Submarine Upward Looking Sonar Ice Draft Profile Data and Statistics, Version 1

USER GUIDE

How to Cite These Data

As a condition of using these data, you must include a citation:

National Snow and Ice Data Center (comp.). 1998, updated 2006. *Submarine Upward Looking Sonar Ice Draft Profile Data and Statistics, Version 1*. [Indicate subset used]. Boulder, Colorado USA. NSIDC: National Snow and Ice Data Center. https://doi.org/10.7265/N54Q7RWK. [Date Accessed].

National Snow and Ice Data Center

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1 DETAILED DATA DESCRIPTION

1.1 Overview

This data set consists of upward looking sonar draft data collected by submarines in the Arctic Ocean. It includes data from both U.S. Navy and Royal Navy submarines. Maps showing submarine tracks are available. Data are provided as ice draft profiles and as statistics derived from the profile data. Statistics files include information concerning ice draft characteristics, keels, level ice, leads, undeformed and deformed ice. Data from the U.S. Navy's Digital Ice Profiling System (DIPS) have been interpolated and processed for release as unclassified data at the U.S. Army's Cold Regions Research and Engineering Laboratory (CRREL) in Hanover, New Hampshire. Data from the analog draft recording system were digitized and then processed by the Polar Science Center, Applied Physics Laboratory, University of Washington. Data from British submarines were provided by the Department of Applied Mathematics and Theoretical Physics, University of Cambridge. All data sources used similar processing methods in order to ensure a consistent data set.

1.2 Background

This data set includes submarine data collected in the Arctic Ocean by U.S. Navy and Royal Navy submarines. U.S. Navy guidance has stated that previously classified, submarine-collected ice draft data may be declassified and released according to set guidelines. Those guidelines include restrictions stating that positions of the data must be rounded to the nearest 5 minutes of latitude and longitude, and date is to be rounded to the nearest third of a month. The guidelines also specify a region in which the data may be released. The Chief of Naval Operations has expanded the release area beyond the original "Gore Box" (so called because of Vice President Gore's advocacy for releasing the data). See Figure 1.

The SCience ICe EXercise (SCICEX) is a program that uses U.S. Navy submarines for research. SCICEX data are not classified and do not have restrictions on reporting the precise location and date for the data; therefore, the SCICEX ice draft data in this collection are reported with their date of acquisition, and position is reported to six decimal places. For more information about SCICEX, see the NOAA@NSDIC SCICEX Web site.

Since 1967 U.S. submarines have employed a narrow beam sonar transducer. Since 1976 data have usually been recorded digitally on U.S. Navy submarines with the Digital Ice Profiling System (DIPS). All U.S. Navy data in this data set come from the DIPS system, unless they are part of the analog portion. In processing, data are corrected for depth errors, erroneous drafts are removed, and data are spatially interpolated. The interpolation routine integrates submarine speed and position to obtain drafts at uniform spatial intervals. This is a labor-intensive interactive process, during which segments in which the submarine changed depth or course must be removed from the data. The majority of the cruise data were interpolated and processed for release as unclassified data at the U.S. Army's Cold Regions Research and Engineering Laboratory (CRREL) in Hanover, New Hampshire. SCICEX-97 and SCICEX-98 data were processed at the University of Washington, Polar Science Center, in cooperation with CRREL and using similar processing steps.

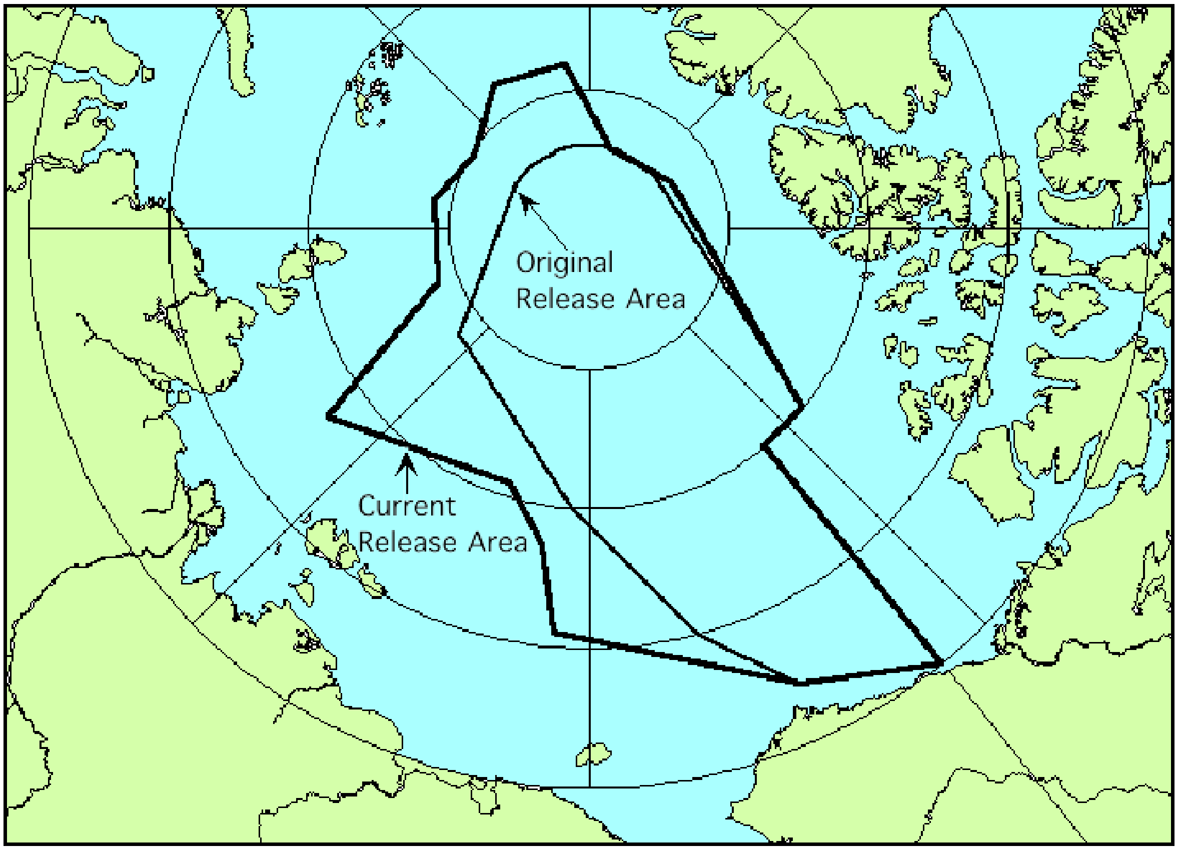


Figure 1. Map Showing the Release Area of these Data.

Data from British submarines were processed by the Department of Applied Mathematics and Theoretical Physics (DAMTP), University of Cambridge, in the same way as were the U.S. submarine data.

ULS draft data acquired on U.S. submarines prior to 1976 were recorded only as traces on paper rolls. In 1976 and thereafter, data were recorded both on analog paper roles and using DIPS. Polar Science Center investigators developed a method to scan and digitize the analog draft data so that they are as equivalent to the digitally recorded DIPS data as possible (Wensnahan and Rothrock, 2005). These data were added in 2006. This portion of the collection is referred to as the analog portion.

The map in Figure 2 shows submarine tracks from the digital (non-analog) portion of the data set.

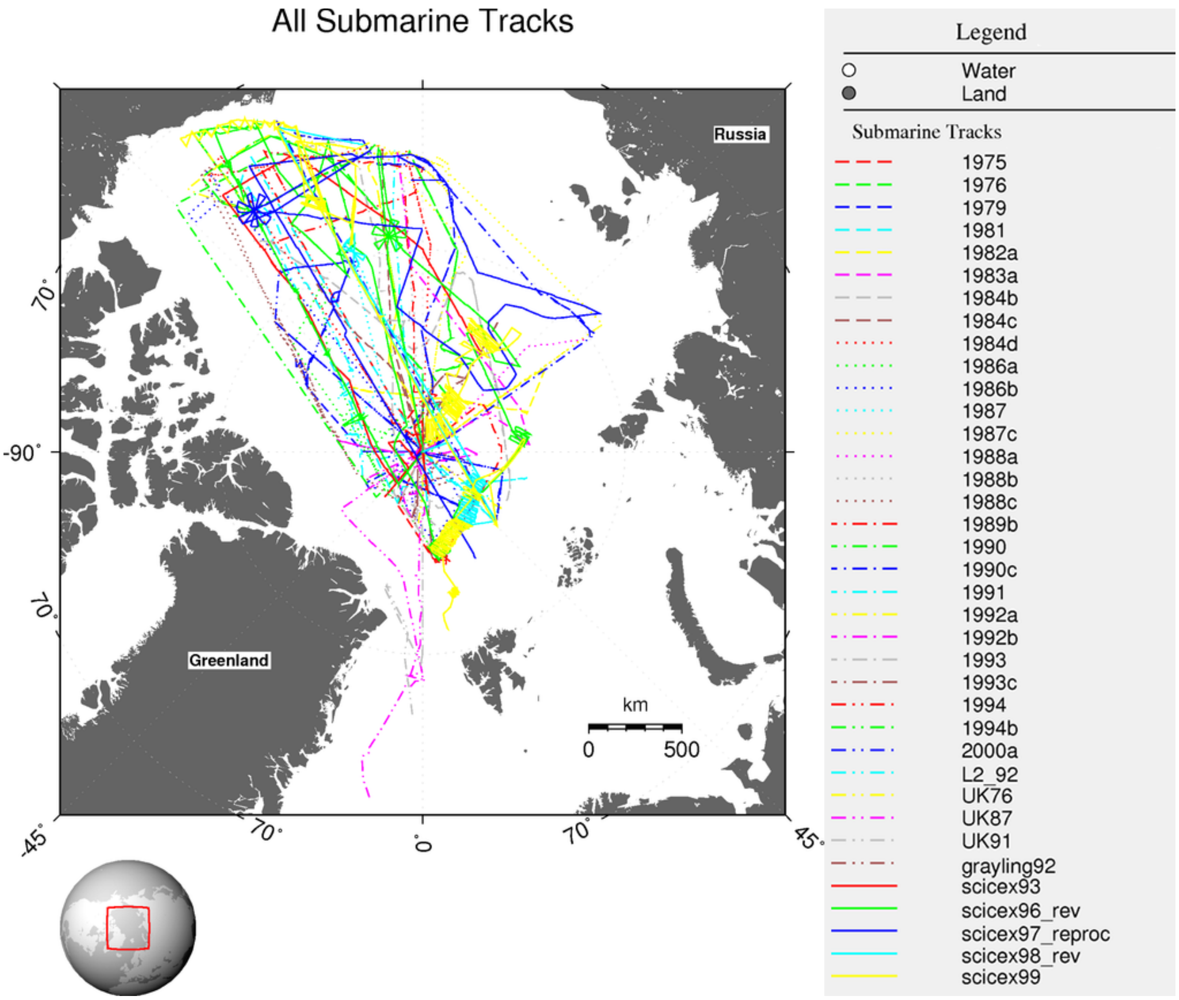


Figure 2. Submarine Tracks from the Digital (Non-Analog) Portion of this Data Set.

1.3 Format

Data files are ASCII text format in two types of files, one for ice draft profiles and the other for statistics derived from the profile data. Ice draft files include a header that gives date and location information followed by a sequential list of drafts spaced at 1.0 m intervals that comprise the bottom-side sea-ice roughness profile. Data in each file fall along a straight-line (great circle) track between the two end points given in the header. The length of the profile in any given file can be up to 50 km, but may be shorter if data dropouts create gaps greater than 0.25 km, or if changes in course cause deviations from a straight-line track. Statistics files include information on ice draft characteristics, keels, level ice, leads, un-deformed, and deformed ice. For background information on scientific uses of ice draft data such as these statistical measures of ice deformation, see Analysis of Arctic Ice Draft Profiles Obtained by Submarines, a note provided by W. Tucker and S. Ackley, CRREL, Hanover, NH, in July 1998.

Appendix A – Submarine Cruise Information shows the cruise reference name (click to see cruise track), dates, number of segments, the size of the directory containing the data (after uncompressing and untarring), and examples of naming conventions for the data files. NSIDC is told how we may refer to each cruise by the data providers. We have agreed to adhere to this naming convention. Therefore, NSIDC cannot provide the submarine names for all cruises to users of this data set. Note that permission was obtained to release some SCICEX-99 data acquired outside the previously mentioned release box.

The description of the data in this section is applicable to the non-analog portion of the data set. The analog portion of the data set is described in a document provided by M. Wensnahan: Documentation for G01360 Analog Portion.

1.4 File Naming Convention

For non-analog U.S. Navy cruise data, the file name begins with four characters denoting the cruise. The next four characters are either `drft` (for draft files) or stat (for statistics files). Each file name is followed by a three-digit extension that corresponds to an ice segment. The extensions were assigned in the order in which the segments were acquired by the submarine. Each draft file contains data for one ice segment. Each statistics file contains data (19 parameters) for one ice segment. For SCICEX-97 and SCICEX-98 data, data files for segments acquired in the vicinity of the Surface Heat Balance of the Arctic Ocean (SHEBA) experiment have `_sheba` added to their names. For SCICEX-99 data, the naming convention is as follows: sc99drft.404_002.002 indicates data collected on April 4 (404), and this is the second segment processed for this day (_002). The segment required processing in parts, and this is the second (.002) part of the segment.

See Notes on U.K. Data Files, and Documentation for G01360 Analog Portion for information on the naming convention for Royal Navy and U.S. Navy analog portion files.

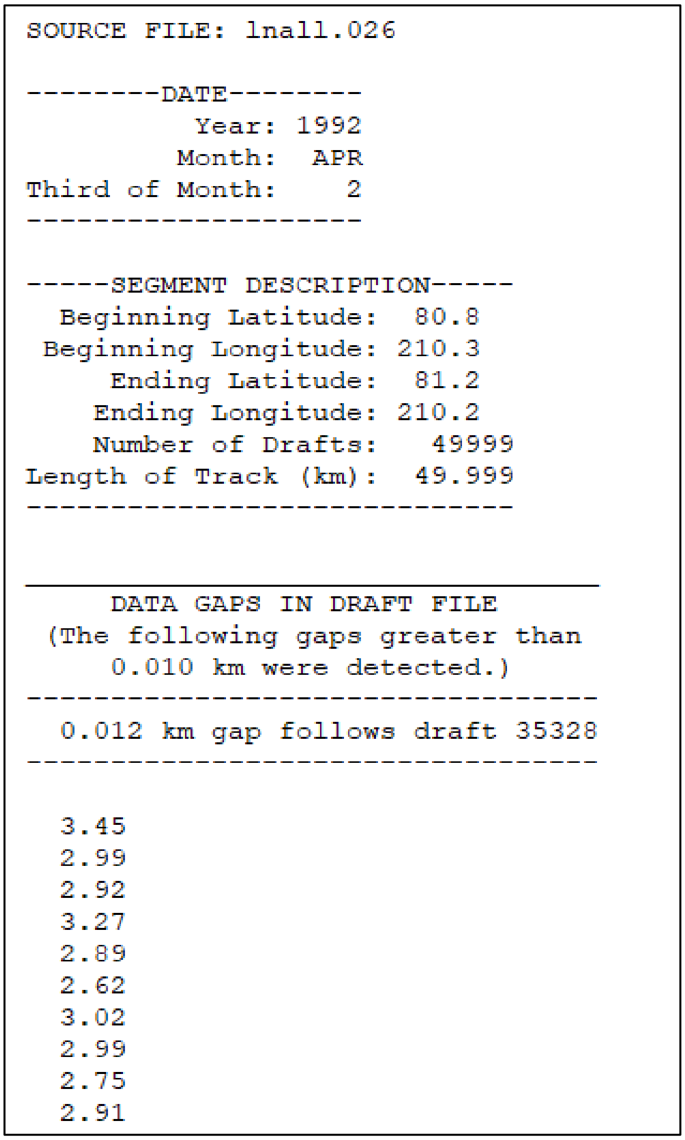
1.5 File Header Format and Information

File headers at the beginning of the draft and statistics files give the following information concerning the data segment from which information in the archive file was generated (Figure 3):

1. The name of the source file from which the data were generated.
2. Date information consisting of the exact date (year, month, and day) the data were acquired, for SCICEX data; in the case of previously classified data, the year, month, and the third of the month (1=Days 1 to 10, 2=Days 11 to 20, 3=Days 21 to 31) in which the data were acquired.
3. Geographic coordinates of the first and last drafts in the file; in the case of previously classified data, the coordinates are rounded to the nearest 0.1° north latitude and east longitude.

4. The number of drafts in the profile segment.
5. The length of track included in the profile segment in kilometers.
6. The length and location within the draft file of any gaps that exceed 10.0 m in length.
   Profile length is the great circle distance between unrounded latitude-longitude coordinates of the first and last drafts, for both SCICEX and previously classified data. Individual draft measurements are equally spaced at approximately 1.0 m intervals along the great circle arc.

   Note that the number of draft values at 1.0 m spacing can sometimes be greater or less than the profile length in meters. Two reasons for this are rounding error (draft values are nominally every 1 meter, but may be slightly more or less), and the fact that minor turns or turns of short duration in the submarine track may not have been edited from the data record.



```
SOURCE FILE: lnall.026

--------DATE--------
         Year: 1992
        Month:  APR
Third of Month:    2
--------------------

-----SEGMENT DESCRIPTION-----
  Beginning Latitude:  80.8
 Beginning Longitude: 210.3
     Ending Latitude:  81.2
    Ending Longitude: 210.2
    Number of Drafts:   49999
Length of Track (km):  49.999
-----------------------------


__________________________________
     DATA GAPS IN DRAFT FILE
 (The following gaps greater than
     0.010 km were detected.)
----------------------------------
  0.012 km gap follows draft 35328
----------------------------------


  3.45
  2.99
  2.92
  3.27
  2.89
  2.62
  3.02
  2.99
  2.75
  2.91
```

Figure 3. Ice draft file (L292drft.026) showing header and first 10 drafts in meters

1.6 Notes on U. K. Data Files

The header file for the U.K. data (the equivalent of Figure 3) has a slightly different format. The naming convention for the U.K. files is `XXYYzzzz.xyy`, where `XX` designates month, `YY` is the year, `zzzz` is `drft` or `stat`, for draft or statistics file, `x` is a placeholder that designates which survey of the cruise the data are from when a cruise has more than one survey, and `yy` is the segment number.

The 1976 UK submarine data are from USS Gurnard in the Beaufort Sea with approximate latitude/longitude coordinates supplied. Centroids were not determined. An experimental narrow-beam sonar was used (Wadhams and Horne, 1980).

The 1987 UK submarine data are from the HMS Superb in the Greenland Sea & Eurasian basin. Data are in two legs (a and b). Segments a03 and b46 have insufficient data for analysis. For segments b45, b55, b58, b60 and b61 the ice regime is not conducive to standard analyses; therefore, these segments were processed with level ice slope of 0.05 and minimum lead width set to zero.

1.7 Volume

The entire data set is approximately 150 MB.

1.8 Spatial Coverage

The following are the approximate latitude/longitude bounding coordinates:

Northernmost Latitude: 90° N
Southernmost Latitude: 70° N
Easternmost Longitude: 180° E
Westernmost Longitude: 180° W

1.8.1 Spatial Resolution

Varies

1.9 Temporal Information

The data span from 1 February 1960 to 30 November 2005 with varying resolutions.

1.10 Parameter or Variable

The parameters in this data set are the following:

- Sea Ice Draft
- Sea Ice Depth/Thickness
- Sea Ice Deformation
- Sea Ice Roughness
- Sea Ice Leads

2 DATA ACQUISITION AND PROCESSING

The description of the data in this section is applicable to the non-analog (digital) portion of the data set. The analog portion of the data set is described in a document provided by M. Wensnahan: Documentation for G01360 Analog Portion.

Also see Processing of the SCICEX '98 Submarine Data, by Y. Yu and S Dickinson, for information on corrections that needed to be applied to the SCICEX 98 data due to errors that were caused by an improperly working depth gauge.

2.1 Ice Draft Files

In order to statistically analyze these data, they were interpolated to even spatial intervals. The raw, digital data contain information only about ice draft and time, which is not useful for statistical, fractal, or spectral analysis. To obtain ice drafts at uniform spatial intervals, the speeds and positions of the submarine were integrated with the interpolation routine. Segments of the data during which the submarine changed course and/or depth were removed. For some cruises, only segments greater than 10 km in straight-line length were retained for this data set.

Raw top-sounder profiles, from which data presented here are derived, were created by sampling ice draft with top-sounder profilers at intervals spaced equally in time as the submarine moved beneath the ice cover. Adjacent drafts in the raw profile, though recorded at intervals that are constant in time, represent spot measurements separated by non-constant distances, the length of which vary with changes in vessel speed. In this raw format, profiles from different tracks (or even from different segments of the same track) are not directly comparable because the same feature (keel, lead, etc.) sampled twice will have a different shape depending on whether the sensor platform was moving rapidly or slowly. Keels and other roughness elements in raw top-sounder profiles thus appear compressed at high speeds, and stretched out at low speeds. Such apparent differences in sampling rate bias summary statistics (mean draft, variance, etc.) and spectral characteristics (Fourier transforms, auto- and cross-correlation, etc.) because the bottom-side ice profile represented in one section of data is over- or under-sampled with respect to that in another section.

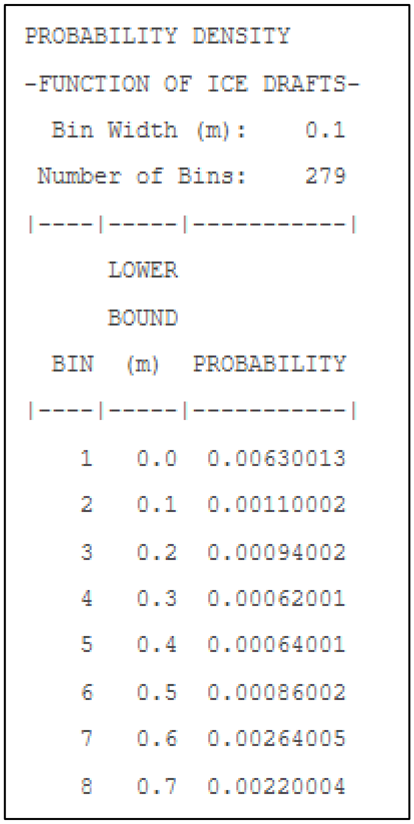
To eliminate this problem, interpolated profiles composed of drafts spaced equally in distance (as opposed to time) are created. Navigation data combined with speed and bearing information give good estimates of the geographic location of each draft. Great circle distances between points, calculated from geographic coordinates using standard mapping equations, provide a basis for interpolating a derivative set of equidistant drafts using a cubic spline algorithm [spline( ) and splint( )] (Press et al. 1992). The interpolated profiles that result, consisting of drafts spaced equally with respect to distance (nominally 1.0 m apart), form the basis of this data archive (Figure 3).

Individual ice draft files represent data acquired continuously over straight-line tracks that span distances up to 50 km in length. Data acquired while the vessel was turning have been removed. Gaps within archived profiles, resulting from dropouts and other sensor malfunctions, are shorter than 0.25 km; their length and location within the profile is noted in header information described above. When gaps greater than 0.25 km in length were encountered, one file was closed and the next opened. Draft measurements are given in meters, and the distance between consecutive drafts is 1.0 m.

2.2 Ice Statistics Files, Ice Draft PDF, and General Statistics

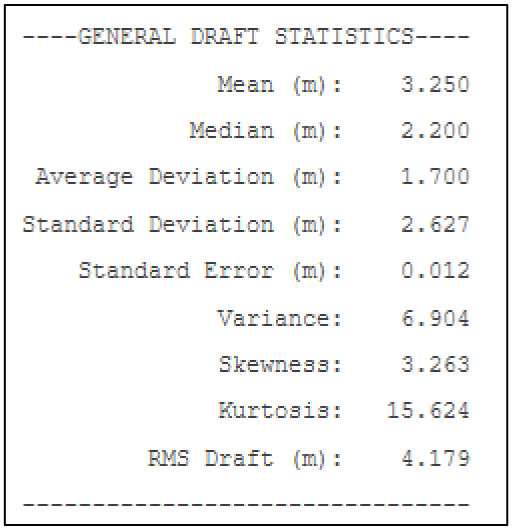
Basic statistical analysis was performed on the processed, interpolated data. Data of lengths 10 km to 50 km were retained. Although 50 km segments are preferable (Wadhams 1984), shorter segments were included because they add value to the data set, especially in regions where the ice morphology changes rapidly. Because these shorter segments were included, caution must be exercised when analyzing regional, seasonal, and interannual variations. The statistics data files are ASCII text files. Probability Density Functions (PDFs) (Figure 4) are derived from the frequency distribution of all drafts in the track segment. Bin width is 0.1 m. Counts in each bin are normalized by the total number of drafts in the segment to give the probability of occurrence of drafts of any given depth. Bins for which no drafts occur have probability of 0.0 and are omitted from the listing to save storage space (see, for example, BIN 276 for drafts between 27.5 and 27.6 m, Figure 4). This convention is used for all other pdfs in the statistics archive.

General statistics calculated for ice drafts in each segment include standard parametric descriptors of central tendency and dispersion (mean and median draft, variance, standard and average deviation, standard error, skewness, kurtosis, and root-mean-square draft, see Figure 5). Note that the mean is that of all ULS measurements, including open water.



```
PROBABILITY DENSITY
-FUNCTION OF ICE DRAFTS-
  Bin Width (m):    0.1
 Number of Bins:    279
|----|-----|-----------|
      LOWER
      BOUND
  BIN  (m)  PROBABILITY
|----|-----|-----------|
    1   0.0  0.00630013
    2   0.1  0.00110002
    3   0.2  0.00094002
    4   0.3  0.00062001
    5   0.4  0.00064001
    6   0.5  0.00086002
    7   0.6  0.00264005
    8   0.7  0.00220004
```

Figure 4. Example of the Probability Density Function (PDF) of ice drafts in a statistic file



```
----GENERAL DRAFT STATISTICS----
              Mean (m):    3.250
            Median (m):    2.200
 Average Deviation (m):    1.700
Standard Deviation (m):    2.627
    Standard Error (m):    0.012
             Variance:     6.904
             Skewness:     3.263
             Kurtosis:    15.624
         RMS Draft (m):    4.179
--------------------------------
```

Figure 5. Example of ice draft statistics in a statistics file

Specific formulae used to calculate these values are as follows (code used in these calculations borrows heavily from that given in the moment ( ), select ( ), and middle ( ) functions of Press et al.,1992):

$$Mean = \overline{X} = \frac{1}{N}\sum_{i=1}^{N} X_i$$

$$Median = X_{med} = \begin{cases} X_{(N+1)/2} & When \quad N \ is \ odd. \\ \left(X_{N/2} + X_{(N/2)+1}\right)/2 & When \quad N \ is \ even. \end{cases}$$

$$Variance = \frac{1}{N-1}\sum_{i=1}^{N}\left(X_i - \overline{X}\right)^2$$

$$Std.Dev = \sigma = \sqrt{Variance}$$

$$Avg.Dev. = \frac{1}{N}\sum_{i=1}^{N}\left|X_i - \overline{X}\right|$$

$$Std.Err = \frac{\sigma}{\sqrt{N}}$$

$$RMS_{draft} = \sqrt{\frac{\sum_{i=1}^{N} X_i^2}{N}}$$

$$Skewness = \frac{1}{N}\sum_{i=1}^{N}\left[\frac{X_i - \overline{X}}{\sigma}\right]^3$$

$$Kurtosis = \left\{\frac{1}{N}\sum_{i=1}^{N}\left[\frac{X_i - \overline{X}}{\sigma}\right]^4\right\} - 3$$

2.2.1 Autocorrelation

Function Autocorrelation measures the correlation between pairs of consecutive drafts within a profile. Pairs may consist of adjacent drafts, or drafts separated by a particular distance (lag). This process compares the ice draft profile with itself. Successive comparisons with increasing values of lag in effect slide the profile past itself and allow one to determine whether periodicities exist that lead to higher correlations at some offsets than at others. Such periodicities, if they exist, may arise from periodic noise in the profile, or may reflect geophysical phenomena that produce recurring features.

First-order autocorrelation considers correlation between the set of all pairs of adjacent drafts:

`(X1, X2), (X2, X3), (X3, X4), ....., (Xi-1, Xi), ....., (Xn-1, Xn).`

This assumes that the distance between consecutive drafts is constant; drafts used here are interpolated to a nominal spacing of 1.0 m, so this requirement is met. Higher order autocorrelations are calculated in sequence by comparing pairs of drafts separated by successively greater distance or lag. In the case where lag=2, for example, the set of adjacent pairs is represented by:

`(X1, X3), (X2, X4), (X3, X5), ....., (Xi-2, Xi), ....., (Xn-2, Xn),`

and for lag=5:

`(X1, X6), (X2, X7), (X3, X8), ....., (Xi-5, Xi), ....., (Xn-5, Xn).`

Autocorrelation r as a function of lag is defined as:

$$r_{lag} = \frac{\sum_{i=(lag+1)}^{n} (X_{i-1} - \overline{X})(X_i - \overline{X})}{\sum_{i=lag}^{n} \left(X_i - \overline{X}\right)^2}$$

The analog to this procedure in conventional correlation analysis is calculation of a correlation coefficient associated with the cluster of points produced by plotting, in a scatter diagram, all possible pairs of drafts that are separated by a given lag. The statistics archive lists autocorrelation as a function of lag from 0 to 150, inclusive (Figure 6). Inasmuch as the spatial separation between individual draft measurements is 1.0 m, this corresponds to a range of lags from 0.0 m to 150.0 m. In addition, a variable called Correlation Length, defined as the lag at which r_{lag} less than or equal to 1/e, is given as a basis for making general comparisons between autocorrelation functions calculated for different profile segments.

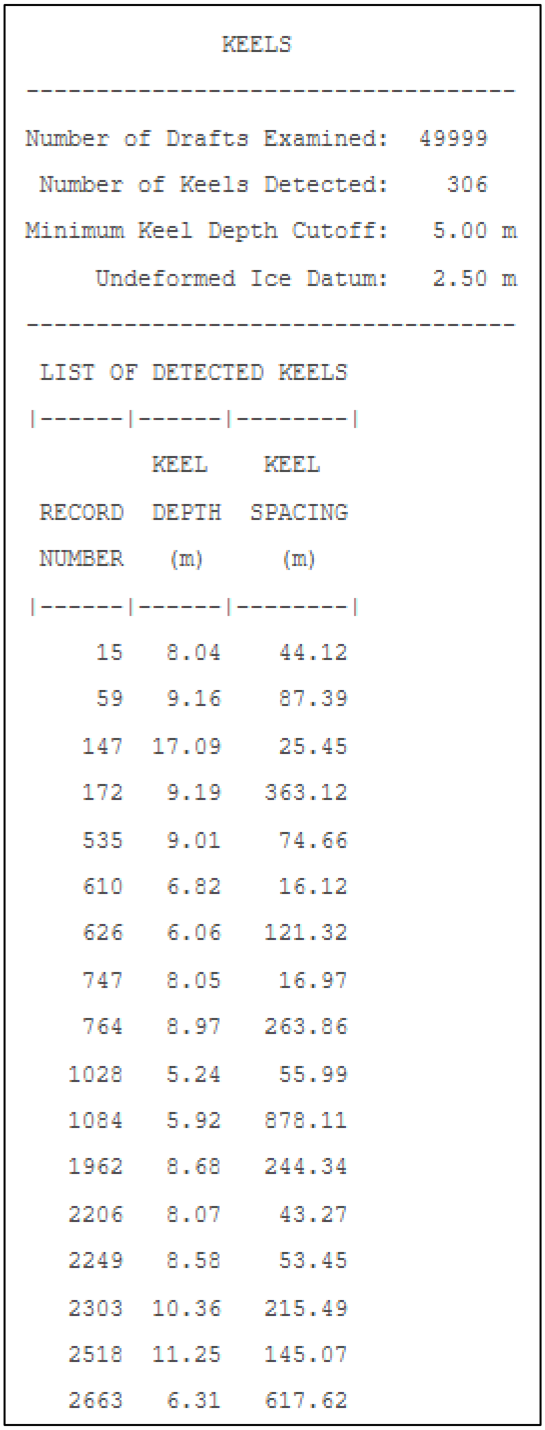
```
_______________
AUTOCORRELATION
---------------
Evaluated Lags From 0 To 150
Criterion for Correlation Length = 0.367879
Correlation Length = 45
|----|--------|
  LAG  R[LAG]
|----|--------|
    0  1.00000
    1  0.98696
    2  0.96349
    3  0.94327
    4  0.92245
    5  0.90072
    6  0.87947
    7  0.85825
    8  0.83758
    9  0.81778
```

Figure 6. Example of an autocorrelation function in a statistics file

2.2.2 Keels

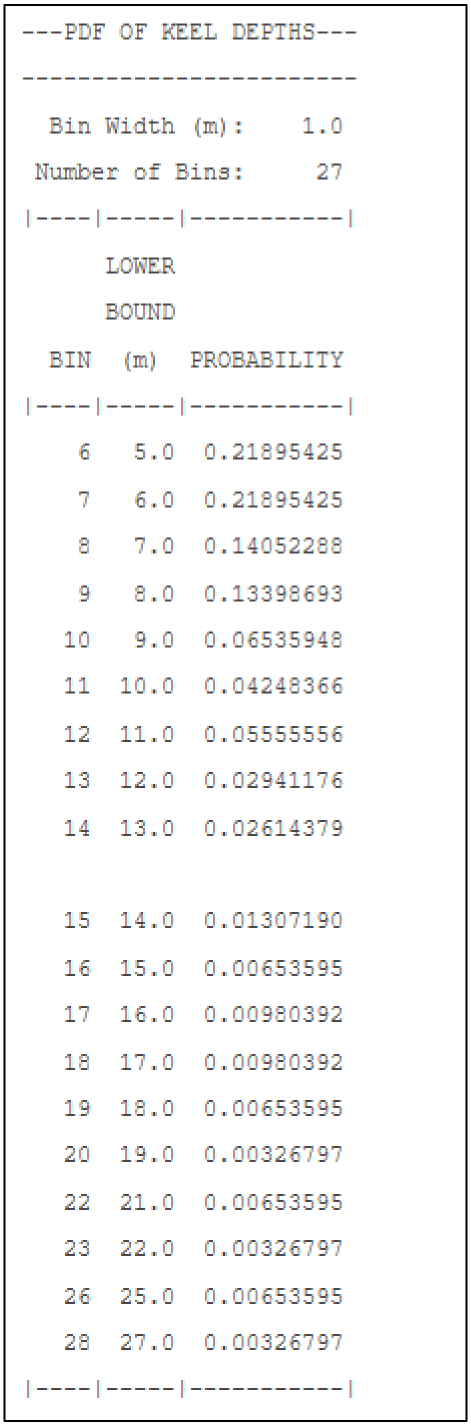
Keel detection is accomplished using an algorithm developed by A.W. Lohanick (unpublished). Lohanick's routine, which was originally written to detect ridges in laser profilometer data acquired during Project Birdseye, uses a Rayleigh criterion to identify local maxima (or, in the case of ice draft data, minima) that correspond to ridges (or keels). To qualify as a keel, an ice draft must be at least twice as deep as the local minimum draft measured from an undeformed ice datum (2.5 m), it must be the deepest draft among all local drafts, and it must be deeper than 5.0 m. Two or more keels that occur adjacent to each other are identified as independent features if they are separated by at least one draft that is less than half the depth of the first keel in the pair, as measured from the undeformed ice datum (2.5 m). Otherwise they are identified as a single feature with a draft equal to the local maximum.

Keels detected using this routine are listed in a table giving the record number at which the keel occurs in the draft file, the depth of the keel, and the distance to the previous keel (Figure 7). Additional tables give pdfs of keel depths with a bin width of 1.0 m (Figure 8) and of spacings between adjacent keels with a bin width of 50.0 m (Figure 9). Summary statistics calculated for keel depths and keel spacings using equations given above for draft statistics give mean, median, maximum and minimum draft and spacing, average and standard deviation, and variance, skewness, and kurtosis (Figure 10).



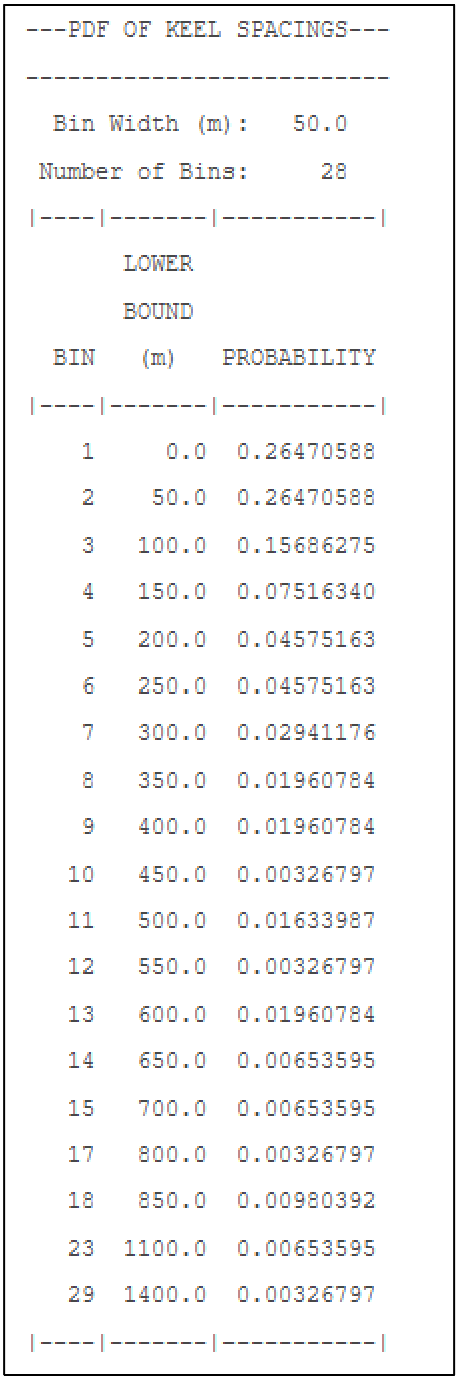
```
                KEELS
-----------------------------------
Number of Drafts Examined:  49999
 Number of Keels Detected:    306
Minimum Keel Depth Cutoff:   5.00 m
     Undeformed Ice Datum:   2.50 m
-----------------------------------
 LIST OF DETECTED KEELS
|------|------|--------|
        KEEL    KEEL
 RECORD DEPTH  SPACING
 NUMBER  (m)     (m)
|------|------|--------|
     15   8.04    44.12
     59   9.16    87.39
    147  17.09    25.45
    172   9.19   363.12
    535   9.01    74.66
    610   6.82    16.12
    626   6.06   121.32
    747   8.05    16.97
    764   8.97   263.86
   1028   5.24    55.99
   1084   5.92   878.11
   1962   8.68   244.34
   2206   8.07    43.27
   2249   8.58    53.45
   2303  10.36   215.49
   2518  11.25   145.07
   2663   6.31   617.62
```

Figure 7. Example list of keels in a statistics file



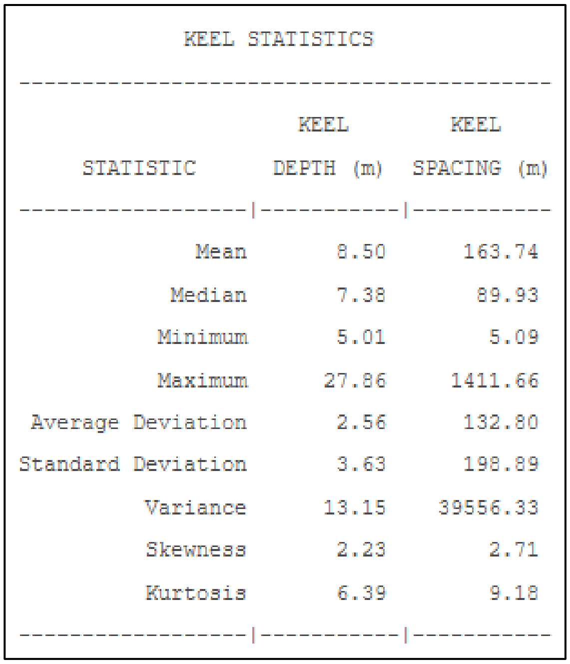
```
---PDF OF KEEL DEPTHS---
------------------------
  Bin Width (m):    1.0
 Number of Bins:     27
|----|-----|-----------|
      LOWER
      BOUND
  BIN  (m)  PROBABILITY
|----|-----|-----------|
    6   5.0  0.21895425
    7   6.0  0.21895425
    8   7.0  0.14052288
    9   8.0  0.13398693
   10   9.0  0.06535948
   11  10.0  0.04248366
   12  11.0  0.05555556
   13  12.0  0.02941176
   14  13.0  0.02614379

   15  14.0  0.01307190
   16  15.0  0.00653595
   17  16.0  0.00980392
   18  17.0  0.00980392
   19  18.0  0.00653595
   20  19.0  0.00326797
   22  21.0  0.00653595
   23  22.0  0.00326797
   26  25.0  0.00653595
   28  27.0  0.00326797
|----|-----|-----------|
```

Figure 8. Example Probability Density Function of keel depths in a statistics file



```
---PDF OF KEEL SPACINGS---
--------------------------
  Bin Width (m):   50.0
 Number of Bins:     28
 |----|-------|-----------|
       LOWER
       BOUND
  BIN   (m)    PROBABILITY
 |----|-------|-----------|
    1     0.0  0.26470588
    2    50.0  0.26470588
    3   100.0  0.15686275
    4   150.0  0.07516340
    5   200.0  0.04575163
    6   250.0  0.04575163
    7   300.0  0.02941176
    8   350.0  0.01960784
    9   400.0  0.01960784
   10   450.0  0.00326797
   11   500.0  0.01633987
   12   550.0  0.00326797
   13   600.0  0.01960784
   14   650.0  0.00653595
   15   700.0  0.00653595
   17   800.0  0.00326797
   18   850.0  0.00980392
   23  1100.0  0.00653595
   29  1400.0  0.00326797
 |----|-------|-----------|
```

Figure 9. Example Probability Density Function of keel spacings in a statistics file

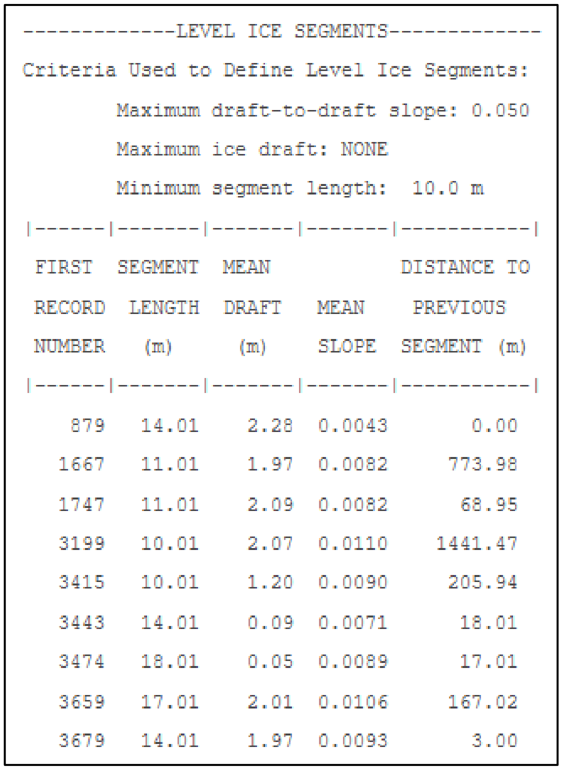


```
              KEEL STATISTICS
------------------------------------------
                        KEEL       KEEL
     STATISTIC       DEPTH (m)  SPACING (m)
------------------|-----------|-----------
              Mean       8.50     163.74
            Median       7.38      89.93
           Minimum       5.01       5.09
           Maximum      27.86    1411.66
 Average Deviation       2.56     132.80
Standard Deviation       3.63     198.89
          Variance      13.15   39556.33
          Skewness       2.23       2.71
          Kurtosis       6.39       9.18
------------------|-----------|-----------
```

Figure 10. Example keel depth and spacing statistics in a statistics file

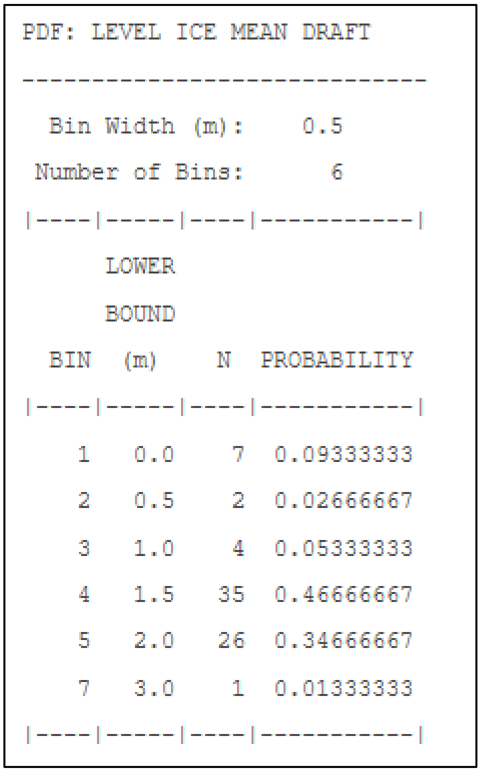
2.2.3 Level Ice Segments

Level ice segments are defined as a series of consecutive drafts spanning a distance greater than 10 m in length over which the slope between any two adjacent drafts is less than or equal to 0.050 (Figure 11). The magnitude of individual drafts is not a criterion. Level ice defined on this basis thus does not necessarily indicate thin ice or lead ice but can occur (and occasionally does occur) within thick first-year ice, multiyear ice, and regions of heavily deformed ice. Parameters given for each level ice segment include the record number within the draft file at which the segment begins, segment length, the mean of drafts within the segment, the mean of slopes between adjacent drafts within the segment, and the distance (spacing or separation) from the end of the previous level ice segment to the start of the current segment. Separate tables list pdfs of mean draft (Figure 12), level ice spacing (Figure 13), and level ice segment length (Figure 14). The bin width used for mean draft pdfs is 0.5 m, for mean spacing pdfs is 50.0 m, and for mean level ice segment length is 10.0 m.



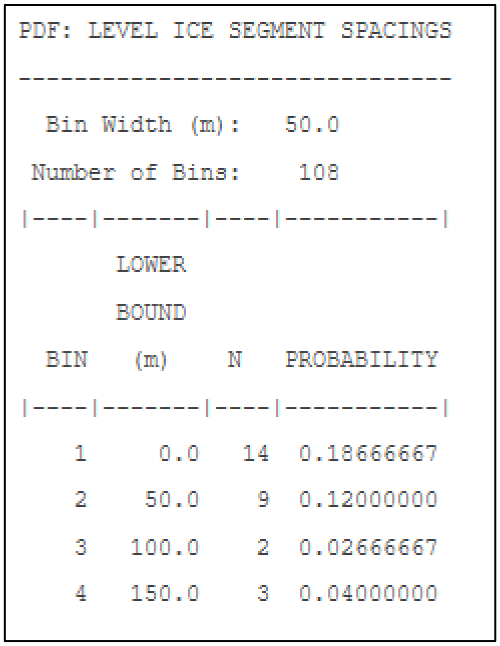
```
-------------LEVEL ICE SEGMENTS-------------
Criteria Used to Define Level Ice Segments:
        Maximum draft-to-draft slope: 0.050
        Maximum ice draft: NONE
        Minimum segment length:  10.0 m
|------|-------|-------|-------|-----------|
 FIRST  SEGMENT  MEAN           DISTANCE TO
 RECORD  LENGTH  DRAFT   MEAN    PREVIOUS
 NUMBER   (m)     (m)    SLOPE  SEGMENT (m)
|------|-------|-------|-------|-----------|
    879   14.01    2.28  0.0043        0.00
   1667   11.01    1.97  0.0082      773.98
   1747   11.01    2.09  0.0082       68.95
   3199   10.01    2.07  0.0110     1441.47
   3415   10.01    1.20  0.0090      205.94
   3443   14.01    0.09  0.0071       18.01
   3474   18.01    0.05  0.0089       17.01
   3659   17.01    2.01  0.0106      167.02
   3679   14.01    1.97  0.0093        3.00
```

Figure 11. Example list of level ice segments in a statistics file



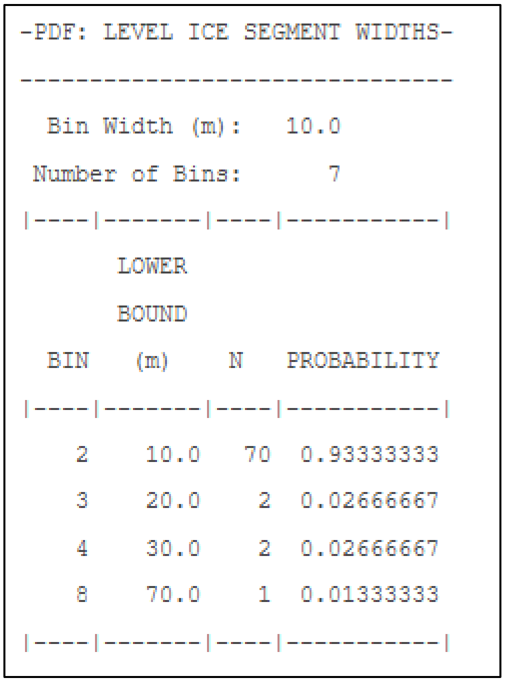
```
PDF: LEVEL ICE MEAN DRAFT
------------------------------
  Bin Width (m):    0.5
 Number of Bins:      6
|----|-----|----|-----------|
      LOWER
      BOUND
  BIN  (m)    N  PROBABILITY
|----|-----|----|-----------|
    1   0.0    7  0.09333333
    2   0.5    2  0.02666667
    3   1.0    4  0.05333333
    4   1.5   35  0.46666667
    5   2.0   26  0.34666667
    7   3.0    1  0.01333333
|----|-----|----|-----------|
```

Figure 12. Example of probability density function of mean draft in level ice segments in a statistics file



```
PDF: LEVEL ICE SEGMENT SPACINGS
-------------------------------
  Bin Width (m):   50.0
 Number of Bins:    108
|----|-------|----|-----------|
       LOWER
       BOUND
  BIN   (m)    N   PROBABILITY
|----|-------|----|-----------|
    1     0.0   14  0.18666667
    2    50.0    9  0.12000000
    3   100.0    2  0.02666667
    4   150.0    3  0.04000000
```

Figure 13. Example probability density function of separation between level ice segments in a statistics file

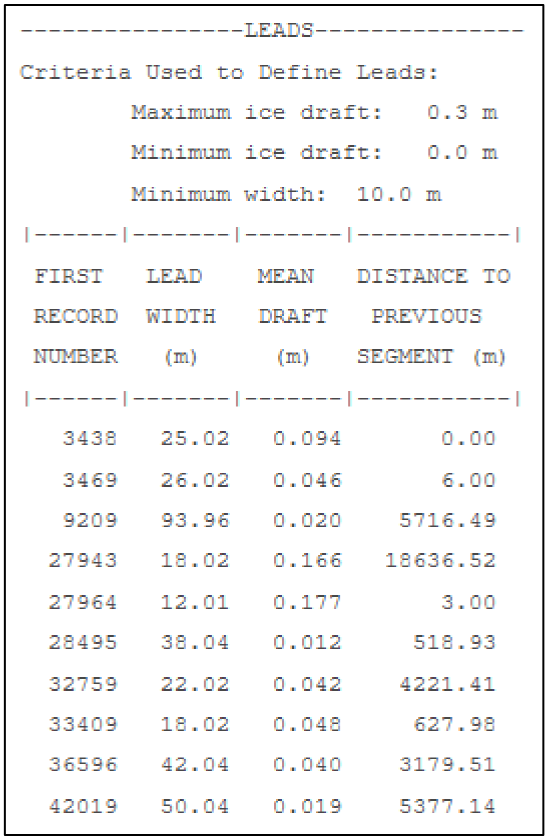


```
-PDF: LEVEL ICE SEGMENT WIDTHS-
-------------------------------
  Bin Width (m):   10.0
 Number of Bins:      7
|----|-------|----|-----------|
       LOWER
       BOUND
  BIN   (m)    N   PROBABILITY
|----|-------|----|-----------|
    2    10.0   70  0.93333333
    3    20.0    2  0.02666667
    4    30.0    2  0.02666667
    8    70.0    1  0.01333333
|----|-------|----|-----------|
```

Figure 14. Example probability density function of the width of level ice segments in a statistics file

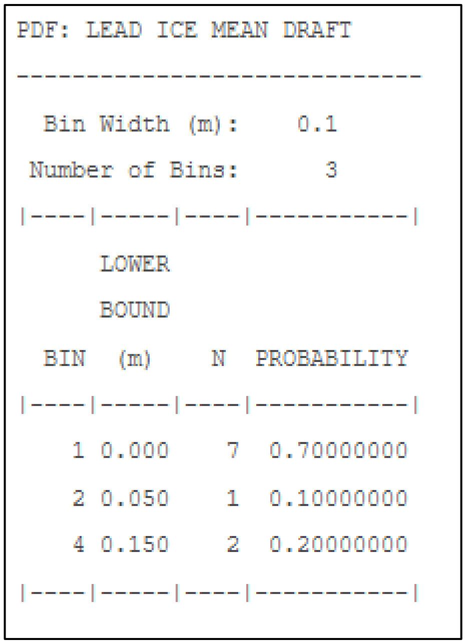
2.2.4 Leads

Leads are defined as a series of consecutive drafts, all of depth less than 0.3 m, that span a distance 10.0 m or greater in length. Parameters given for each lead segment include the record number within the draft file at which the segment begins, lead width, the mean of drafts within the segment, and the distance (spacing or separation) from the end of the previous lead to the start of the current lead (Figure 15). Separate tables list pdfs of mean draft within leads (Figure 16) and distance between adjacent leads (Figure 17). The bin width used for pdfs of mean lead draft is 0.05 m, and for mean spacing pdfs is 50.0 m.



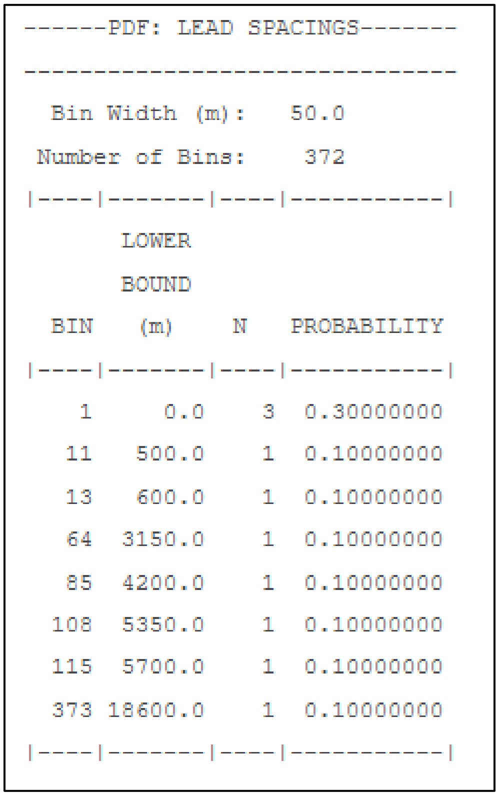
```
----------------LEADS---------------
Criteria Used to Define Leads:
        Maximum ice draft:   0.3 m
        Minimum ice draft:   0.0 m
        Minimum width:  10.0 m
|------|-------|-------|-----------|
 FIRST   LEAD    MEAN   DISTANCE TO
 RECORD  WIDTH   DRAFT   PREVIOUS
 NUMBER   (m)     (m)   SEGMENT  (m)
|------|-------|-------|-----------|
   3438   25.02   0.094        0.00
   3469   26.02   0.046        6.00
   9209   93.96   0.020     5716.49
  27943   18.02   0.166    18636.52
  27964   12.01   0.177        3.00
  28495   38.04   0.012      518.93
  32759   22.02   0.042     4221.41
  33409   18.02   0.048      627.98
  36596   42.04   0.040     3179.51
  42019   50.04   0.019     5377.14
```

Figure 15. Example list of leads in a statistics file



```
PDF: LEAD ICE MEAN DRAFT
-----------------------------
  Bin Width (m):    0.1
 Number of Bins:      3
|----|-----|----|-----------|
      LOWER
      BOUND
  BIN  (m)    N  PROBABILITY
|----|-----|----|-----------|
    1 0.000    7  0.70000000
    2 0.050    1  0.10000000
    4 0.150    2  0.20000000
|----|-----|----|-----------|
```

Figure 16. Example probability density function of mean draft in leads in a statistics file



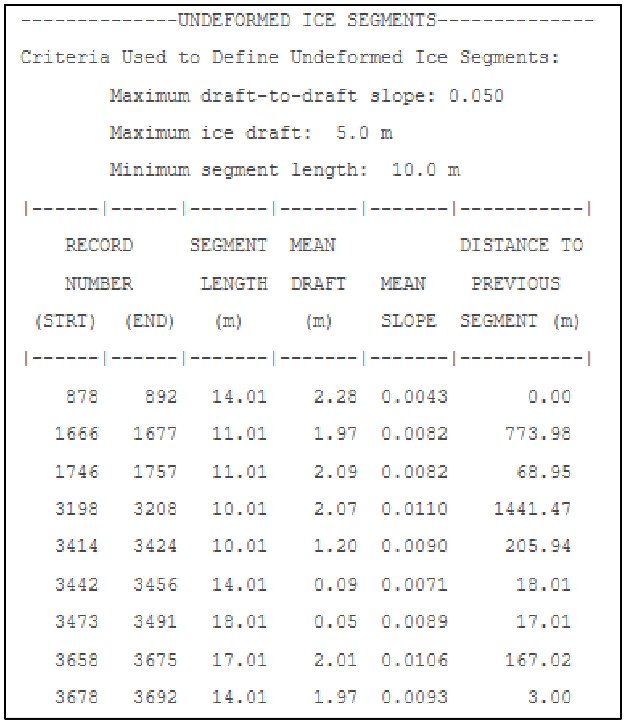
```
------PDF: LEAD SPACINGS-------
-------------------------------
  Bin Width (m):    50.0
 Number of Bins:     372
|----|-------|----|-----------|
        LOWER
        BOUND
  BIN    (m)     N   PROBABILITY
|----|-------|----|-----------|
    1     0.0     3  0.30000000
   11   500.0     1  0.10000000
   13   600.0     1  0.10000000
   64  3150.0     1  0.10000000
   85  4200.0     1  0.10000000
  108  5350.0     1  0.10000000
  115  5700.0     1  0.10000000
  373 18600.0     1  0.10000000
|----|-------|----|-----------|
```

Figure 17. Example probability density function of distances between leads in a statistics file

The depth criterion used to define lead segments effectively excludes ice that has undergone significant deformation. Adjacent lead segments separated by short distances, although listed here as separate features, thus may be part of the same lead. In the absence of sound criteria with which to distinguish ridged ice within a lead from thick ice between two adjacent but separate leads unambiguously, we leave it to the user community to establish their own rules to be applied to the draft profiles and lead statistics for discriminating between these two cases.

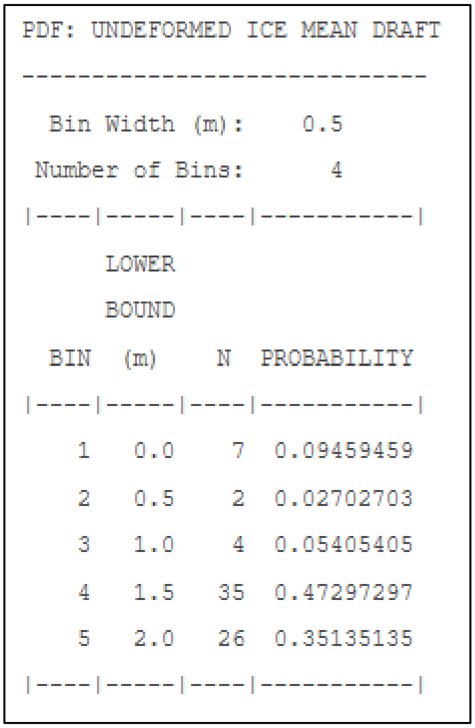
2.2.5 Undeformed and Deformed Ice

Undeformed ice is defined as a series of consecutive drafts, all of depth less than 5.0 m, that span a distance 10.0 m or greater in length over which the slope between adjacent drafts does not exceed 0.050; deformed ice is all ice that is not classified as undeformed on the basis of these criteria. Undeformed and deformed ice segments are listed in different tables of the same format. Parameters given include record numbers within the draft file at which segments begin and end, segment width, the mean of drafts within the segment, the mean of slopes between adjacent drafts within each segment, and the distance (spacing or separation) from the end of the previous segment to the start of the current segment (Figure 18). Separate tables list pdfs of mean draft within undeformed and deformed ice segments (Figure 19), distance between adjacent segments (Figure 20), and segment lengths (Figure 21). The bin width used for pdfs of mean draft is 0.5 m, for mean spacing pdfs is 50.0 m, and for segment length is 10.0 m.



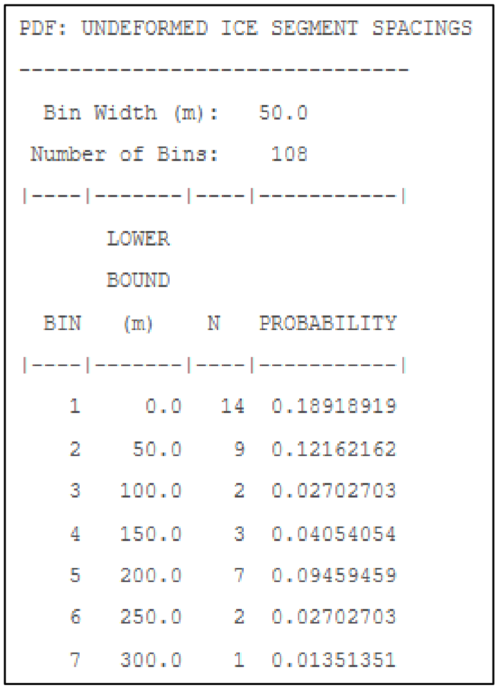
```
--------------UNDEFORMED ICE SEGMENTS--------------
Criteria Used to Define Undeformed Ice Segments:
        Maximum draft-to-draft slope: 0.050
        Maximum ice draft:  5.0 m
        Minimum segment length:  10.0 m
|------|------|-------|-------|-------|-----------|
   RECORD      SEGMENT  MEAN            DISTANCE TO
   NUMBER       LENGTH  DRAFT   MEAN     PREVIOUS
 (STRT)  (END)   (m)     (m)    SLOPE   SEGMENT (m)
|------|------|-------|-------|-------|-----------|
    878    892   14.01    2.28  0.0043        0.00
   1666   1677   11.01    1.97  0.0082      773.98
   1746   1757   11.01    2.09  0.0082       68.95
   3198   3208   10.01    2.07  0.0110     1441.47
   3414   3424   10.01    1.20  0.0090      205.94
   3442   3456   14.01    0.09  0.0071       18.01
   3473   3491   18.01    0.05  0.0089       17.01
   3658   3675   17.01    2.01  0.0106      167.02
   3678   3692   14.01    1.97  0.0093        3.00
```

Figure 18. Example list of undeformed ice segments (deformed segments given in identical format) in a statistics file



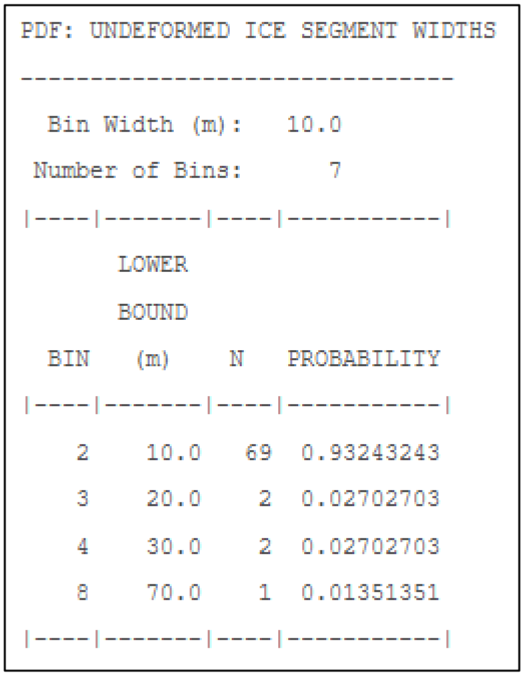
```
PDF: UNDEFORMED ICE MEAN DRAFT
------------------------------
  Bin Width (m):    0.5
 Number of Bins:      4
|----|-----|----|-----------|
      LOWER
      BOUND
  BIN   (m)    N  PROBABILITY
|----|-----|----|-----------|
    1   0.0    7  0.09459459
    2   0.5    2  0.02702703
    3   1.0    4  0.05405405
    4   1.5   35  0.47297297
    5   2.0   26  0.35135135
|----|-----|----|-----------|
```

Figure 19. Example probability density function of mean draft within undeformed ice segments in a statistics file



```
PDF: UNDEFORMED ICE SEGMENT SPACINGS
-------------------------------
  Bin Width (m):   50.0
 Number of Bins:    108
|----|-------|----|-----------|
      LOWER
      BOUND
  BIN   (m)     N   PROBABILITY
|----|-------|----|-----------|
    1     0.0   14  0.18918919
    2    50.0    9  0.12162162
    3   100.0    2  0.02702703
    4   150.0    3  0.04054054
    5   200.0    7  0.09459459
    6   250.0    2  0.02702703
    7   300.0    1  0.01351351
```

Figure 20. Example probability density function of distance between adjacent undeformed ice segments in a statistics file



```
PDF: UNDEFORMED ICE SEGMENT WIDTHS
-------------------------------
  Bin Width (m):   10.0
 Number of Bins:      7
|----|-------|----|-----------|
      LOWER
      BOUND
  BIN   (m)     N  PROBABILITY
|----|-------|----|-----------|
    2    10.0   69  0.93243243
    3    20.0    2  0.02702703
    4    30.0    2  0.02702703
    8    70.0    1  0.01351351
|----|-------|----|-----------|
```

Figure 21. Example probability density function of the width of undeformed segments in a statistics file

2.2.6 Note on Data Intervals and Segment Length

The following information was added to the documentation on 21 August 2003. It was provided by D. Eppler, Bronson Hills Associates, on 27 September 1999 in response to a user's question regarding why the track distance based on track endpoints is sometimes less or greater than would be expected based on number of meter-spaced data values in that segment. The text provided by D. Eppler was edited slightly by F. Fetterer:

"There are three possible explanations for why the track distance based on track endpoints is sometimes less or greater than would be expected based on number of meter-spaced data values in that segment. Two of the explanations arise from certain aspects of these data that cannot be changed. The third explanation involves errors we may have introduced by failing to detect turns in what we otherwise thought were long straight-line course segments.

1. Rounding Error: We create the profiles using an algorithm that converts time and speed in the raw data set to distance, which in turn allows us to apply a cubic spline technique to interpolate a series of equally spaced points (drafts) that are located 1.0 m apart. This entails a series of non-trivial calculations involving trig functions, square roots, and other library functions that introduce rounding errors. The nominal spacing between adjacent drafts thus is 1.0 m, but the actual spacing may be slightly greater than or less than this. I would expect that the sum of all errors over a long profile would approach 0.0 m, but this might not be the case. If, for example, the error tends to be negative more often than it is positive, the outcome would be a profile with more drafts in it than you would otherwise expect if the spacing was exactly 1.0 m between consecutive drafts. I do not think that the this type of imprecision in the exact location of a draft will have significant impact on most end-users of the data set, especially where the user is interested in summary statistics calculated for all drafts in an entire segment.

2. Navigation Uncertainty: We determine the location of drafts in the profile using a set of tie points taken from navigation logs provided to us by the Arctic Submarine Laboratory. At best, these points are recorded 30 minutes apart, but in some cases the time gap between successive points is on the order of an hour or more. That is to say that in the ideal case, we know exactly where the boat was twice in an hour; but we really don't know with certainty where the boat was in between successive navigation tie points. In the absence of conflicting information (from navigation notes, bearing or information recorded in the raw profile data set) we assume the course taken is a straight line between the successive tie points. As a check on this we look at the ship's heading that is recorded in the raw profile data provided us. If we see a course change, we break off the current straight-line segment and begin a new one after the turn ends. Recognize, however, that even a straight-line course typically deviates a bit--plus or minus two or three degrees from a mean heading is typical. Barring deviations greater that this we assume that a straight course is followed.

The straight-line course between navigation points is of course the shortest distance between them. Given that we know the actual course is not perfectly straight, it is likely that many profiles will have more points in them than would be expected if the nominal spacing is absolutely constant at 1.0 m. A 50 km segment thus may in fact end up with slightly more than 50,000 drafts because, in reality, the boat sailed a distance further than 50 km to get to the next tie point.

3. We erred in creating the segments: Occasionally we err when we put together a segment by including data taken while the boat was turning. Abrupt, tight 360 degree turns where the boat changes course, circles, and then comes back immediately to its previous course heading are common in some of the cruises. If we miss such momentary excursions from a straight-line course, this leads to segments in which there are many more points than there should be for the distance supposedly traveled. We believe we removed most if not all of these bad segments, but some may have been overlooked."

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3.2 Related Data Collections

- Ice Draft and Ice Velocity Data in the Beaufort Sea, 1990-2003
- AWI Moored ULS Data, Weddell Sea (1990-1998)
- AWI Moored ULS Data, Greenland Sea and Fram Strait, 1991-2002
- Moored Upward Looking Sonar Data

- The Environmental Working Group (EWG) Joint U.S.-Russian Arctic Sea Ice Atlas also contains formerly classified ULS data collected by U.S. Navy submarines from 1977 to 1993. Ice draft profiles and statistics, including probability density and cumulative distribution functions, are provided for over 200 individual track segments. Note that submarine cruise data in the EWG data set and in this data set were processed differently; ice draft profiles and statistics from the same cruise may differ in the two data sets. The EWG data were processed at the University of Washington Applied Physics Laboratory (APL) using APL software modified in 1994 by the addition of two routines (BSQTIME3 and BSQSPAC2) from Bronson Hills Associates (BHA) -- hereafter referred to as the APL software. The Submarine Upward Looking Sonar Ice Draft Profile Data and Statistics data were processed at CRREL using a suite of all-BHA software. APL software processing is nearly automatic, while BHA processing requires extensive interactive analysis. BHA allows data viewing, but it can potentially recover up to 30% more ice draft profiles. The Environmental Research Institute of Michigan (developers of the EWG data set) and Bronson Hills Associates compared the two processing methods at APL using SCICEX-93 ice draft data collected on September 4, 6, and 11 in the eastern Chukchi Sea, Beaufort Sea, and the North Pole regions. Results were as follows:
    - Segment length: Differences were always less than 6 m and most were less than 3 m. APL and BHA routines were consistent with respect to distances calculated from the raw top sounder data records.
    - Ice draft statistics: The mean and standard deviation compared well, but values of RMS draft departed significantly because the two software packages used different formulae for the RMS calculation.
    - Keel location: APL software selects more keels than the BHA software. Most discrepancies appear to arise from keel picks associated with broad keels characterized by multiple closely spaced peaks. APL software identifies these as separate keels and the BHA software a single keel.
    - Keel statistics: The APL software consistently provided mean keel drafts that exceeded the BHA values by 2.0 to 2.5 m. Standard deviations were consistent. This difference is thought to have occurred from the slightly different application of the Rayleigh criterion used for keel detection and APL interpolation methods (Fred Tanis, ERIM International, Yanling Yu, University of Washington, and Dennis Farmer, Bronson Hills Associates, provided this information.).
- Mooring data from the Beaufort Gyre Exploration Project

4 CONTACTS AND ACKNOWLEDGMENTS

The National Science Foundation Office of Polar Programs project "Analysis of Arctic Ice Draft Profiles Obtained by Submarines," W. B. Tucker III and S. F. Ackley, principal investigators, supported preparation of data for those cruises identified in Appendix A – Submarine Cruise Information as provided to NSIDC by Tucker or Eppler. The upward looking sonar data were interpolated and processed for release as unclassified data at the U.S. Army's Cold Regions Research and Engineering Laboratory (CRREL) in Hanover, New Hampshire. The U.S. Navy's Arctic Submarine Laboratory (ASL) provided the original data to CRREL. ASL approved declassification on behalf of the Chief of Naval Operations. Software and processing algorithms for these data were developed by D. Eppler and D. Farmer of Bronson Hills Associates, Hanover, NH. Bronson Hills Associates also provided technical documentation.

Preparation of the U.K. data (identified in Appendix A – Submarine Cruise Information as provided to NSIDC by Davis) was funded by a subcontract under the same National Science Foundation Office of Polar Programs project "Analysis of Arctic Ice Draft Profiles Obtained by Submarines." The data were processed by the Department of Applied Mathematics and Theoretical Physics, University of Cambridge, with the cooperation of the Royal Navy and the U.K. Hydrographic Office. N.R Davis and P. Wadhams were involved in the production of the U.K. data.

SCICEX-97 and SCICEX-98 data were provided by D.A. Rothrock and Y. Yu with the support of National Science Foundation (OPP-9617343). These are identified in Appendix A – Submarine Cruise Information as provided by Yu. The original data were provided by the U.S. Navy's Arctic Submarine Laboratory and were subsequently processed at the Polar Science Center, Applied Physics Laboratory, University of Washington. The software and processing algorithms were provided by B. Markham of ASL and by Bronson Hills Associates, making the data compatible with other submarine data archived previously by NSIDC. SCICEX-99 data were delivered to NSIDC by Tucker, and were processed by Bronson Hills Associates (D. Farmer) through the support of the Applied Physics Laboratory, University of Washington, and NSF grant OPP-9910331.

The U.S. analog data were processed at the Polar Science Center at the University of Washington and provided with documentation by M. Wensnahan and D. A. Rothrock (identified in Appendix A – Submarine Cruise Information as provided to NSIDC by Wensnahan). These data were prepared with funding from NSF Office of Polar Programs grant OPP-9910331.

Researchers making use of these invaluable data owe a debt of gratitude to the present and past staff of the Arctic Submarine Laboratory, San Diego, California, for their long-term stewardship of the data. Without guidance from ASL, and in particular without the collaboration of D. Bentley, J. Gossett, and T. Luallin release of these data to the scientific community would not be possible. The Arctic Submarine Laboratory holds raw data from all U.S. submarine cruises beginning with the first cruise under the ice in 1958.

This data set is maintained at NSIDC with support from the NOAA NESDIS National Geophysical Data Center.

5 DOCUMENT INFORMATION

5.1 Document Authors

This documentation was originally drafted by NSIDC's M. Marquis, based on information and incorporating written documentation provided by D. Eppler, Bronson Hills Associates. Supplementary documentation (information linked in the documentation) was provided by Y. Yu and S. Dickinson (Processing of the SCICEX '98 Submarine Data, on 14 May 2002), by W. Tucker and S. Ackley, (Analysis of Arctic Ice Draft Profiles Obtained by Submarines on 6 July 1998) and by M. Wensnahan (Documentation for G01360 Analog Portion, 17 July 2006).

5.2 Publication Date

24 July 1998

5.3 Document Revision Date

December 2020: A. Windnagel moved the content from HTML format to PDF, moved Table 1 to Appendix A, and updated broken links as needed.

August 2015: A. Windnagel added four new cruises to Table 1: 1960a, 1960b, 1969c, and 1970a. Also updated the temporal coverage.

January 2011: A. Windnagel added a table of acronyms and links to the SCICEX Web site.

December 2010: A. Windnagel added two new cruises to Table 1: 2005a and 2005e.

April 2008: L. Ballagh added new submarine track images created by B. Raup.

February 2007: L. Ballagh fixed three broken links in Table 1.

2006: F. Fetterer extensively edited and reformatted the documentation. This revision to the documentation coincided with the addition of the analog portion of cruise data.

The documentation was minimally revised as data from several additional cruises were provided by CRREL and the Polar Science Center after the initial 1998 release.

APPENDIX A – SUBMARINE CRUISE INFORMATION

Table A - 1. Cruise Information (*See acknowledgments, **Analog/Hand-digitized)

Cruise Reference Name	Start Date	End Date	Number of Draft Segments	Size of Untarred/ Uncompressed File Directory	File Name Convention/ Examples	Data Provider*, Date Provided	Date published by NSIDC	Raw data source
1960a (analog)	February 1960	February 1960	58	18.2 MB	1960a-r09-00-uwa.series 1960a-r09-00-uwa.stats	Wensnahan, April 2015	August 2015	USchart
1960b (analog)	August 1960	Augusts 1960	33	12.3 MB	1960b-r07a-00b-uwa.series 1960b-r07a-00b-uwa.stats	Wensnahan, April 2015	August 2015	USchart
1969c (analog)	April 1969	April 1969	6	2.4 MB	1969c-r10-00_-uwa.series 1969c-r10-00_-uwa.stats	Wensnahan, April 2015	August 2015	USchart
1970a (analog)	August 1970	August 1970	26	9.5 MB	1970a-r04-01_-uwa.series 1970a-r04-01_-uwa.stats	Wensnahan, April 2015	August 2015	USchart
1975 (analog)	May 1975	May 1975	32	23.7 MB	1975-000_-uwa.series 1975-000_-uwa.stats	Wensnahan, June 2006	September 2006	USchart
UK-76 (Gurnard)	07 April 1976	10 April 1976	27	22.0 MB	0476drft.002 0476stat.013	Davis, February 1999	May 1999	UKDIPS
1976 (analog)	April 1976	April 1976	182	75.0 MB	1976-002c-uwa.series 1976-002c-uwa.stats	Wensnahan, June 2006	September 2006	USchart

Cruise Reference Name	Start Date	End Date	Number of Draft Segments	Size of Untarred/ Uncompressed File Directory	File Name Convention/ Examples	Data Provider*, Date Provided	Date published by NSIDC	Raw data source
1979 (analog)	April 1979	April 1979	71	15.2 MB	1979-000_-uwa.series 1979-000_-uwa.stats	Wensnahan, June 2006	September 2006	USchart
1981 (analog)	October 1981	October 1981	24	6.2 MB	1981-005b-uwa.series 1981-005b-uwa.stats	Wensnahan, June 2006	September 2006	USchart
1982a (analog)	November 1982	November 1982	147	36.5 MB	1982a-000_-uwa.series 1982a-000_-uwa.stats	Wensnahan, June 2006	September 2006	USchart
1983a (analog)	August 1983	August 1983	49	15.8 MB	1983a-000_-uwa.series 1983a-000_-uwa.stats	Wensnahan, June 2006	September 2006	USchart
1984b (analog)	September 1984	September 1984	67	16.0 MB	1984b-000_-uwa.series 1984b-000_-uwa.stats	Wensnahan, June 2006	September 2006	USchart
1984c (analog)	November 1984	November 1984	101	10.2 MB	1984c-000_-uwa.series 1984c-000_-uwa.stats	Wensnahan, June 2006	September 2006	USchart
1984d (analog)	October 1984	November 1984	162	36.8 MB	1984d-002_-uwa.series 1984d-002_-uwa.stats	Wensnahan, June 2006	September 2006	USchart
1986a	May 1986	June 1986	111	19.1 MB	1986adrft.053 1986astat.090	Unknown, February 2001	December 2001	USDIPS
1986b	02 April 1986	03 April 1986	82	21.0 MB	1986bdrft.001 1986bstat.001	Tucker, February 2001 (original)	March 2001	USDIPS
						Tucker, May 2004 (corrected)	July 2004	
UK-87 (analog)	08 May 1987	26 May 1987	130	82.8 MB	0587drft.a41 0587stat.b13	Davis, February 1999	May 1999	UK, A/H**

Cruise Reference Name	Start Date	End Date	Number of Draft Segments	Size of Untarred/ Uncompressed File Directory	File Name Convention/ Examples	Data Provider*, Date Provided	Date published by NSIDC	Raw data source
1987	02 April 1987	03 April 1987	64	17.7 MB	1987drft.035 1987stat.035	Unknown, February 2001	March 2001	USDIPS
1987c (analog)	May 1987	June 1987	182	50.0 MB	1987c-000_-uwa.series 1987c-000_-uwa.stats	Wensnahan, June 2006	September 2006	USchart
1988a	03 May 1988	03 May 1988	32	10.5 MB	1988drft.050 1988stat.064	Tucker, March 2000 (original)	May 2000	USDIPS
						Tucker, May 2004 (corrected)	July 2004	
1988b	01 August 1988	03 August 1988	47	12.9 MB	1988bdrft.018 1988bstat.018	Unknown, February 2001	March 2001	USDIPS
1988c (analog)	April 1988	May 1988	107	39.5 MB	1988c-000_-uwa.series 1988c-000_-uwa.stats	Wensnahan, June 2006	September 2006	USchart
1989b	September 1989	September 1989	47	13.6 MB	1989bdrft.018 1989bstat.099	Tucker, April 2002	June 2002	USDIPS
1990	March 1990	April 1990	35	5.3 MB	1990drft.131 1990stat.143	Tucker, November 2001	December 2001	USDIPS
1990c (analog)	September 1990	September 1990	79	24.3 MB	1990c-001a-uwa.series 1990c-001a-uwa.stats	Wensnahan, June 2006	September 2006	USchart
UK-91 (analog)	20 April 1991	22 April 1991	16	11.6 MB	0491drft.012 0491stat.021	Davis, February 1999	May 1999	UK, A/H**
1991	03 March 1991	02 May 1991	142	20.2 MB	1991drft.047 1991stat.107	Tucker, March 2000	May 2000	USDIPS

Cruise Reference Name	Start Date	End Date	Number of Draft Segments	Size of Untarred/ Uncompressed File Directory	File Name Convention/ Examples	Data Provider*, Date Provided	Date published by NSIDC	Raw data source
Grayling-1992	April 1992	April 1992	9	2.9 MB	g92drft.032 g92stat.0431992a	Tucker, February 1998 (original)	February 1998	USDIPS
						Tucker, May 2004 (corrected)	July 2004	
1992a	May 1992	May 1992	17	2.9 MB	1992adrft.015 1992astat.021	Tucker, September 2001	December 2001	USDIPS
1992b	August 1992	September 1992	38	8.8 MB	1992badrft.038 1992bstat.027	Tucker, September 2001	December 2001	USDIPS
L2-92	02 April 1992	02 April 1992	64	16.5 MB	L292drft.010 L292stat.052	Eppler, October 1998	November 1998	USDIPS
SCICEX-93	01 September 1993	12 September 1993	139	43.2 MB	sc93drft.041 sc93stat.131	Eppler, October 1998	November 1998	USDIPS
1993	02 April 1993	03 April 1993	86	24.1 MB	1993drft.034 1993stat.034	Tucker, February 2001	March 2001	USDIPS
1993c (analog)	April 1993	April 1993	81	20.7 MB	1993c-000a-uwa.series 1993c-000a-uwa.stats	Wensnahan, June 2006	September 2006	USchart
1994	01 April 1994	01 April 1994	85	30.1 MB	1994drft.146 1994stat.161	Tucker, September 1999	October 1999	USDIPS

Cruise Reference Name	Start Date	End Date	Number of Draft Segments	Size of Untarred/ Uncompressed File Directory	File Name Convention/ Examples	Data Provider*, Date Provided	Date published by NSIDC	Raw data source
1994b (analog)	September 1994	September 1994	31	10.5 MB	1994b-000_-uwa.series 1994b-000_-uwa.stats	Wensnahan, June 2006	September 2006	USchart
SCICEX-96	20 September 1996	22 October 1996	217	64.9 MB	sc96drft.095 sc96stat.141	Eppler, February 1999 (original)	March 1999	USDIPS
						Tucker, May 2004 (corrected)	July 2004	
SCICEX-97	03 September 1997	02 October 1997	217	64.9 MB	sc97drft.111 sc97drft_sheba.15 sc97stat.054 sc97stat_sheba.167	Yu, September 1999 (original)	October 1999	USDIPS
						Yu, June 2002 (corrected)	June 2002	
SCICEX-98 Note	02 August 1998	16 August 1998	129	44.2 MB	sc98drft.020 sc98drft_sheba.036 sc98stat.116 sc98stat_sheba.028	Yu, May 2002	June 2002	USDIPS
SCICEX-99	02 April 1999	13 May 1999	41 (plus subsegments)	119.0 MB	sc99drft.404_002.002 sc99stat.404_002.002	Tucker, November 2004	June 2005	USDIPS
2000a (analog) SCICEX SAM	October 2000	October 2000	158	46.9 MB	2000a-000_-uwa.series 2000a-000_-uwa.stats	Wensnahan, June 2006	September 2006	USchart

Cruise Reference Name	Start Date	End Date	Number of Draft Segments	Size of Untarred/ Uncompressed File Directory	File Name Convention/ Examples	Data Provider*, Date Provided	Date published by NSIDC	Raw data source
2005a (analog)	July 2005	July 2005	34	9.5 MB	2005a r03 - 00_ - release.Ser 2005a r03 - 00_ - release.Stats	Wensnahan, April 2010	December 2010	USchart
2005e (analog) SCICEX SAM	November 2005	November 2005	85	24.3 MB	2005e r05 - 03b - release.Ser 2005e r05 - 03b - release.Stats	Wensnahan, April 2010	December 2010	USchart