a new line following each group and an additional new line at the end of the file.

For cross-referencing with original data held by the investigators, this file contains data copied from WHOI optical disk CRX58.dat. Six records starting at record 26 are included. Because of excessive noise, channel 16 was deleted.

Ambient Noise Data

The ambient noise data can be read from the archive using the FORTRAN statements presented in the CD-ROM documentation file.

Noise intensity is presented for one-third octave bands from 2 Hz to 1000 Hz. Units are micropascal (μPa). Average values over each one-third octave band have been divided by bandwidth and therefore describe spectrum level. Missing values are indicated by data values of 1.E-9. Time (Greenwich Mean Time) is presented in consecutive days of the year (decimal fractions), where 1 January 1988 at 0000 UT is TIME = 1.0000.

Prior to day 272.5219, eight, seven-minute average FFTs were given, in contrast with the one- to three-minute averages calculated later. The times of these closely spaced data cannot be resolved by the resolution of 1.E-4 day, with the result that several consecutive records have identical times. This limitation occurs only for the first 988 data points.

Notes:

For a discussion of the motivation for the CEAREX **acoustic** noise work, please refer to the CD-ROM documentation file.

For a discussion of the results of the CEAREX **ambient** noise work, please refer to the CD-ROM documentation file.

Investigators:

Arthur M. Baggeroer, Massachusetts Institute of Technology - acoustic noise data

Robert S. Pritchard, IceCasting, Inc. - ambient noise data

Keith von der Heydt, Woods Hole Oceanographic Institution - acoustic noise data

APPENDIX H – POSITION DATA

Data Description

The CEAREX position data files contain the latitude and longitude of the sample position as well as the time that the position was determined. The data were perused, and any obvious outliers were marked with asterisks.

For the manned camps (POLARBJORN Drift, Oceanography Camp, and Acoustics Camp), hourly listings of position and velocity were derived from a complex demodulation algorithm described in McPhee (1988). The results of complex demodulation for the buoys are not included.

Data Organization

The position data are contained in 24 ASCII data files, each with one header record followed by "position fix" records with:

- time in decimal days of the year
- latitude in decimal degrees
- longitude in decimal degrees (east positive)

Data Format

Data files are numbered or named to meet the MS-DOS convention limiting file names to eight characters. Headers for these files contain information about the file contents: original file name, '0' (zero), year, start time (in decimal days of the year), end time (in decimal days of the year), number of fixes, and PI for data collection. The data file headers are not traditional "field" headers. Data records are the same length as the headers.

Manned Station Data

The POLARBJORN Drift Data header is a 65-character record providing information about the start and end times and the source of the data. For example:

```
pbdrift 0 1988 start 260.37153 end 335.1278 fixes 4776 PI bunch
      ERIM satnav fixes = code 0
      PSC Salargos buoy = code 1
      ERIM dead reckoning estimates = code 2
      Scripps ADCP satnav fixes = code 3
```

The Oceanography Camp Drift header is 62-character record providing information about the start and end times and the source of the data. For example:


```
ocamp 0 1989 start 78.4306 end 120.7347 fixes 753 PI McPhee
PSC satnav fixes = code 0
PSC Salargos buoy = code 1
MFO log from satellite navigator = code 2
```

The Acoustics Camp Drift header is a 67-character record providing information about the data start and end times, and source. For example:

```
alpha 0 1989 start 82.27431 end 110.43775 fixes 680 PI Baggeroer
MIT satnav fixes
```

Buoy Drift Data

The buoy drift data file headers provide information about file contents, type, file name, year, start date (in decimal days of the year), end date (in decimal days of the year), number of fixes, and data collection PI. All the file names beginning with numbers have the same format, although the record size varies.

For more detailed information about the buoy data file format, manned station and unmanned buoy drift positions, and the steps used for the complex demodulation, see the POSITION.DOC Word file in the /DOCUMENT directory.

Investigators:

Arthur Baggeroer, Massachusetts Institute of Technology - A-Camp drift data

Miles McPhee, McPhee Research Company - O-Camp drift data

James Morison, University of Washington - POLARBJORN drift data

APPENDIX I – SEA ICE DATA

Data Description

Ice Accelerometer Data

The CEAREX ice accelerometer data were collected during Leg II of the POLARBJORN Drift from October through November 1988. The data consists of 76 sampled data hours that occurred between Julian Day (JD) 308 and JD 330, and include most hours from the four periods during which significant accelerations above the noise level were observed. The data include all of the hours analyzed in Martin and Drucker (1991). Other hours are included for completeness and to provide several hours in which nothing happened as a control.

Buoy activity consisted of a noise floor and at least four periods of enhanced activity. Most of the observed peaks occur in these periods:

JD 12 through JD 314

JD 17 through JD 321

JD 22 through JD 324

JD 27 through JD 329

Ice Floe Deformation Data

Ice floe deformation data files hold the time series of the deformation of a single line defined by a master and a remote transponder pair.

Sea Ice Stress Data

Because ice stresses could be correlated with other environmental parameters, CEAREX provided an ideal setting for measuring the stresses. Pack ice geophysical stresses in the eastern Arctic were monitored for the two month drift period by investigators from BDM International, Inc. (BDM) the U.S. Army Cold Regions Research and Engineering Laboratory (CRREL).

BDM investigators measured in-plane compressive stresses in a multiyear floe in the eastern Arctic during October and November 1988. In addition to stress data, ice mechanical properties of flexural strength, in-plane compressive strength, and elastic modules of ice samples were determined in a shipboard laboratory. Stress invariants, principal stresses and direction of the largest compressive stress are included on the CEAREX CD-ROM.

CRREL investigators obtained high quality pack ice stress data. Stresses were monitored during a floe disintegration when a large deformation occurred at the end of the experiment. Data from different vertical levels and different horizontal locations were obtained.

Data Acquisition

Ice Accelerometer Data

The CEAREX ice accelerometer data were collected from the ship POLARBJORN, which was frozen into the sea ice north and east of Svalbard. The ship was moored between two multiyear ice floes, a kilometer-scale floe (Alpha) and a 100 meter-scale floe (Beta). These floes in turn were surrounded primarily by multiyear ice floes. During the drift, three ice accelerometer buoys were deployed at three sites (Alpha-1, Alpha-2, and Beta), where the buoys were located on their named floes. The buoys were used to measure the ice accelerations associated with deformation and breakup. The investigators also measured the relative compass heading of each buoy. Details of the buoy deployment and of their locations relative to the ship and the floes are given in Martin and Drucker (1991).

Each buoy contained a compass and a set of three orthogonally mounted accelerometers, with two accelerometers in the horizontal plane and one in the vertical. For each buoy, the accelerometers are referred to as X, Y and Z, where Z is vertical, and X and Y lie in the horizontal plane, but have no particular orientation. At the beginning of each hour, each buoy transmitted 840 seconds of acceleration data, followed by 60 seconds of calibration and compass data. At the ship, the data were received, digitally sampled at 10 Hz, and recorded. The compass heading was sampled at hourly intervals and transmitted with the calibration data. The standard deviation of the quiescent acceleration was about 0.5 mm/s², except for buoy Alpha-2, channel Y, which was noisier than the others and had a standard deviation of about 1 mm/s². The bandpass of the accelerometers was 0.04 to 5 Hz or 0.2 to 25 s.

The investigators arrived at the ship on October 11 (JD 285) and deployed the three buoys by October 22 (JD 296). Data collection occurred for 15 minutes each hour beginning at six minutes past the hour. The hourly transmitting and recording process, which was interrupted at approximately weekly intervals to download data from the computer, continued until November 25 (JD 330). Between JD 296 and JD 330, the ship and buoys drifted southwest in the broad passage between Svalbard and Franz Josef Land toward Kvitoya Island, a small island east of Svalbard lying between the Arctic Ocean and the Barents Sea. Pritchard and twenty-eight others (1990) shows the drift track of the ship for this period. Before JD 310, the ice drifted as a solid body, and no activity from the buoys was observed. Between JD 310 and JD 329, accelerations were observed in the ice cover during discrete periods. On JD 327, floes Alpha and Beta broke up, and

the ice experienced its largest accelerations and rotations. This continued until JD 329, when the buoys were apparently destroyed by compressive forces.

Martin and Drucker (1991) concentrate on the ice behavior between JD 310 and JD 330. Martin and Becker (1987, 1988) discuss instrument design.

Ice Floe Deformation Data

Ice floe deformation data were collected during the drift phase of CEAREX by a master and a remote transponder pair. One master transponder (B) was located over the bridge of the POLARBJORN while the second master transponder (A) was located on Alpha floe perpendicular to the ship at the bridge location of the first transponder. The master transponders defined a baseline 115 meters long, perpendicular to the ship. The three remote transponders were located in the vicinity of the ship. Remote 1 was about 1 kilometer dead ahead of the ship. Remote 2 was on Beta floe about 500 meters from the ship. Remote 3 was beyond Beta floe, separated from Beta floe by an active lead. Raw data were gathered at two minute intervals from JD 282 through JD 320.5. At JD 320.5, the POLARBJORN moved and the baseline was lost.

BDM Stress Data

Stresses were measured using a hydraulic fluid-filled, flatjack-type stress sensor, 20 cm in diameter. The sensors were manufactured by GEOTECH. Coon (1988) describes the sensor. The range of the sensors was 0 to 689 kPa with an accuracy of ± 1.7 kPa.

The sensors were installed approximately 230 meters from the ship. At the stress site, ice thickness averaged 1.60 meters, with thickness variations of less than 20 cm within a 15 m region. Coon et al. (1989) discuss the details of implantation methods and data collection. The sensors were installed at roughly the neutral surface of the floe. Three sensors were installed in a rosette pattern to allow calculation of principal stresses. A thermistor was installed at the stress sensor depth to monitor ice temperature. Sensor and thermistor data were recorded on a Campbell Scientific data logger. Data samples were taken once per second, averaged over a two minute interval, and the two minute average values stored in a Campbell Scientific SM107 storage module. Stress data were subsequently downloaded into a Macintosh SE computer. Coon et al. (1989) discuss the data processing. There is a continuous record from JD 279 through JD 327, except for data dropouts on JD 283 and JD 284. Missing data on day 284 are due to a test of the stress sensors to check their coupling to the ice.

In addition to stress data, ice mechanical properties of flexural strength, in-plane compressive strength, and elastic modulus of ice samples in the vicinity of the stress gauges were determined in a shipboard laboratory. Coon et al. (1989) and Lau and Browne (1989) discuss test methods and

present selected data. The ice samples tested were predominantly first year lead ice, however, a limited number of flexural tests were run on multiyear ice. All tests were run in a controlled temperature laboratory at -10 degrees C. Compression tests were run on samples where the load was applied in the horizontal or "C" plane. Bending tests were loaded in the plane of crystal growth. Tests were run at a strain rate of approximately 1.0×10^{-4} .

Stress invariants, principal stresses and direction of the largest compressive stress are included on the CEAREX CD-ROM. While stress invariants are a useful parameter for comparison with other scalar quantities such as ambient noise, they provide no information about the directionality of the stress. To compare stress with vector quantities such as wind, current or deformation, the user must have information about the stress direction. For a discussion of the stress state in a body (i.e. principal stresses, stress invariants, relationships between stress and strain, etc.), please refer to the CD-ROM documentation file.

CRREL Stress Data

The POLARBJORN was moored to a multiyear floe and allowed to drift with the pack while the behavior of the ice, ocean and atmosphere were monitored. From September 18 to November 25, the ship drifted from 82 degrees 40 minutes north, 32 degrees 26 minutes east to 80 degrees 10 minutes north, 31 degrees 13 minutes east.

The stress measurements were obtained with biaxial vibrating wire stress sensors similar to those described by Cox and Johnson (1983). These instruments were chosen because of their relative ease of installation and maintenance, the extensive calibrations that had been previously performed (Cox and Johnson 1983), and their success in earlier field programs (Johnson et al. 1985). The sensor consists of a stiff steel cylinder which is 0.25 m long, 57 mm in diameter and has a wall thickness of 16 mm. The gauge is much stiffer than the ice, having a modulus of about 200 GPa, and thus should not be affected by spatial variations or temporal changes of the ice modulus. Six tensioned wires are set at 30° intervals across the inside diameter of the gauge. Only three wires are necessary for the determination of principal stress components; the remaining wires are for redundancy.

The POLARBJORN was moored to a multiyear floe on September 16, 1988 at 82 degrees 40 minutes north, 32 degrees 26 minutes east. Over the next two weeks, four stress sensor sites were established on each of two adjacent multiyear floes. At site 1, on floe Alpha, three sensors were installed at vertical levels near the top, mid-depth and bottom of the ice sheet. At site 2, which was located on the edge of the multiyear floe Beta adjacent to a freezing lead, one sensor was placed in the first year ice while the remaining two were located at shallow depths in the multiyear ice. Because of sensor and data logger difficulties, the data from sites 3 and 4 were generally unreliable.

The sensors were installed in holes approximately 0.1 m in diameter made with a standard ice coring auger. Each sensor is attached to a length of PVC pipe suspended to the proper depth from the surface by a cross bar through the PVC extension. Once the sensor was placed in the hole at the proper depth and leveled in the horizontal plane, the hole was filled with fresh water. Under normal conditions, the hole completely froze within a day or two, depending upon the air and ice temperature. Stresses associated with the "freeze in" can be from 200 to 300 kPa, and usually take several days to dissipate.

At site 1, the multiyear ice was 1.60 m thick. Sensors were installed at depths of 0.25, 0.70 and 1.20 m. At site 2, one sensor was located in the first year ice at a depth of 0.20 m. The thickness of this frozen lead increased from 0.38 to 0.54 m during the stress monitoring period. The sensor was located about 7.0 m from the edge of the multiyear floe in the thin ice which was about 200 m wide. The two remaining sensors were located in 2.0 m thick multiyear ice, at distances of 2 and 15 m from the edge of the floe. The three sensors were configured in a straight line normal to the edge of the floe and the frozen lead.

Data from each site were recorded on Campbell Scientific, Inc. data loggers. The sensors were sampled and recorded at two minute intervals, and the period (frequency) of each wire in each sensor was stored. The data loggers cached data in memory modules that required replacement with empty modules at five to seven day intervals. Normally, no interruption in sampling occurred during this exchange, though there were occasional breaks in the data if the memory modules were filled to capacity.

Data Processing

Ice Accelerometer Data

The acceleration data were minimally processed in order to allow the greatest flexibility of use. The only alterations of raw digital data were the removal of means, the filtering out of certain large errors due to radio noise, and the reformatting of binary data into ASCII.

The buoy acceleration signals were FM-telemetered to a ship receiver on three audio frequency FM subcarriers, individually discriminated, digitally sampled, and stored in binary files in a 2-byte format. The sampling resolution was approximately six bits per mm/s² and varied slightly per channel. Calibration was provided by pre-deployment measurement and by the one-minute calibration cycle following each collection period.

Because of its greater machine independence, the ASCII format was used for the CEAREX CD-ROM. To convert to ASCII, the binary data were first read into memory arrays. Then, the mean of each time series was computed and removed. This was justified because the buoy instruments

were AC-coupled and any remaining mean in the signal would be due to offsets in the discriminators.

After removing the means, the signals were passed through software that identified large single-point errors probably due to radio noise. A threshold of 5 mm/s² above or below adjacent samples was used. Samples lying outside the thresholds were replaced by the mean of their immediate neighbors. These are not flagged.

The two byte samples represented signed integer data with a range of -32768 to +32767. These were multiplied by gain constants that had been established for each channel. These constants varied slightly by channel but were approximately 0.16 mm/s² per bit. Thus, although the resolution of the five digit data representation is 0.01 mm/s², its true resolution is only about 0.16 mm/s² because of the analog to digital conversion (quantization).

The resulting data in units of acceleration have a possible range of about +/- 5000 mm/s². However, no actual accelerations above a few hundred mm/s² were experienced. To reduce data size for the CD-ROM, the range was limited to +/- 999.99 mm/s²; each sample was then multiplied by 100 and rounded to integers to provide a five digit integer with no decimal point. Thus the samples on the CD-ROM can be put directly into acceleration units of mm/s² by dividing by 100.

Ice Floe Deformation Data

Gaps in the raw data were linearly interpolated. The data were smoothed by low passing frequencies at a cutoff frequency of eight per day. The smoothed data were then resampled at 15 minute intervals. The accuracy of the ranges is about +/- 0.1 meter.

Data Organization

The sea ice data are presented in 103 data files in three subdirectories on the CEAREX CD-ROM, one each for ice accelerometer data, ice floe deformation data, and stress data. The stress subdirectory contains two subdirectories, one for BDM stress data and another for CRREL stress data.

Ice Accelerometer Data

The ice acceleration data are organized into hourly files. Each file is named according to its collection day and hour in the format "Addd.hh" where "ddd" is the day of the year and "hh" is the hour in Universal Time (UT). Data collection occurred for 15 minutes each hour beginning at six minutes past the hour. Thus, for example, the file A328.01 was collected from 01:06 UT to 01:21 UT on JD 328 (November 23, 1988).

Each file consists of nine time series corresponding to the nine channels (three buoys; three channels per buoy). There are 9000 samples per channel, corresponding to a sampling rate of ten samples per second for 900 seconds. Approximately the first 8400 samples are acceleration data; the last minute of each collection period consists of calibration signals and compass readings. This period is easily distinguished visually from the data period by its large pulse-like excursions.

Ice Floe Deformation Data

The ice floe deformation data are contained in six files on the CEAREX CD-ROM. Each file holds the time series of the deformation of a single line defined by a master and a remote transponder pair. The correspondence between the data files and the master remote pairs is defined as follows:

POS07.DFM master A/remote 2

POS08.DFM master B/remote 2

POS09.DFM master A/remote 3

POS10.DFM master B/remote 3

POS11.DFM master A/remote 1

POS12.DFM master B/remote 1

Stress Data

The CRREL stress sensor data consists of six files, each containing the entire time series of data from one sensor.

Data Format

Ice Accelerometer Data

The files are written as ASCII flat files of columnar number tables. There are nine columns of space-delimited numbers corresponding to the nine time series, and 9000 rows corresponding to the 9000 samples per channel. The order of the channels is as follows:

BETA X / Y / Z 1ALPHA X / Y / Z 2ALPHA X / Y / Z

The sample numbers are written as five digit decimal integers in a seven character field. This provides for one sign character (minus sign or space) and a minimum of one additional space between entries.

The decimal integers represent accelerations in units of 0.01 mm/s^2 . That is, the data may be read as mm/s^2 by dividing by 100. The dynamic range is thus -999.99 to 999.99 mm/s^2 . Sample values in excess of this range are set to the limits (± 99999), but any such data should be considered spurious.

To facilitate machine reading of the data and simplify importation into spreadsheets, graphics software, or other software, the data files contain no headers. It is essential that the file name not be lost as it contains the only reference to the file identity. The file names are in the format "A308_09.ACC" where "308_09" represents "308.09," the beginning year-day of the data. Because the file names on a CD-ROM must have a 3-character extension, the decimal point in "308.09" was changed to an underscore (_).

Compass Data

In addition to the acceleration data, a single ASCII file on the CD-ROM contains compass readings for selected hours between JD 300 and JD 330. The compass readings were manually derived from the information in the 60-second calibration cycle at the end of each hourly sample. Because of the laborious nature of extracting them, compass readings are given only as needed; i.e., hourly readings are only provided during periods of rapid rotation. This occurred primarily after JD 327, when floes Alpha and Beta broke up into small floes that rotated relative to one another. The compass readings are in units of degrees with arbitrary orientation. Because these numbers were derived manually, their accuracy is probably on the order of ± 5 to 10 degrees. Missing values are flagged as 999 in the compass file.

Ice Floe Deformation Data

The FORTRAN format is (f8.4,2x,f8.1,1x):

Time (JD) f8.4

Blanks 2x

Range (meters) f8.1

Blank 1x

BDM Stress Data

IMPORTANT NOTE: Different sign conventions are used in stress measurements for the BDM and CRREL stress data. The BDM data employs standard solid mechanics sign conventions in which negative stress indicates compression and positive stress indicates tension. The CRREL data uses the rock mechanics notation in which compression is positive and tension is negative.

Two types of stress data files are presented on the CEAREX CD-ROM. File names with the extension ".INV" are stress invariants, while file names with the extension ".PRI" contain principal stress and direction of stress. Files are named with the Julian Day (JD) range of the data in each file.

Stress Invariant Files

Data fields are:

time (JD)

first invariant (kPa)

second invariant (kPa)

2.795403E+02,-3.689658E+00, 2.707161E+00

2.795417E+02,-3.787702E+00, 2.753809E+00

2.795431E+02,-3.855021E+00, 2.694015E+00

time (JD)

first principal stress (Sigma 1) (kPa)

second principal stress (Sigma 2) (kPa)

direction of sigma 2 (degrees measured counterclockwise from east)

2.795403E+02,-9.824974E-01,-6.396819E+00, 7.700866E+01

2.795417E+02,-1.033894E+00,-6.541511E+00, 7.591252E+01

2.795431E+02,-1.161006E+00,-6.549036E+00, 7.558513E+01

CRREL Stress Data

IMPORTANT NOTE: Different sign conventions are used in stress measurements for the BDM and CRREL stress data. The BDM data employs standard solid mechanics sign conventions in which negative stress indicates compression and positive stress indicates tension. The CRREL data uses the rock mechanics notation in which compression is positive and tension is negative.

Each CRREL stress sensor data file consists of a header line followed by data, with each data line containing:

time (decimal JD)

the first stress invariant

the second stress invariant

File name	Sensor Depth	Ice Thickness	Distance From Floe Edge	Ice Type

Group 1				
CRREL1A.INV	0.25 m	1.6 m	200 m	Multiyear
CRREL1B.INV	0.70 m	1.6 m	200 m	Multiyear
CRREL1C.INV	1.20 m	1.6 m	200 m	Multiyear
Group 2				
CRREL2A.INV	0.20 m	0.6 m	7 m	Young ice
CRREL2B.INV	0.25 m	2.0 m	2 m	Multiyear
CRREL2C.INV	0.25 m	2.0 m	15 m	Multiyear

Investigators

Max D. Coon, BDM International, Inc. - BDM stress data

Robert Drucker, University of Washington - acceleration data

William D. Hibler III, Dartmouth College - deformation data

Mark A. Hopkins, Dartmouth College - deformation data

Paula A. Lau, BDM International, Inc. - compressive stress data

Seelye Martin, University of Washington - acceleration data

D. K. Perovich, U.S. Army Cold Regions Research and Engineering Laboratory (CRREL) - stress data

W. B. Tucker III, U.S. Army Cold Regions Research and Engineering Laboratory (CRREL) - stress data