Unified Sea Ice Thickness Climate Data Record, 1947 Onward, Version 1

USER GUIDE

How to Cite These Data

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

Lindsay, R. and A. J. Schweiger. 2013, updated 2017. *Unified Sea Ice Thickness Climate Data Record, 1947 Onward, Version 1*. [Indicate subset used]. Boulder, Colorado USA. NSIDC: National Snow and Ice Data Center. https://doi.org/10.7265/N5D50JXV. [Date Accessed].

FOR QUESTIONS ABOUT THESE DATA, CONTACT NSIDC@NSIDC.ORG

FOR CURRENT INFORMATION, VISIT https://nsidc.org/data/G10006

National Snow and Ice Data Center

TABLE OF CONTENTS

Notice: In September 2013, the official archive for this data set was transferred from the Polar Science Center to NSIDC. However, the original Unified Sea Ice Thickness Climate Data Record web site, at the University of Washington, is still active and may contain more recent data than what is housed at NSIDC. If the latest data have not been added to this archive, yet, please visit the original Unified Sea Ice Thickness Climate Data Record web site for access to those data.

1 DETAILED DATA DESCRIPTION

1.1 Overview

This data set provides a collection of observations of sea ice from 1947 onward. It is the result of a concerted effort to collect as many observations as possible of Arctic and Antarctic sea ice draft, freeboard, and thickness and to format them consistently with clear documentation, allowing the scientific community to better utilize what is now a considerable body of observations. The Unified Arctic Sea Ice Thickness Climate Data Record includes data from moored and submarine-based upward looking sonar (ULS) instruments, airborne electromagnetic (EM) induction instruments, satellite laser altimeters (ICESat), and airborne laser altimeters (IceBridge). These instruments offer adequate sampling, starting in 1975, to establish the mean Arctic sea-ice thickness and the sea-ice thickness distribution at scales generally appropriate for change detection and climate model validation. The Unified Sea Ice Thickness Climate Data Record consists of over 15 different data sets. Each data set consists of a Summary file and a Distribution file. The majority of the data in this data set are for the Arctic with a small portion covering the Antarctic but is open to accepting more Antarctic data.

This document contains general information common to all the data sets, as well as specific information about each data set, and access to all the Summary and Distribution files. The metadata for each data set includes pointers to the original source data. For the complete list of all data sets see Table 1 for a summary or section 2 Data Acquisition and Processing for complete details.

1.2 History of Product Development

While sea ice extent is well measured by satellites, measuring sea ice thickness remains a challenge. However, the amount of sea ice draft and sea ice freeboard data available from both polar regions has increased markedly, providing a large and growing resource. Existing observations of sea ice thickness span a variety of methods, accuracies, and temporal and spatial scales and are archived in a variety of different locations and in different formats. Each data source has its own strengths in terms of sampling or accuracy. The uncertainties are documented to

various levels of detail for the different data sources but the documentation in general is spread throughout the literature.

This effort was funded by a grant from the NOAA Climate Program Office (from 2009 to 2013) to R.W. Lindsay at the Polar Science Center, University of Washington, Seattle to create a climate data record of sea ice thickness. A climate data record is "a time series of measurements of sufficient length, consistency, and continuity to determine climate variability and change" (NRC, 2004). Lindsay collected all the data, divided it into monthly or 50 km aggregates, calculated the statistics, formatted the output, posted the products on a web site, and wrote the documentation. An article describing the project was published in Eos:

Lindsay, R. W. 2010. New Unified Sea Ice Thickness Climate Data Record. Eos 91(44): 405-406.

In September 2013, the data set and documentation for the Unified Sea Ice Thickness Climate Data Record were transitioned from the Polar Science Center to NSIDC. The original Unified Sea Ice Thickness Climate Data Record web site, at the University of Washington, is still active.

If you have data on sea-ice draft, freeboard, or thickness that you would like to contribute to the Unified Sea Ice Thickness Climate Data Record, please contact one of the investigators listed at the end of this document in section 4 Contacts and Acknowledgments of this document.

1.3 File Contents

All data records are based on either a calendar month (for moorings) or on a region approximately 50 km in diameter (for submarine, airborne, or satellite data). Each one-month or 50 km aggregate represents a variable number of point measurements, depending on the measurement system and the specific sampling.

The Summary files contain monthly averages of moored ULS data or 50 km averages of submarine, airborne, or satellite data. Roughly 50 km of sea ice passes over a typical mooring site in a month, and monthly output is commonly saved in computer model runs. The Summary files also include the minimum, maximum, and standard deviation of the data in each one-month or 50 km aggregate. All Summary files are in the same ASCII text format.

The Distribution files are based on the same data that go into the Summary files. They consist of the fractional number of samples in each bin of sea ice draft or thickness. There are 300 bins of width 10 cm each, centered at 0, 10, 20, 30, ... 2990 cm. The first bin, centered at 0 cm, is for the open water fraction. All Distribution files are in the same ASCII text format.

One data set in this collection contains sea ice thickness measurements prior to 1975: the Ice Thickness Program run by Environment Canada, known here as CanCoast. Point measurements

of sea ice thickness on landfast ice at coastal stations in the Canadian Arctic Archipelago began in 1947. The program peaked during the years 1959-1991. Since only a few measurements were made each month at each station, no thickness distributions were calculated and hence there is no Distribution file.

Finally, a number of the data sets in this collection report sea ice draft. In order to convert sea ice draft into thickness, assumptions must be made about the density of sea ice and the density and depth of the snow on the sea ice. Only one data set (CanCoast) contains direct measurements of sea ice thickness and snow depth. The Airborne EM (Air-EM) data set measures the combined snow-plus-ice thickness. ICESat measures sea ice freeboard and then sea ice thickness is computed by the data set provider based on assumptions about snow depth and density. IceBridge aircraft measure sea ice freeboard and snow depth, and the IceBridge project derives sea ice thickness from them. Converting all data sets into consistent estimates of sea ice thickness is not a straightforward task, due in part to uncertainties in estimates of the depth and density of snow on sea ice. When a data set does not report sea ice thickness, the conversion to thickness is left to the user.

Table 1 lists the data set number and data set name, the years for which data are available, and the general location of the data. The Records column contains the number of lines in the Summary and Distribution files, excluding the initial one-line header. The Parameter/instrument column gives the primary parameter in the data set (draft or thickness) and the type of instrument that measured it. The Summary Variables column gives the three variables in the Summary file. **Note:** The third summary variable is always the primary variable of the data set.

Table 1. Data Sets Used in this Unified Sea Ice Thickness CDR

Data Set #	Short Name	Long Name	Years	Location	Records	Parameter/ Instrument	Summary Variables (See Table 2 for details)
1	NPEO	North Pole Environmental Observatory	2001 - 2010	North Pole	64	Draft / moored ULS	Temperature, Depth, Draft
2	BGEP	Beaufort Gyre Exploration Project	2003 - 2013	Beaufort Sea	371	Draft / moored ULS	Temperature, Depth, Draft
3	IOS-EBS	Institute of Ocean Sciences - Eastern Beaufort Sea	1990 - 2003	Eastern Beaufort Sea	382	Draft / moored ULS	Temperature, Depth, Draft

Data Set #	Short Name	Long Name	Years	Location	Records	Parameter/ Instrument	Summary Variables (See Table 2 for details)
4	IOS-CHK	Institute of Ocean Sciences - Chukchi Sea	2003 - 2005	Chukchi Sea	26	Draft / moored ULS	Temperature, Depth, Draft
5	US-Subs-AN	US Navy Submarines - Analog	1960 - 2005	Arctic Ocean	844	Draft / submarine ULS	None, Depth, Draft
6	US-Subs-DG	US Navy Submarines - Digital	1986 - 1999	Arctic Ocean	1001	Draft / submarine ULS	None, None, Draft
7	UK-Subs-AN	UK Navy Submarines - Analog	1987 and 1991	Arctic Ocean	149	Draft / submarine ULS	None, None, Draft
8	UK-Subs-DG	UK Navy Submarines - Digital	1976	Arctic Ocean	27	Draft / submarine ULS	None, None, Draft
9	AWI-GS	Alfred Wegener Institute - Greenland Sea	1991 - 2002	Greenland Sea	134	Draft / moored ULS	Temperature, Depth, Draft
10	Air-EM	Airborne Electromagnetic Induction	1991 - 2002	Arctic Ocean	134	Ice + Snow thickness / aircraft EM	None, Height, Ice+Snow Thickness
11	ICESat1-G	NASA ICESat Mission - Goddard	2003 - 2008	Arctic Ocean	29452	Thickness / sat. laser altimeter	None, Freeboard, Thickness
12	BIO-LS	Bedford Institute of Oceanography Lancaster Sound	2003 - 2007	Lancaster Sound	36	Draft / moored ULS	Temperature, Depth, Draft
13	CanCoast	Environment Canada	1947 - 2013	Canadian Archipelago, coastal stations	6242	Thickness / bore holes	None, Snow, Thickness
14	Davis_St	Polar Science Center - DS	2005 - 2008	Davis Strait	67	Draft / moored ULS	Temperature, Depth, Draft
15	IceBridge-V2	NASA Operation IceBridge V2	2009 - 2013	Arctic Ocean	933	Thickness / air. laser altimeter	Snow, Uncertainty, Thickness

Data Set #	Short Name	Long Name	Years	Location	Records	Parameter/ Instrument	Summary Variables (See Table 2 for details)
16	IceBridge-QL	NASA Operation IceBridge Quick Look	2012 - 2016	Arcitc Ocean	882	Thickness / air. laser altimeter	Snow, Uncertainty, Thickness
17	CryoSat-AWI	European Space Agency CryoSat satellite - Alfred Wegener Institute	2011 - 2017	Arctic Ocean	141714	Freeboard / radar altimeter	Uncertainy, Uncertainy, Thickness
18	ICESAT1-SH	NASA ICESat Mission - Southern Hemisphere	2003 - 2008	Southern Ocean	12432	Thickness / sat. laser altimeter	None, Freeboard, Thickness
19	AWI-WS	Alfred Wegener Institute - Weddell Sea	1990 - 2010	Weddell Sea	757	Draft / moored ULS	Temperature, Depth, Draft

Table 2. Description of Summary Variables from Table 1.

Summary Variable	Abbreviation used in Summary Files[1]	Description (units)
Temperature	Temp	Water temperature (°C)
Depth	Depth	Instrument depth (meters)
Draft	Draft	Sea-ice draft (meters)
Height	Hight	Instrument height (meters)
Ice+Snow Thickness	Ic+sn	Sea-ice thickness plus snow depth (meters)
Thickness	Thkns	Sea-ice thickness (meters)
Freeboard	Frbrd	Sea-ice freeboard (meters)
Snow	Snow	Snow depth (meters)
Uncertainty	Uncert	Sea-ice thickness uncertainty (meters) (Note for the CryoSat-AWI there are two uncertainties both labeled uncertainty. The first is random uncertainty and the second is systematic uncertainty.)

[1]In the actual Summary Files, these abbreviations are prepended by either Avg_, Min_, Max_, or SD_.

In addition, a complete listing of dates and specific geographic locations of each individual data set used is available in the following file: sea_ice_CDR_data_set_overview_v1.1.txt. Table 3 describes the columns of that file.

Table 3. Description of the Columns in sea_ice_CDR_data_set_overview_v1.1.txt

Column	Description
DSN	Data set number
DataSet	Data set name
Platform	Lists an abbreviation for the instrument used for each data set. For the ULS moorings, the platform name indicates the instrument. For example, for data set #1 (NPEO), NPEO-2001 indicates the ULS instrument that was put in place in 2001; NPEO-2002 indicates the instrument that was put in place in 2002, etc. For submarine data, the platform name indicates a different cruise by year. For Air-EM, the platform is the "Campaign". Different campaigns are different sets of flights. For example, the aircraft might be based at a certain location and make several flights from there. That would be one campaign. Later, the plane is based at another location and makes another set of flights. That is considered another campaign. For ICESat1-G, the platform (campaign) indicates which lasers were used. For CanCoast, the platform is the station where the measurements were made. For IceBridge, the platform is the campaign (like Air-EM, IceBridge is aircraft flights). For ICESat1-SH, see Table 24 for campaign descriptions and dates.
StartDate	Start date (yyyy mm dd)
StopDate	Stop date (yyyy mm dd)
MinLat	Minimum latitude (degrees)
MaxLat	Maximum latitude (degrees)
MinLon	Minimum longitude (degrees)
MaxLon	Maximum longitude (degrees)
Nobs	Number of point observations that went into the aggregated values given in the Summary and Distribution files.
Nagr	Number of aggregated values given in the Summary and Distribution files. The total of "Nagr" for a given data set is the number of Records given in Table 1 for that data set.

1.4 Format

1.4.1 Summary Files

Each Summary file is in ASCII plain text format. The first line of the file is a header identifying the variables, which are listed in Table 4. Subsequent lines of the file are the values of the variables for each one-month or 50 km aggregate. The number of data lines in each file is given in Table 1 in the column labeled Records.

The first 16 fields of each row in a Summary file, except the initial header row, contain the location, time, and other identifying information about the data. The last 12 fields of each row contain the average, minimum, maximum, and standard deviation of up to three variables. See Table 1 (last column) for a list of these three variables by file name. The values of these variables are computed from the underlying point measurements over a calendar month (for moorings) or over a region approximately 50 km in diameter (for other data sets). For example, in the North Pole Environmental Observatory (NPEO) summary data file, the three variables in the file are water temperature, instrument depth, and sea ice draft. So, the last four fields in each line of this file are the average, minimum, maximum, and standard deviation of sea ice draft over the one-month period given by the Month field in the year given by the Year field.

The header and data formats are:
header_format = (2a12, a10, 5a7, 6a8, a7, a10, 4(4a10))
data_format = (2a12, i10, i7, 3f7.1, i7, 6f8.2, i7, i10, 4(4f10.2))

Table 4. Summary File Column Descriptions

Column Name	Description
Source	Data set short name (see Table 1 for description)
Platform	This column heading is one of four terms, depending on the file: station, mooring, cruise, or campaign. Listed in this column is the name of the station, mooring, etc.
Index	Unique index for this summary record
Year	Year of observations used in this record
Yday	Mean day of year of observations used in this record
MinDay	Earliest day of year of observations used in this record
MaxDay	Latest day of year of observations used in this record
Month	Month (1 to 12) of observations used in this record
Lat	Mean latitude (degrees N)
Lon	Mean longitude (degrees E) (0 to 360)

Column Name	Description
MinLat	Minimum latitude of observations used in this record
MaxLat	Maximum latitude of observations used in this record
MinLon	Minimum longitude of observations used in this record
MaxLon	Maximum longitude of observations used in this record
Ndays or Length	Number of days in the month with observations (for moorings) or length of track (km) excluding gaps
Nsamps	Number of point measurements used in this record
avg_x	Average of first summary variable[1]
min_x	Minimum of first summary variable[1]
max_x	Maximum of first summary variable[1]
sd_x	Standard deviation of first summary variable[1]
avg_y	Average of second summary variable[1]
min_y	Minimum of second summary variable[1]
max_y	Maximum of second summary variable[1]
sd_y	Standard deviation of second summary variable[1]
avg_z	Average of third summary variable[1]
min_z	Minimum of third summary variable[1]
max_z	Maximum of third summary variable[1]
sd_z	Standard deviation of third summary variable[1]

[1]The values for 'x', 'y', and 'z' can be one of nine summary variable abbreviations. See the second column in Table 2 for a list of these abbreviations.

For example, the header for the NPEO Summary file is the following:

```
Source  Mooring  Index  Year  Yday  MinDay  MaxDay  Month
Lat  Lon  MinLat  MaxLat  MinLon  MaxLon  Ndays  Nsamps
Avg_temp  Min_temp  Max_temp  SD_temp
Avg_depth Min_depth Max_depth SD_depth
Avg_draft Min_draft Max_draft  SD_draft
```

The first line of data in the NPEO Summary file is the following (a value of -999 indicates a missing value where the data are not applicable or not available):

```
NPEO   NPEO-2001   1000000   2001   110.7   100.0   120.0   4
89.56   33.65   89.56   89.56   33.65   33.65   21   5490
-999.00   -999.00   -999.00   -999.00
48.63     46.53     50.33      0.25
3.70      0.00      18.60      2.61
```

1.4.2 Distribution Files

Each Distribution file is in ASCII plain text format. The first line of the file is a header identifying the variables, which are listed in Table 5. Subsequent lines of the file are the values of the variables for each one-month or 50 km aggregate, depending on the file. The number of lines in each file is given in Table 1 in the column labeled Records.

The first 19 fields of each row in a Distribution file, except the initial header line, contain the location, time, and other identifying information about the data. The first 16 of these are the same information as is found in the first 16 fields of the Summary files. After the first 19 fields, the Distribution file contains the probability density function (PDF) of either sea ice draft or sea ice thickness, depending on the data set. For example, the Distribution file for the NPEO data set contains the PDF of sea ice draft. The PDF constitutes the last 300 fields of each row. The PDF is based on the same one-month or 50 km aggregate of data as in the Summary file. The PDF consists of the fractional number of data values in each of 300 bins. The bins are 10 cm wide, and they are centered at 0 cm, 10 cm, 20 cm, 30 cm, ... 2990 cm. The first bin, centered at 0 cm, is for the open water fraction.

The header and data formats are:
header_format = (2a12, a10, 5a7, 6a8, a7, a10, a6, 8a7)
data_format = (2a12, i10, i7, 3f7.1, i7, 6f8.2, i7, i10, i6, 2f7.2, 300f7.4)

Table 5. Variables in Distribution Files

Column Name	Description
Source	data set short name (see Table 1 for description)
Platform	This column heading is one of four terms, depending on the file: station, mooring, cruise, or campaign.
Index	unique index (same as in corresponding Summary file)
Year	year of observations used in this record
Yday	mean day of year of observations used in this record
MinDay	earliest day of year of observations used in this record
MaxDay	latest day of year of observations used in this record
Month	month (1 to 12) of observations used in this record
Lat	mean latitude (degrees N)
Lon	mean longitude (degrees E) (0 to 360)
MinLat	minimum latitude of observations used in this record
MaxLat	maximum latitude of observations used in this record
MinLon	minimum longitude of observations used in this record

Column Name	Description
MaxLon	maximum longitude of observations used in this record
Ndays or Length	number of days in the month with observations (for moorings) or length of track (km) excluding gaps
Nsamps	number of point measurements used in this record
Nbins	number of bins in the distribution [300]
Width	width of bins (m) [0.10 meters]
First	center of first bin (m) [0.00 meters]
Distribution	Probability density function as decimal fractions [300 (Nbins) columns]

For example, the header for the NPEO Distribution file is the following:

```
Source    Mooring   Index   Year   Yday   MinDay   MaxDay   Month
Lat  Lon  MinLat  MaxLat  MinLon  MaxLon  N_days  Nsamps  Nbins  Width  First
```

The first line of data in the NPEO Distribution file is the following (a value of -999 indicates a missing value where the data are not applicable or not available):

```
NPEO NPEO-2001 1000000 2001 110.7 100.4 121.0 4
89.56 33.65 89.56 89.56 33.65 33.65 21 5490 300 0.10 0.00
0.0007 0.0047 0.0022 0.0035 0.0011 0.0013 0.0004 0.0040 0.0018 0.0024 0.0011
0.0026 0.0016 0.0020 0.0062 0.0066 0.0106 0.0206 0.0404 0.0590 0.0692 0.0625
0.0539 0.0454 0.0352 0.0308 0.0284 0.0242 0.0264 0.0164 0.0213 0.0160 0.0133
0.0155 0.0131 0.0113 0.0113 0.0107 0.0104 0.0080 0.0098 0.0106 0.0104 0.0087
0.0073 0.0084 0.0080 0.0084 0.0047 0.0100 0.0071 0.0071 0.0084 0.0062 0.0049
0.0056 0.0055 0.0062 0.0051 0.0066 0.0069 0.0047 0.0044 0.0049 0.0051 0.0035
0.0051 0.0033 0.0033 0.0047 0.0035 0.0038 0.0024 0.0031 0.0035 0.0024 0.0031
0.0029 0.0033 0.0024 0.0031 0.0026 0.0040 0.0031 0.0031 0.0009 0.0027 0.0018
0.0015 0.0022 0.0031 0.0027 0.0011 0.0011 0.0013 0.0018 0.0018 0.0015 0.0016
0.0007 0.0011 0.0011 0.0015 0.0013 0.0013 0.0009 0.0015 0.0011 0.0011 0.0007
0.0000 0.0009 0.0020 0.0002 0.0015 0.0009 0.0004 0.0007 0.0004 0.0013 0.0002
0.0007 0.0009 0.0005 0.0002 0.0005 0.0009 0.0007 0.0007 0.0002 0.0000 0.0004
0.0000 0.0007 0.0000 0.0002 0.0005 0.0004 0.0002 0.0004 0.0005 0.0002 0.0005
0.0004 0.0000 0.0004 0.0004 0.0002 0.0004 0.0004 0.0000 0.0002 0.0002 0.0000
0.0004 0.0004 0.0000 0.0002 0.0000 0.0002 0.0002 0.0000 0.0004 0.0000 0.0004
0.0002 0.0002 0.0002 0.0002 0.0002 0.0000 0.0002 0.0000 0.0002 0.0000 0.0000
0.0004 0.0004 0.0000 0.0002 0.0000 0.0000 0.0000 0.0000 0.0004 0.0005 0.0004
0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000
```

```
0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000
0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000
0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000
0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000
0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000
0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000
0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000
0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000
0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000
0.0000 0.0000 0.0000
```

1.5 File Naming Convention

All files reside in a single zip file named unified-sea-ice-thickness-cdr-1947-2017.zip. Once unzipped, the files are named according to the following convention:

```
DATASET_type_YYYY1_YYYY2_vx.txt
```

Where:

Table 6. File Naming Convention Variables

Variable	Description
DATASET	Short name of the data set. See Table 1 for the list of short names.
type	Type of data file: summaries or distributions
YYYY1	4-digit year of the start of the data
YYYY2	4-digit year of the end of the data
vx	Version number of the data (v1: version 1)
.txt	File extension designating this as an ASCII text file

Note: The the UK submarine analog files contain an "and" in the file name to distinguish that this file only contains two years of data instead of a range like the other files do.

1.6 File Size

See Table 1 for the number of records in each Summary and Distribution file. The size of each Summary file is 255 bytes × (number of records + 1). The size of each Distribution file is 2255 bytes × (number of records) + 154.

The zipped data file is 14 MB and the total volume is 146 MB unzipped.

1.7 Spatial Coverage and Resolution

For the moored ULS data sets, the spatial coverage is just a single point. See the Summary file or the Distribution file for the latitude and longitude of the instrument.

For other data sets, the underlying data have been grouped into regions approximately 50 km in diameter before computing the statistics in the Summary file and the probability density function in the Distribution file. The mean latitude and longitude of the underlying data in each 50 km region are given in both the Summary and the Distribution files, as are the minimum and maximum latitude and longitude. For a complete list of the geographic locations, see the sea_ice_CDR_data_set_overview_v1.1.txt file.

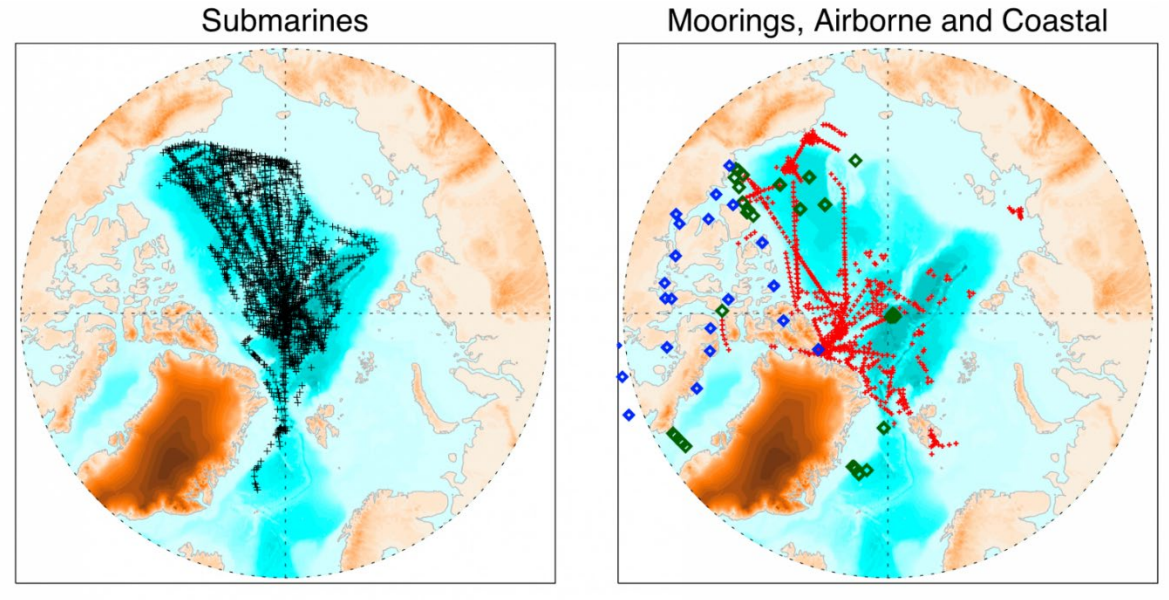

Figure 1. Left panel: Locations of all submarine observations. Right panel: Locations of moored (green), airborne (red), and coastal (blue) observations. ICESat observations (2005-2007) are not shown because their coverage includes the entire Arctic Ocean up to 86° N. These figures have not been updated since 2013.

1.8 Temporal Coverage and Resolution

The temporal coverage varies depending on the data set but the unified CDR begins in 1947 and goes through most recent processing. The mooring data have been grouped into calendar months before computing the statistics in the Summary file and the probability density function in the Distribution file. Each line (record) of the Summary and Distribution files contains the month and year for that record, as well as the mean day-of-year of the data for that month. The years spanned by the data are given in Table 1, but not every month of the entire span contains data - there are some gaps. See the Summary or Distribution files for the exact months and years of coverage. For a complete list of the dates, see the sea_ice_CDR_data_set_overview_v1.1.txt file.

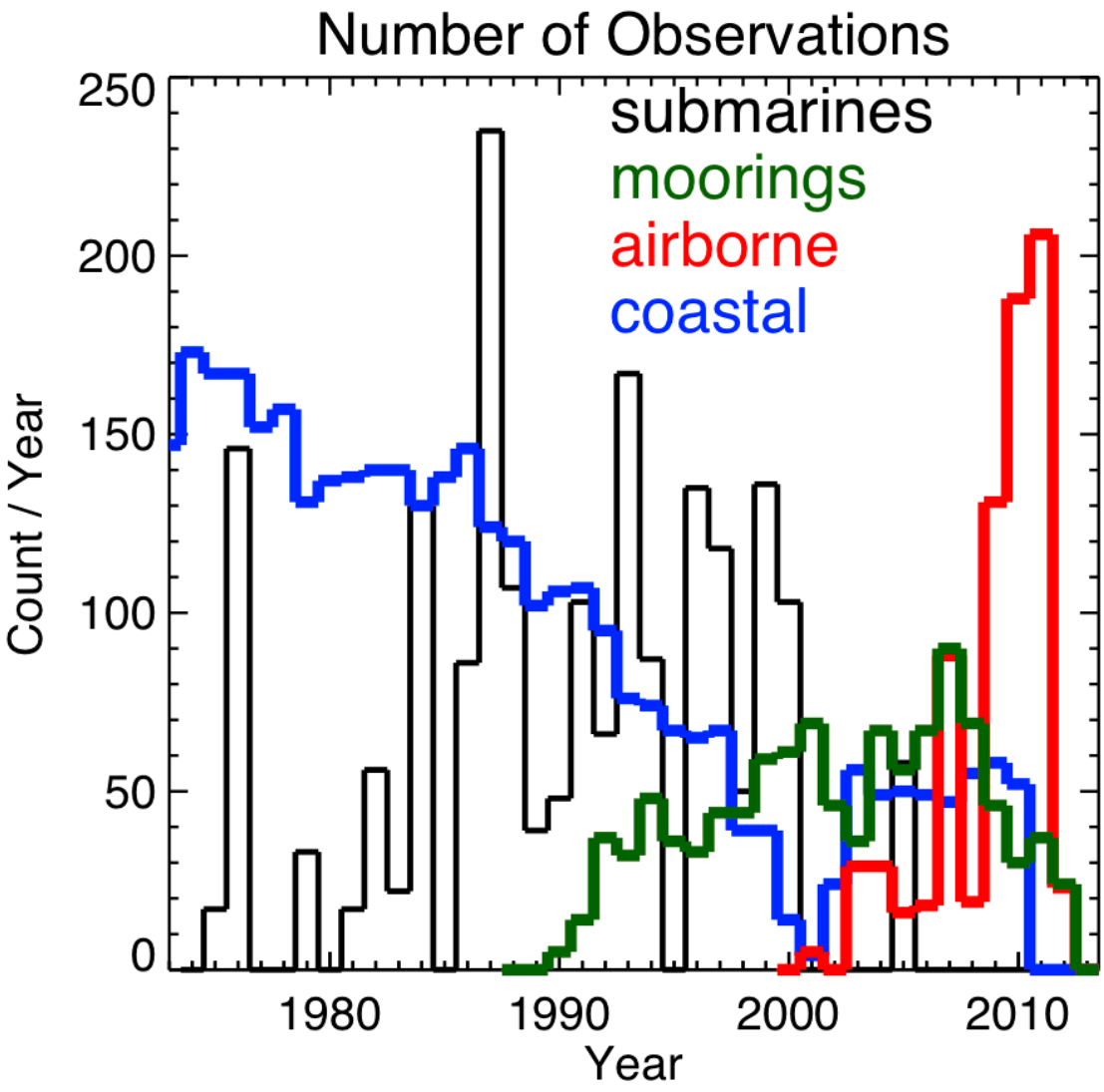

Figure 2. Temporal distribution of the aggregate observations from 1970 to 2012. This figure has not been updated since 2013.

1.9 Parameter or Variable

The parameters of this data collection are sea ice draft, sea ice thickness, and sea-ice-plus-snow thickness, depending on the data set. Ice draft is a measurement of the thickness of the sea ice below the waterline and often serves as a close proxy for total ice thickness. Note that draft, thickness, and sea-ice-plus-snow measurements are not available for the entire temporal coverage. Other Summary variables may also include water temperature, instrument depth or height, sea ice freeboard, snow depth, or sea ice thickness uncertainty. See Table 1 for a listing.

2 DATA ACQUISITION AND PROCESSING

2.1 Data Sources

This unified sea ice thickness data set was compiled from the sources described below.

North Pole Environmental Observatory (NPEO)

Table 7. NPEO Data Details

Organization	Polar Science Center, Applied Physics Laboratory, University of Washington, Seattle WA
Principal contact	Dr. Richard Moritz (dickm@apl.washington.edu)
Data web sites	http://psc.apl.washington.edu/northpole/ http://psc.apl.washington.edu/northpole/Mooring.html https://arcticdata.io/catalog/view/doi:10.18739/A29033
Methodology	APL Upward Looking Sonar (ULS) on bottom anchored moorings
Location	North Pole
Time interval	2001-2010
Number of samples	369490 point samples, 71 monthly averages
Documentation	2001 2002 2004 2005 2006-8 2008-10

Data Processing Notes

ULS data were processed and calibrated by R. Moritz. The ULS instruments were manufactured by the Applied Physics Laboratory, University of Washington. Statistical summaries were computed and reformatted by R. Lindsay from the point data. Additional details on the ULS instruments and calibration procedures are presented in Drucker et al. (2003). All of the NPEO ULS data through 2012 are included in this data set.

References

Drucker, R., S. Martin, and R. Moritz. 2003. Observations of ice thickness and frazil ice in the St. Lawrence Island polynya from satellite imagery, upward looking sonar, and salinity/temperature moorings. J. Geophys. Res., 108 (C5): 18-1 - 18-18. doi:10.1029/2001JC001213.

Rothrock, D. A. and M. Wensnahan. 2007. The Accuracy of Sea Ice Drafts Measured from U.S. Navy Submarines. J. Atmos. Oceanic Technol. 24: 1936-1949. doi: http://dx.doi.org/10.1175/JTECH2097.1.

Beaufort Gyre Exploration Project (BGEP)

Table 8. BGEP Data Details

Organization	Woods Hole Oceanographic Institute, Woods Hole, MA
Principal contact	Dr. Andrey Proshutinsky (aproshutinski@whoi.edu)
Project web site	http://www.whoi.edu/beaufortgyre
Methodology	ASL Upward Looking Sonar on bottom anchored moorings
Location	Four locations in the Beaufort Sea
Time interval	September 2003 to August 2011
Number of samples	417 x 106 2-second point values, 334 monthly averages
Documentation	ASL Ice Profiler Specifications (PDF, 88 KB) Data Processing Procedures (PDF, 2.9 MB)
Point data	http://www.whoi.edu/page.do?pid=66559
Citation	"The data were collected and made available by the Beaufort Gyre Exploration Project based at the Woods Hole Oceanographic Institution." If you use these data, please provide us with a citation to include in our compilation of publications. Send to Andrey Proshutinsky aproshutinsky@whoi.edu and Rick Krishfield rkrishfield@whoi.edu. See the BGEP publications list for a list of publications and PDF files.
Acknowledgments	National Science Foundation: The BGEP project is funded by the Office of Polar Programs grant numbers ARC-0230184, ARC-0424824, ARC-0532754, ARC-063399, ARC-0631951, ARC-0722694, ARC-0806115, ARC-0938137. Woods Hole Oceanographic Institution: WHOI is a private, nonprofit research facility dedicated to the study of marine science. Support to continue the BGEP field program for a second year was provided by the Ocean and Climate Change Institute.

Data Processing Notes

Data were processed and calibrated by R. Kirshfield, WHOI. The ULS instruments were manufactured by ASL Environmental Sciences. Statistical summaries were computed from the 2-second data by R. Lindsay, PSC. After 2008, significant new processing steps were required at WHOI to account for extensive open water seen during some periods. All available data through August 2011 are included.

Institute of Ocean Sciences - Eastern Beaufort Sea (IOS-EBS)

Table 9. IOS-EBS Data Details

Organization	Institute of Ocean Sciences, Sidney, BC, Canada
Principal contact	Dr. Humfrey Melling (Humfrey.Melling@dfo-mpo.gc.ca)
Data web site	http://nsidc.org/data/g02177
Methodology	ASL Upward Looking Sonar on bottom anchored moorings
Location	Eastern Beaufort Sea at 9 different sites
Time interval	April 1990 to September 2003
Number of samples	4.13 x 106 point values, 382 monthly averages at 9 locations
Documentation	NSIDC Documentation: Ice Draft and Ice Velocity Data in the Beaufort Sea, 1990-2003 ASL Ice Profiler Specifications (PDF, 88 KB)
Citation	Melling, H. and D.A. Riedel. 2008. Ice Draft and Ice Velocity Data in the Beaufort Sea, 1990-2003. Boulder, Colorado USA: National Snow and Ice Data Center. http://dx.doi.org/10.7265/N58913S6. See the NSIDC documentation for additional references.
Acknowledgments	Distribution of the data set from NSIDC is supported by funding from NOAA's National Environmental Satellite, Data, and Information Service (NESDIS) and the National Geophysical Data Center (NGDC).

Data Processing Notes

Data were processed and calibrated by H. Melling and D. A Reidel, IOS. The ULS instruments were manufactured by ASL Environmental Sciences. Monthly statistical summaries were computed by IOS and reformatted by R. Lindsay. The NSIDC data set has 10 observation sites, but the tenth has ice velocity data only.

Institute of Ocean Sciences - Chukchi Sea (IOS-CHK)

Table 10. IOS-CHK Data Details

Organization	Institute of Ocean Sciences, Sidney, BC, Canada
Principal contact	Dr. Humfrey Melling (Humfrey.Melling@dfo-mpo.gc.ca)
Data web site	https://www.erdc.usace.army.mil/Media/Fact-Sheets/Fact-Sheet-Article-View/Article/553850/ice-mass-balance-imb-buoy-program/
Methodology	ALS Upward Looking Sonar on bottom anchored moorings
Location	Chukchi Sea (75.1° N, 168.0 ° W)
Time interval	August 2003 to August 2005
Number of samples	23.9 x 106 point values, 26 monthly averages
Documentation	ASL Ice Profiler Specifications (PDF, 88 KB)

Acknowledgments	The mooring is a collaborative undertaking of the Canadian Institute of Ocean Sciences, the USA Cold Regions Research Engineering Laboratory and the NOAA Arctic Research Office. The effort is jointly supported by NOAA Climate Program Office and the Canadian Department of Fisheries and Oceans.

Data Processing Notes

Data were processed and calibrated by H. Melling and D. A Reidel, IOS. The ULS instruments were manufactured by ASL Environmental Sciences. Statistical summaries were computed by IOS and reformatted by R. Lindsay, PSC. The summaries here are from the point data, not the distributions corrected for ice motion (the so-called pseudo-spatial data sets that are also available).

US Navy Submarines - Analog (US-Subs-A)

Table 11. US-Subs-A Data Details

Organization	Polar Science Center, Applied Physics Laboratory, University of Washington; US Navy Arctic Submarine Laboratory; Cold Regions Research and Engineering Laboratory (CRREL)
Principal contact	Dr. Mark Wensnahan, PSC (thinice@apl.washington.edu) and Dr. Terry Tucker, CRREL
Data web site	http://nsidc.org/data/g01360
Methodology	Upward Looking Sonar on submarines using analog charts
Location	Arctic Ocean
Time interval	1975-2005
Number of samples	17 cruises, 23.9 x 106 point values, 782 50-km averages
Documentation	NSIDC Documentation: Submarine Upward Looking Sonar Ice Draft Profile Data and Statistics Release notes for US analog data from charts by M. Wensnahan.
Acknowledgments	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. These data were prepared with funding from NSF Office of Polar Programs. From the NSIDC documentation: “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.”

Data Processing Notes

The point data have been averaged for clusters that fall within 50-km diameter circles, so where the submarine has turned or crossed back over its track, more than 50-km of track length is used for a single average distribution. All of the submarine data archived at NSIDC are included here.

References

National Snow and Ice Data Center. 1998, updated 2006. Submarine upward looking sonar ice draft profile data and statistics. Boulder, Colorado USA. doi: 10.7265/N54Q7RWK.

Rothrock, D.A. and M. Wensnahan. 2007. The accuracy of sea-ice drafts measured from U. S. Navy submarines. J. Atmos. Oceanic Technol. doi:10.1175/JTECH2097.1.

Wensnahan, M. and D. A. Rothrock. 2005. Sea-ice draft from submarine-based sonar: Establishing a consistent record from analog and digitally recorded data. Geophysical Research Letters 32(L11502). doi:10:1029/2005GL022507.

Tucker, W. B. III, J. W. Weatherly, D. T. Eppler, D. Farmer, and D. L. Bentley. 2001. Evidence for the rapid thinning of sea ice in the western Arctic Ocean at the end of the 1980s. Geophys. Res. Let. 28 (14): 2851-2854.

US Navy Submarines - Digital (US-Subs-D)

Table 12. US-Subs-D Data Details

Organization	Polar Science Center, Applied Physics Laboratory, University of Washington; US Navy Arctic Submarine Laboratory; Cold Regions Research and Engineering Laboratory (CRREL)
Principal contact	Dr. Mark Wensnahan, PSC (thinice@apl.washington.edu) and Dr. Terry Tucker, CRREL
Data web site	http://nsidc.org/data/g01360.html
Methodology	Upward Looking Sonar on submarines using digital recording
Location	Arctic Ocean
Time interval	1975-2005
Number of samples	19 cruises, 68.4 x 106 point values, 1001 50-km averages
Documentation	NSIDC Documentation: Submarine Upward Looking Sonar Ice Draft Profile Data and Statistics Release notes for US analog data from charts by M. Wensnahan
Acknowledgments	The U.S. digital data were processed at the Polar Science Center at the University of Washington and provided with documentation by M. Wensnahan and D. A. Rothrock. These data were prepared with funding from NSF Office of Polar Programs. From the NSIDC documentation: “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.”

Data Processing Notes

Same as US Navy Submarines - Analog (US-Subs-A) Section.

References

Same as US Navy Submarines - Analog (US-Subs-A) Section.

UK Navy Submarines - Analog (UK-Subs-A)

Table 13. UK-Subs-A Data Details

Organization	Department of Applied Mathematics and Theoretical Physics, University of Cambridge
Principal contact	Dr. Peter Wadhams (pw11@cam.ac.uk)
Data web site	http://nsidc.org/data/g01360
Methodology	Upward Looking Sonar on submarines using analog charts
Location	Arctic Ocean and Fram Strait
Time interval	1987, 1991
Number of samples	2 cruises, 6.4 x 106 point values, 149 50-km averages
Documentation	NSIDC Documentation: Submarine Upward Looking Sonar Ice Draft Profile Data and Statistics
Acknowledgments	Preparation of the U.K. data was funded by a subcontract under a 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.

Data Processing Notes

The point data at NSIDC for 50-km segments (which are interpolated to 1-m samples and gaps are interpolated) were summarized by R. Lindsay. Segments with a length of less than 25 km were dropped.

References

National Snow and Ice Data Center. 1998, updated 2006. Submarine upward looking sonar ice draft profile data and statistics. Boulder, Colorado USA. doi: 10.7265/N54Q7RWK.

Wadhams, P. and R. J. Horne. 1980. An analysis of ice profiles obtained by submarine in the Beaufort Sea. Journal of Glaciology 25: 401-424.

Wadhams, P. 1984. Arctic sea ice morphology and its measurement. Arctic Technology and Policy. I. Dyer and C. Chryssostomidis, eds., Washington, D.C., Hemisphere Publishing Corp.: 179-195.

UK Navy Submarines - Digital (UK-Subs-D)

Table 14. UK-Subs-D Data Details

Organization	Department of Applied Mathematics and Theoretical Physics, University of Cambridge
Principal contact	Dr. Peter Wadhams (pw11@cam.ac.uk)
Data web site	http://nsidc.org/data/g01360
Methodology	Upward Looking Sonar on submarines using digital recording
Location	Arctic Ocean and Fram Strait
Time interval	1976
Number of samples	1 cruises, 1.3 x 106 point values, 27 50-km averages
Documentation	NSIDC Documentation: Submarine Upward Looking Sonar Ice Draft Profile Data and Statistics
Acknowledgments	Preparation of the U.K. data was funded by a subcontract under a 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.

Data Processing Notes

Same as UK Navy Submarines - Analog (UK-Subs-A) Section.

References

Same as UK Navy Submarines - Analog (UK-Subs-A) Section.

Alfred Wegener Institute - Greenland Sea (AWI-GS)

Table 15. AWI-GS Data Details

Organization	Alfred Wegener Institute for Polar and Marine Research, Bremerhaven, Germany
Authors	Dr. Hannalore Witte and Dr. Eberhard Fahrbach, AWI
Principal contact	Dr Wolfgang Dierking, AWI (Wolfgang.Dierking@awi.de)
Data web site	http://nsidc.org/data/G02139
Methodology	APL Upward Looking Sonar on bottom anchored moorings
Location	Greenland Sea and Fram Strait at 11 different sites
Time interval	1991-2002

Number of samples	1.06 x 106 point values, 134 monthly averages
Documentation	NSIDC Documentation: AWI Moored ULS Data, Greenland Sea and Fram Strait, 1991-2002 R.E. Moritz. 2004. Upward Looking Sonar ULS Mark-2 User Documentation. This informal document is an instruction manual updated and provided with each APL ULS when shipped for deployment.

Data Processing Notes

Data were processed and calibrated by AWI. The ULS instruments were manufactured by the Applied Physics Laboratory, University of Washington. The data processed here were obtained from the NSIDC archives. Statistical summaries were computed by R. Lindsay, PSC, from the 5-minute point data.

Dr. Dierking notes that one problem with the data sets available at NSIDC is that a bias factor was applied to account for the width of the sonar beam. However, only an approximate average value was used that was based on a limited comparison of ice thickness values derived from the ULS and those obtained from drilling. Since we think that such a value is not generally valid we decided not to include such a bias correction in our future data sets, leaving the choice of handling this problem to the end-user. This is the only ULS data set for which an unknown constant correction was applied to account for beam width and first-return bias.

References

Harms, S., Fahrbach, E., and Strass, V. 2001. Sea ice transports in the Weddell Sea. Journal of Geophysical Research 106 (C5): 9057-9073.

Witte, H. and E. Fahrbach. 2005. AWI Moored ULS Data, Greenland Sea and Fram Strait, 1991-2002. Boulder, Colorado USA: National Snow and Ice Data Center. doi: 10.7265/N5G15XSR.

Airborne Electromagnetic Induction (Air-EM)

Table 16. Air-EM Data Details

Organization	Alfred Wegener Institute for Polar and Marine Research, and York University
Principal contact	Dr Christian Haas (hassc@yorku.ca) and Dr. Stefan Hendricks (stefan.hendricks@awi.de)
Location	Arctic Ocean and Fram Strait
Time interval	2001-2013
Number of samples	4.42 x 106 point values, 391 cluster averages, 22 campaigns

Methodology

Airborne electromagnetic induction measures snow + ice thickness. EM sounding is a classical geophysical method to detect the distance between an EM instrument and the boundary between the resistive sea ice and the conductive seawater, in other words, its altitude above the ice/water-interface. The method is based on measurements of the amplitude and phase of a secondary EM field induced in the seawater by a primary field transmitted by the EM instrument. Surveys are usually performed with a towed sensor package, which is operated some tens of meters below the aircraft and 20 m above the ice. The instrument's altitude above the snow or ice surface is measured with a laser altimeter. Ice-plus-snow thickness results from the difference between the altitude above the ice/water-interface and above the snow or ice surface [Haas et al., 2009]. The accuracy of EM measurements is ±0.1 m over level ice [Pfaffling et al., 2007; Haas et al., 2009]. However, the maximum thickness of pressure ridges is generally underestimated due to their porosity and the EM footprint diameter of up to 3.7 times the instrument altitude [Reid et al., 2006]. The measured thickness of unconsolidated ridges can be less than 50% of the "true" thickness (Haas and Jochmann, 2003). Therefore, the measured thickness distributions are most accurate with respect to their modal thickness, while mean ice thickness can still be used for relative comparisons between regions and campaigns.

Data Processing Notes

Data were processed and calibrated by Dr. Haas and Dr. Hendricks. Statistical summaries and distributions for 50-km clusters were computed by R. Lindsay from the point data. Where the tracks overlap or bend, more than 50 km of track is included in many clusters. When flights spanned a few days in a small region, the flights were combined when the clusters were formed.

References

General

Haas, C., Lobach, J., Hendricks, S., Rabenstein, L., and Pfaffling, A. 2009. Helicopter-borne measurements of sea ice thickness, using a small and lightweight, digital EM system. Journal of Applied Geophysics 67(3): 234-241.

Pfaffling, A., Haas, C., and Reid, J. E. 2007. A direct helicopter EM sea ice thickness inversion, assessed with synthetic and field data. Geophysics 72: F127-F137.

Ark17, Ark20, Ark22, NP_07

Haas, C., Pfaffling, A., Hendricks, S., Rabenstein, L., Etienne, J.-L., and Rigor, I. 2008. Reduced ice thickness in Arctic Transpolar Drift favors rapid ice retreat. Geophys. Res. Lett. 35(L17501): 1-5. doi:10.1029/2008GL034457.

Ark19

Haas, C., J. Lieser, J. Lobach, T. Martin, A. Pfaffling, S. Willmes, V. Alexandrov, and S. Kern.

2004. Sea ice remote sensing, thickness profiling, and ice and snow analyses, In The Expedition ARKTIS XIXI1 a, b and XIW2 of the Research Vessel POLARSTERN in 2003, U. Schauer and G. Kattner with contributions of the participants (Eds.). Rep. Pol. Mar. Res. 481: 13-46.

GreenICE04, GreenICE05

Haas, C., S. Hendricks, and M. Doble. 2006. Comparison of the sea ice thickness distribution in the Lincoln Sea and adjacent Arctic Ocean in 2004 and 2005. Annals of glaciology 44: 247-252.

SEDNA

Jennifer K. Hutchings. 2007. The Sea Ice Experiment: Dynamic Nature of the Arctic (SEDNA) Applied Physics Laboratory Ice Station (APLIS) 2007, Field Report PDF file Funding Agency: NSF.

SIZONet, PAM-ARCMIP

(Seasonal Ice Zone Observing Network, Pan-Arctic Measurements and Arctic Regional climate model simulations) PAM-ARCMIP report, Funding Agency (SIZONet): NSF

Haas, C., S. Hendricks, H. Eicken, and A. Herber. 2010. Synoptic airborne thickness surveys reveal state of Arctic sea ice cover. Geophys. Res. Lett. 37(L09501). doi:10.1029/2010GL042652.

TransDrift

Russian-German Cooperation: The Transdrift I Expedition to the Laptev Sea

Field report Please contact Thomas Krumpen (thomas.krumpen@awi.de) Funding Agency: BMBF (German Federal Ministry of Education and Research)

NASA ICESat Mission - Goddard (ICESat1-G)

Table 17. ICESat1-G Data Details

Organization	NASA Goddard Space Flight Center (GSFC) National Snow and Ice Data Center
Principal contact	Dr. Donghui Yi, NASA GSFC (donghui.yi@nasa.gov) and Dr. Jay Zwally, NASA GSFC
Data web site	http://nsidc.org/data/nsidc-0393
Methodology	Geoscience Laser Altimeter System (GLAS)
Location	Arctic Ocean

<table>
<tr><td>Time interval</td><td>2005-2007 in six campaigns, each roughly 33 days long:
<table>
<tr><th>Campaign</th><th>Start</th><th>End</th></tr>
<tr><td>3d</td><td>21-Oct-05</td><td>24-Nov-05</td></tr>
<tr><td>3e</td><td>22-Feb-06</td><td>28-Mar-06</td></tr>
<tr><td>3f</td><td>24-May-06</td><td>26-Jun-06</td></tr>
<tr><td>3g</td><td>25-Oct-06</td><td>27-Nov-06</td></tr>
<tr><td>3h</td><td>12-Mar-07</td><td>14-Apr-07</td></tr>
<tr><td>3i</td><td>2-Oct-07</td><td>5-Nov-07</td></tr>
</table></td></tr>
<tr><td>Number of samples</td><td>6 campaigns, 11,085 clusters, 11.1 x 106 point values, 3,345,242 km of track</td></tr>
<tr><td>Documentation</td><td>NSIDC Documentation: Arctic Sea Ice Freeboard and Thickness</td></tr>
<tr><td>Acknowledgments</td><td>ICESat and ICESat data processing are fully supported by NASA</td></tr>
</table>

Data Processing Notes

This data set provides measurements of sea-ice freeboard and sea-ice thickness for the Arctic Ocean. The data were acquired from the Ice, Cloud, and land Elevation Satellite (ICESat) Geoscience Laser Altimeter System (GLAS) instrument, the Special Sensor Microwave/Imager (SSM/I), and climatologies of snow and drift of ice. The data span six GLAS campaigns, laser 3D through 3I, from 21 October 2005 to 05 November 2007. Data parameters include sea-ice freeboard and thickness derived from GLAS Release 28 data. The data at NSIDC are provided in three formats: ASCII track data, 25-km gridded polar stereographic data, and Portable Network Graphic (PNG) image files. The ASCII track data of position and ice thickness have a resolution of about 170 meters in the along-track direction. For this data set the track data for each entire laser campaign have been averaged for clusters that fall within 50-km grid cells. Summary statistics and probability density functions of sea-ice thickness are included here. At least 500 point values are required within a grid cell for the summary to be retained.

References

Yi, Donghui, Jay Zwally. 2009. Arctic Sea Ice Freeboard and Thickness. [indicate subset used]. Boulder, Colorado USA: National Snow and Ice Data Center.

Zwally, H. J., D. Yi, R. Kwok, and Y. Zhao. 2008. ICESat Measurements of Sea Ice Freeboard and Estimates of Sea Ice Thickness in the Weddell Sea. Journal of Geophysical Research 113(C02S15). doi: 10.1029/2007JC004284.

Bedford Institute of Oceanography - Lancaster Sound (BIO-LS)

Table 18. BIO-LS Data Details

Organization	Coastal Ocean Science Bedford Institute of Oceanography Fisheries and Ocean Canada
Principal contact	Dr. Simon Prinsenberg
Project web site	https://www.bio.gc.ca/index-en.php
Methodology	ASL Upward Looking Sonar on bottom anchored mooring
Location	Canadian Arctic Archipelago: Lancaster Sound (one location)
Time interval	2003-2007
Number of samples	34.7 x 106 point samples, 36 monthly averages

Data Processing Notes

The ULS instrument is the ASL Ice Profiler, model IPS-4, that samples once per second. The ULS instruments were manufactured by ASL Environmental Sciences. Sea-ice drafts were processed with standard ASL software.

References

Pettipas, R., J. Hamilton, and S. Prinsenberg. 2008. Moored current meter and CTD observations from Barrow Strait, 2003-2004. Can. Data Rep. Hydrogr. Ocean Sci. 173 : vii, 134 p.

Prinsenberg, S. J. and R. Pettipas. 2008. Ice and ocean mooring data statistics from Barrow Strait, the central section of the NW Passage in the Canadian Arctic Archipelago. Int. J. Offshore Pol. Eng. 18(4): 277-281.

Prinsenberg, S. J., J. Hamilton, I. Peterson, and R. Pettipas. 2008. Observing and interpreting the seasonal variability of the oceanographic fluxes passing through Lancaster Sound of the Canadian Arctic Archipelago, In Influence of climate change on the changing Arctic and Sub-Arctic conditions, Springer Verlag, J. Nihoul and Prof. Andrey Kostianoy eds: 119-136.

Environment Canada (CanCoast)

Table 19. CanCoast Data Details

Organization	Environment Canada
Project web site	https://www.canada.ca/en/environment-climate-change/services/ice-forecasts-observations/latest-conditions/archive-overview/thickness-data.html
Location	27 coastal stations in the Canadian Archipelago. We include here only stations that measured sea ice, not lake ice.
Time interval	1947-2010 (This is the only data set with data before 1975)

Number of samples	21787 point samples, 6092 monthly averages
Point data	https://www.canada.ca/en/environment-climate-change/services/ice-forecasts-observations/latest-conditions/archive-overview/thickness-data.html

Methodology

Weekly bore holes or hotwire thickness gauges were used to measure the thickness of specific locations on fast ice. This data collection contains ice thickness and snow depth measurements for sites going back as far as 1947 for the first stations established in the Canadian Arctic (Eureka and Resolute). Record length varies from station to station. Most of the data in the current archive at Environment Canada's Canadian Ice Service (CIS) have been collected by Environment Canada's Meteorological Service, but some data are provided by other organizations such as the St. Lawrence Seaway Authority, Trent University, and Queen's University.

Measurements are taken at approximately the same location every year on a weekly basis, starting after freeze-up when the ice is safe to walk on, and continuing until break-up or when the ice becomes unsafe. The location is selected close to shore, but over a depth of water which will exceed the maximum ice thickness. Ice thickness is measured to the nearest centimeter using either a special auger kit or a hot wire ice thickness gauge. The depth of snow on the ice at the location of the ice thickness measurement is also measured and reported to the nearest centimeter. Measurements after 1982 include additional information such as the character of the ice surface, water features and method of observation.

Data Processing Notes

Monthly summaries of snow depth and sea-ice thickness were computed by R. Lindsay for each station. There were usually just three or four observations per month. No distributions were computed since there were so few observations per month.

Table 20 gives the station names for each identifier, the start and end years, and the location.

Table 20. Station Names for each Identifier in CanCoast Data

Identifier	Name	Start	End	Latitude	Longitude
HA1	QUAQTAQ	1972	1978	61.05	-69.63
IC1	ISACHSEN (OLD ICE)	1965	1973	78.78	-103.50
LT1	ALERT LT1	1959	2010	82.49	-62.58
WEU	EUREKA	1947	2010	79.98	-85.95
YAB	ARCTIC BAY	1959	1970	73.04	-85.15
YCB	CAMBRIDGE BAY	1959	2010	69.12	-105.13
YCO	COPPERMINE	1958	1988	67.83	-115.08

Identifier	Name	Start	End	Latitude	Longitude
YCS	CHESTERFIELD INLET	1959	1981	63.33	-90.70
YCY	CLYDE	1959	1993	70.48	-68.52
YFB	IQALUIT	1959	2010	63.75	-68.55
YHA	QUAQTAQ	1972	1986	61.05	-69.63
YHI	HOLMAN ISLAND	1960	1969	70.72	-117.72
YIC	ISACHSEN	1948	1978	78.78	-103.50
YIO	POND INLET	1964	1993	72.68	-78.00
YLT	ALERT YLT	1950	2010	82.48	-62.35
YMD	MOULD BAY	1949	1997	76.24	-119.32
YNC	SPENCE BAY	1959	1976	69.41	-93.83
YRB	RESOLUTE	1947	2010	74.72	-94.98
YSY	SACHS HARBOUR	1956	1986	72.00	-125.00
YTE	CAPE DORSET	1970	1993	64.23	-76.53
YUB	TUKTOYAKTUK	1971	1977	69.43	-132.97
YUJ	LADY FRANKLIN POINT	1980	1989	68.48	-113.25
YUR	GLADMAN POINT	1977	1992	68.63	-97.72
YUS	SHEPHERD BAY	1971	1985	68.83	-93.83
YUX	HALL BEACH	1959	2010	68.78	-81.23
YZS	CORAL HARBOUR	1958	2010	64.13	-83.26
ZUE	CAPE PARRY	1959	1992	70.15	-124.67

Davis Strait (Davis_St)

Table 21. Davis_St Data Details

Organization	An Innovative Observational Network for Critical Arctic Gateways, Polar Science Center, Applied Physics Laboratory, University of Washington, Seattle, WA
Principal contact	Dr. Richard Moritz (dickm@apl.washington.edu)
Project web site	http://iop.apl.washington.edu/projects/ds/html/overview.html
Methodology	APL Upward Looking Sonar on bottom anchored moorings
Location	Davis Strait
Time interval	2006-2008
Number of samples	554,000 point samples, 67 monthly averages
Documentation	http://iop.apl.washington.edu/data.php (password protected)
Point Data	http://iop.apl.washington.edu/data.php (password protected)
Acknowledgments	R. E. Moritz, Davis Strait Freshwater Flux Array, NSF Grant OPP-02300381

Data Processing Notes

Data were processed and calibrated by R. Moritz. The ULS instruments were manufactured by the Applied Physics Laboratory, University of Washington. Statistical summaries were computed and reformatted by R. Lindsay from the point data. Additional details on the ULS instrument and calibration procedures are presented in Drucker et al. (2003).

References

Drucker, R., S. Martin, and R. Moritz. 2003. Observations of ice thickness and frazil ice in the St. Lawrence Island polynya from satellite imagery, upward looking sonar, and salinity/temperature moorings. J. Geophys. Res. 108 (C5): 18-1 - 18-18.

NASA Operation IceBridge Version 2 (IceBridge-V2)

Table 22. IceBridge (V2) Data Details

Organization	NASA Operation IceBridge Program Office, GSFC
Principal contact	Dr. Nathan Kurtz and the OIB Program Office
Project web site	http://www.nasa.gov/mission_pages/icebridge/
Methodology	Scanning Lidar Altimeter, Snow Radar, Cameras
Location	Arctic Ocean
Time interval	2009-2013
Number of samples	2009-GrnlV2: 54309 point estimates, 55 50-km cluster averages 2010-GrnlV2: 260705 point estimates, 215 50-km clusters 2011-GrnlV2: 256103 point estimates, 152 50-km clusters 2012-GrnlV2: 289234 points estimates, 267 50-km clusters 2013-GrnlV2: 260693 points estimates, 244 50-km clusters
Documentation	http://nsidc.org/data/idcsi4
Citation	Kurtz, N., M. Studinger, J. Harbeck, V. Onana, and D. Yi. 2015. *IceBridge L4 Sea Ice Freeboard, Snow Depth, and Thickness, Version 1*. [Indicate subset used]. Boulder, Colorado USA. NASA National Snow and Ice Data Center Distributed Active Archive Center. doi: http://dx.doi.org/10.5067/G519SHCKWQV6. [Date Accessed].

Data Processing Notes

All flights with usable data are combined for each campaign. Annual campaigns are conducted in the appropriate spring based either in Greenaland or Punta Arenas, Chile.

The 'Freeboard, Snow Depth, and Ice Thickness' data product from NSIDC was used to form 50-km clusters, combining data from more than one flight if the flights were less than 10 days apart. The spacing of the point thickness estimates is approximately 25 m. The original data set includes a variable for the uncertainty in the estimated ice thickness that is used to select points with an

uncertainty of less than 1 m for very thin ice up to 2 m for ice greater than 4 m thick. The maximum uncertainty in the point measurements included in the clusters is 2 m. Clusters were required to have 500 or more point samples to be retained and some clusters have as many as 7000 points. The average is 1670 points.

In the summary file the minimum, maximum, mean, and standard deviation is given for the snow depth, the uncertainty in the ice thickness, and the ice thickness. See the file headers. The mean uncertainty is not the uncertainty of the mean because we do not know how the errors are correlated, but it does give some information about the relative confidence in the sample estimates. If the errors were uncorrelated the uncertaity in the mean would be approximately 1/sqrt(nsamps) times the mean uncertainty. The 20-m point data for ice thickness is at the National Snow and Ice Data Center as well as all of the calibrated instrument data.

References

Kurtz, N. T., S. L. Farrell, M. Studinger, N. Galin, J. P. Harbeck, R. Lindsay, V. D. Onana, B. Panzer, and J. G. Sonntag. 2013. Sea ice thickness, freeboard, and snow depth products from Operation IceBridge airborne data. The Cryosphere 7: 1035-1056. doi:10.5194/tc-7-1035-2013.

NASA Operation IceBridge Quicklook (IceBridge-QL)

Table 23. IceBridge-QL Data Details

Organization	NASA Operation IceBridge Program Office, Goddard Space Flight Center
Principal contact	Dr. Nathan Kurtz and the OIB Program Office
Project web site	http://www.nasa.gov/mission_pages/icebridge/
Methodology	Scanning Lidar Altimeter, Snow Radar, Cameras
Location	Arctic Ocean
Time interval	2012-2016
Number of samples	2012-GrnlQL: 205297 point estimates, 204 50-km clusters 2013-GrnlQL: 210073 points estimates, 242 50-km clusters 2014-GrnlQL: 235595 points estimates, 231 50-km clusters 2014-GrnlQL: 167012 points estimates, 183 50-km clusters
Documentation	NSIDC documentation: https://nsidc.org/data/idcsi4 and https://nsidc.org/data/nsidc-0708 NASA Operation IceBridge Quicklook Products Documentation (password required)

Citation	Kurtz, N., M. Studinger, J. Harbeck, V. Onana, and D. Yi. 2015. *IceBridge L4 Sea Ice Freeboard, Snow Depth, and Thickness, Version 1*. [Indicate subset used]. Boulder, Colorado USA. NASA National Snow and Ice Data Center Distributed Active Archive Center. doi: http://dx.doi.org/10.5067/G519SHCKWQV6. [Date Accessed].

Data Processing Notes

This is the Quicklook Product. SInce IceBridge data processing typically lags about a year this Quicklook Product is provided. Overlap between 2012 and 2013 V2 products provides some indication of potential differences though those may vary from year to year.

All flights with usable data are combined for each campaign. Annual campaigns are conducted in the appropriate spring based either in Greenaland or Punta Arenas, Chile..

The 'Freeboard, Snow Depth, and Ice Thickness' data product from NSIDC was used to form 50-km clusters, combining data from more than one flight if the flights were less than 10 days apart. The spacing of the point thickness estimates is approximately 25 m. The original data set includes a variable for the uncertainty in the estimated ice thickness that is used to select points with an uncertainty of less than 1 m for very thin ice up to 2 m for ice greater than 4 m thick. The maximum uncertainty in the point measurements included in the clusters is 2 m. Clusters were required to have 500 or more point samples to be retained and some clusters have as many as 7000 points. The average is 1670 points.

In the summary file the minimum, maximum, mean, and standard deviation is given for the snow depth, the uncertainty in the ice thickness, and the ice thickness. See the file headers. The mean uncertainty is not the uncertainty of the mean because we do not know how the errors are correlated, but it does give some information about the relative confidence in the sample estimates. If the errors were uncorrelated the uncertainty in the mean would be approximately 1/sqrt(nsamps) times the mean uncertainty. The 20-m point data for ice thickness is at the National Snow and Ice Data Center as well as all of the calibrated instrument data.

References

Kurtz, N. T., Farrell, S. L., Studinger, M., Galin, N., Harbeck, J. P., Lindsay, R., Onana, V. D., Panzer, B., and Sonntag, J. G. 2013. Sea ice thickness, freeboard, and snow depth products from Operation IceBridge airborne data, The Cryosphere 7: 1035-1056. doi: 10.5194/tc-7-1035-2013.

NASA Goddard ICESat-1 Southern Hemisphere (ICESat1-SH)

Table 24. ICESat1-SH Data Details

<table>
<tr><td>Organization</td><td>NASA Goddard Space Flight Center</td></tr>
<tr><td>Principal contacts</td><td>Dr. Nathan Kurtz, NASA Goddard Space Flight Center
email: nathan.t.kurtz@nasa.gov</td></tr>
<tr><td>Data web site</td><td>http://neptune.gsfc.nasa.gov/csb/index.php?section=272</td></tr>
<tr><td>Methodology</td><td>Geoscience Laser Altimeter System (GLAS) on the ICESat-1 satellite</td></tr>
<tr><td>Location</td><td>Antarctica</td></tr>
<tr><td>Time intervals</td><td>2004-2007 in 13 campaigns:
<table>
<tr><th>ID</th><th>Dates</th><th>N-obs</th></tr>
<tr><td>FM04</td><td>18 February 2004 - 21 March 2004</td><td>264</td></tr>
<tr><td>FM05</td><td>19 February 2005 - 24 March 2005</td><td>290</td></tr>
<tr><td>FM06</td><td>23 February 2006 - 27 March 2006</td><td>170</td></tr>
<tr><td>FM08</td><td>19 February 2008 - 21 March 2008</td><td>94</td></tr>
<tr><td>MA07</td><td>12 March 2007 - 14 April 2007</td><td>310</td></tr>
<tr><td>MJ04</td><td>19 May 2004 - 15 June 2004</td><td>995</td></tr>
<tr><td>MJ05</td><td>21 May 2005 - 23 June 2005</td><td>2146</td></tr>
<tr><td>MJ06</td><td>24 May 2006 - 26 June 2006</td><td>1844</td></tr>
<tr><td>ON03</td><td>25 September 2003 - 18 November 2003</td><td>1949</td></tr>
<tr><td>ON04</td><td>3 October 2004 - 8 November 2004</td><td>1651</td></tr>
<tr><td>ON05</td><td>22 October 2005 - 23 November 2005</td><td>828</td></tr>
<tr><td>ON06</td><td>25 October 2006 - 26 November 2006</td><td>736</td></tr>
<tr><td>ON07</td><td>2 October 2007 - 5 November 2007</td><td>1150</td></tr>
</table>
N-obs is the number of clusters retained for each campaign.</td></tr>
<tr><td>Number of samples</td><td>13 Laser campaigns, 12,432 clusters, 5,370,762 point values</td></tr>
<tr><td>Documentation</td><td>http://neptune.gsfc.nasa.gov/csb/index.php?section=272</td></tr>
<tr><td>Citation</td><td>Kurtz, N.T., and T. Markus, Satellite observations of Antarctic sea ice thickness and volume, J. Geophys. Res., 117, C08025, doi:10.1029/2012JC008141, 2012.
Markus, T., Massom, R., Worby, A., Lytle, V., Kurtz, N., and T. Maksym, Freeboard, snow depth, and sea ice roughness in East Antarctica from in-situ and multiple satellite data, Ann. Glaciol., 52(57), 2011.</td></tr>
<tr><td>Acknowledgements</td><td>ICESat and ICESat data processing are fully supported by NASA</td></tr>
</table>

Data Processing Notes

This data set provides measurements of sea ice freeboard and sea ice thickness for the Antarctic region. The data were acquired from the Ice, Cloud, and land Elevation Satellite (ICESat) Geoscience Laser Altimeter System (GLAS) instrument, the Special Sensor Microwave/Imager

(SSM/I). The data span thirteen GLAS campaigns, laser 2004 to 2007. Data parameters include sea ice freeboard and sea ice thickness measured in meters. The data at Goddard are provided in three formats: ASCII track data with individual retrieval points, ASCII gridded and interpolated data for each campaign on a 25-km grid, and gridded and interpolated data for each season (FM, MJ, or ON, averaged over all years). The ASCII track data have a resolution of about 175 meters in the along-track direction.

The track data for each individual laser campaign have been averaged for clusters that fall within 50-km square grid cells. Summary statistics of both freeboad and ice thickness are computed. At this time no distribution files are included. At least 250 point values are required within a 50-km cell for the summary to be retained.

Alfred Wegener Institute - Weddell Sea (AWI-WS)

Table 25. AWI-WS Data Details

Organization	Alfred Wegener Institute for Polar and Marine Research, Bremerhaven, Germany
Authors	Dr. Hannalore Witte and Dr. Eberhard Fahrbach, AWI
Principal contacts	Dr Wolfgang Dierking, AWI, email: Wolfgang.Dierking at awi.de Dr. Axel Behrendt, AWI, email Axel.Behrendt at awi.de
Data web site	http://doi.pangaea.de/10.1594/PANGAEA.785565
Methodology	Upward Looking Sonar on bottom anchored moorings
Location	Weddell Sea at 13 different sites
Time interval	1990-2010
Number of samples	12,533,581 point values, 757 monthly averages
Documentation	Behrendt, Axel. 2013. The sea ice thickness in the Atlantic sector of the Southern Ocean. Berichte zur Polar- und Meeresforschung (Reports on Polar and Marine Research) 667: 246 pp. doi: 10.2312/BzPM_0667_2013. Behrendt, Axel, Wolfgang Dierking, Eberhard Fahrbach, Hannelore Witte. 2013. Updates of figures 2 & 11 and table 5. hdl: 10013/epic.39714.d007.
Citation	Behrendt, A et al. 2013. Sea ice draft measured by upward looking sonars in the Weddell Sea (Antarctica). doi: 10.1594/PANGAEA.785565. Supplement to: Behrendt, Axel, Wolfgang Dierking, Eberhard Fahrbach, Hannelore Witte. 2013. Sea ice draft in the Weddell Sea, measured by upward looking sonars. Earth System Science Data 5(1): 209-226. doi: 10.5194/essd-5-209-2013.

Data Processing Notes

Data were processed and calibrated by AWI. Statistical summaries were computed and reformatted by R. Lindsay, PSC from the point data which ranged fro 0.5 to 15 minutes, depending on the mooring.

The summary files have the statistics for

- water temperature
- instrument depth
- sea ice draft.

One mooring, AWI206, has what appear to be a lot of ice bergs (or bad data) with drafts up to 100 m. We have removed any draft greater than 30 m in computing the draft statistics. The uncorrected (for sea level) ULS draft values are included in the point data set but are not included in the summary file. The point data were obtained from http://doi.pangaea.de/10.1594/PANGAEA.785565.

CryoSat 2 Radar Altimeter (CryoSat-AWI)

Table 26. CryoSat-AWI Data Details

Organizations	European Space Agency (ESA) Alfred Wegener Institute, Helmholtz Centre for Polar and Marine Research
Principal contacts	Dr. Stefan Hendricks (Stefan.Hendricks@awi.de) Dr. Robert Ricker (Robert.Ricker@awi.de) Dr. Veit Helm (Veit.Helm@awi.de)
Project Web SIte	http://www.meereisportal.de/en/seaicemonitoring/sea-ice-observations-from-satellite-measurements/wwwmeereisportaldecryosat/
Data web site	http://data.seaiceportal.de/data/cryosat2/version1.2/n/
Methodology	CryoSat Radar Altimeter
Location	Arctic Ocean
Time intervals	Nov 2010 - Feb 2016 (no data from June through September)
Number of samples	134354 clusters from Nov 2010 through Feb 2016
Documentation	AWI documentation
Citation	Ricker, R., S. Hendricks, V. Helm, H. Skourup, and M. Davidson. 2014. Sensitivity of CryoSat-2 Arctic sea-ice freeboard and thickness on radar-waveform interpretation. The Cryosphere 8(4): 1607-1622. doi: 10.5194/tc-8-1607-2014.
Acknowledgments	Processing of the CryoSat-2 (PARAMETER) is funded by the German Ministry of Economics Affairs and Energy (grant: 50EE1008) and data from DATE to DATE obtained from http://www.meereisportal.de (grant: REKLIM-2013-04).

Data Processing Notes

This data provides measurements of sea ice thickness and associated uncertainties from the CryoSat-2 mission. Thickness is derived from Radar Altimeter freeboard measurements. The

unified thickness data version is derived from the original monthly average AWI products by creating clusters of 50 km averages from the 25 km grid of the AWI source product. Mean ice thickness for each cluster is computed by averaging adjacent grid cells. The input thicknesses are weighted by the random uncertainties provided for each grid cell during averaging (Equation 1). The AWI data sets separates random and systematic uncertainties (see Ricker et al. 2014 for details). Random uncertainties for the unified thickness CDR version of this product are computed from the individual grid cell uncertainties (Equation 2).

$$\overline{T}_{cdr} = \frac{\sum_{i=1}^{N} T_i \frac{1}{\sigma_i^2}}{\sum_{i=1}^{N} \frac{1}{\sigma_i^2}}$$

Equation 1

$$\sigma_{cdr-random} = \sqrt{\frac{1}{\sum_{i=1}^{N} \frac{1}{\sigma_i^2}}}$$

Equation 2

Where T_{cdr} is the CDR cluster average thickness, N the number of grid cells from the AWI product used in cluster (4 or 5), T_i is the sea ice thickness for input grid cell, $\sigma_{cdr\text{-}random}$ is the random ice thickness uncertainty for the cluster, and σ^2_i the variance of the random uncertainty in the AWI input product.

Systematic uncertainties are computed as the mean of the input systematic uncertainties.

V20160413: created from AWI data set downloaded on 2016-04-13. The point data came from: Gridded Cryosat 2 data from AWI.

2.2 Quality Assessment and Error

Regarding the accuracy of the underlying data in the Unified Sea Ice Thickness Climate Data Record: typical RMS errors in the submarine and moored ULS measurements are of the order of 25 cm. (Note: A correction for the first return of the ULS signal has not been applied to any of the ULS data prior to calculating the sea ice draft in the Summary and Distribution files. See Rothrock and Wensnahan (2007) for a discussion of ULS errors). The ICESat freeboard measurements are accurate to within approximately 5 cm, and the current evaluation of the ICESat sea ice thickness error is approximately 50 cm since the thickness is on the order of 10 times the freeboard. If the errors of the point measurements are random, the error in the average draft or thickness is reduced by a factor of 1/sqrt(N), where N is the number of measurements. However, some of the error is not

random, and small but significant biases may be present in the aggregate values. The size of these biases is a subject of ongoing research.

2.3 Version History

Table 27. Version History

Version	Date	Description
V1.0	August 2013	Initial release of data set. Data go through April 2012
V1.1	May 2017	Data go through January 2017 and now include Antarctic data

3 REFERENCES AND RELATED PUBLICATIONS

For references specific to each data set used in this CDR, see the Data Acquisition and Processing section for each data set.

National Research Council. 2004. Climate Data Records from Environmental Satellites. Washington D.C.: National Academy Press. ISBN-10:0-309-09168-3, ISBN 978-0-309-09168-8.

Publications using these data:

Johnson, M, A. Proshutinsky, A. Nuyen, R. Lindsay, C. Haas, J. Zhang, N. Diansky, R. Kwok, W. Maslowski, S. Hakkinen, I. Ashik, B. deCuevas, 2012: Evaluation of Arctic sea ice thickness simulated by AOMIP models. J. Geophys. Res., 117, C00D13, doi:10.1029/2011JC007257.

Lindsay, R. and A. Schweiger. 2014. Arctic sea ice thickness loss determined using subsurface, aircraft, and satellite observations. *The Cryosphere* 9: 269-283. doi:10.5194/tc-9-269-2015.

Lindsay, R. W. 2010. New Unified Sea Ice Thickness Climate Data Record. Eos 91(44): 405-406.

Schweiger, A., R. Lindsay, J. Zhang, M. Steele, H. Stern, and R. Kwok. 2011. Uncertainty in Modeled Arctic Sea Ice Volume. J. Geophys. Res., doi:10.1029/2011JC007084.

3.1 Related Data Collections

- Sea-ice Thickness and Draft Statistics from Submarine ULS, Moored ULS, and a Coupled Model
- Submarine Upward Looking Sonar Ice Draft Profile Data and Statistics
- Morphometric Characteristics of Ice and Snow in the Arctic Basin: Aircraft Landing Observations from the Former Soviet Union, 1928-1989

3.2 Related Websites

- Unified Sea Ice Thickness Climate Data Record at the University of Washington: This is the original web site at the University of Washington that holds all or most of the data you can find here at NSIDC but has some additional features. NSIDC is the permanent, long-term archive.
- NSIDC Moored Upward Looking Sonar Data: Summary of moored ULS data at NSIDC.
- Ice Glossary: Glossary of ice related terms hosted by Environment Canada.
- SMOSice: The aim of the SMOSIce study is to develop, improve and validate algorithms for sea-ice thickness retrieval from the 1.4 GHz (L-band, wavelength 20 cm) data of the European Space Agency's Soil Moisture and Ocean Salinity (SMOS) mission.
- Operation IceBridge Data Portal: Interactive portal to obtain IceBridge data.

4 CONTACTS AND ACKNOWLEDGMENTS

Ron Lindsay

Polar Science Center / Applied Physics Laboratory / University of Washington

Seattle, WA 98105-6698

Harry Stern

Polar Science Center / Applied Physics Laboratory / University of Washington

Seattle, WA 98105-6698

4.1 Acknowledgments

The Unified Sea Ice Thickness Climate Data Record project was supported by the NOAA Climate Program Office, Climate Change Data and Detection Program. Distribution of the data set from NSIDC is supported by funding from NOAA's National Environmental Satellite, Data, and Information Service (NESDIS) and the National Geophysical Data Center (NGDC).

5 DOCUMENT INFORMATION

5.1 Document Authors

R. Lindsay and H. Stern (Polar Science Center, APL-UW, Seattle), and F. Fetterer and A. Windnagel (NSIDC, Boulder)

5.2 Publication Date

August 2013

5.3 Date Last Updated

April 2017: A. Windnagel updated the document to reflect the addition of data through 2017 and the addition of Antarctic data.