Canadian Ice Service Arctic Regional Sea Ice Charts in SIGRID-3 Format, Version 1

USER GUIDE

How to Cite These Data

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

Canadian Ice Service, 2009. *Canadian Ice Service Arctic Regional Sea Ice Charts in SIGRID-3 Format, Version 1*. [Indicate subset used]. Boulder, Colorado USA. NSIDC: National Snow and Ice Data Center. https://doi.org/10.7265/N51V5BW9. [Date Accessed].

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

FOR CURRENT INFORMATION, VISIT https://nsidc.org/data/G02171

National Snow and Ice Data Center

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1 DETAILED DATA DESCRIPTION

1.1 Summary

The Canadian Ice Service (CIS) is an operational data provider that produces digital Arctic regional sea ice charts for marine navigation and climate research. The ice charts are created through the manual analysis of in situ, satellite, and aerial reconnaissance data. The Manual of Standard Procedures for Observing and Reporting Ice Conditions (MANICE) is the authoritative guide produced by the CIS that explains how sea ice charts are produced (Environment Canada, 2005). The ice charts have information on ice concentration, stage of development, and ice form, following World Meteorological Organization (WMO) terminology. These sea ice charts begin in 2006 and cover the following regions of the Canadian Arctic: Northern Canadian waters (Western Arctic, Eastern Arctic, and Hudson Bay) and Southern Canadian waters (Great Lakes and East Coast). Each regional shapefile (.shp) (encoded in SIGRID-3 format) and associated metadata file (.xml) are combined into a tar archive file (.tar) for distribution.

Please note that the latest SIGRID-3 charts are available for operational or tactical users directly from CIS servers.

1.2 Format

These data are available in SIGRID-3 format. The SIGRID-3 format includes several files: a shape file (.shp), with associated files (`.dbf, .prj, .shx`), and a metadata file (`.xml`). Each set of files is combined into a tar file (.tar) for distribution.

The CIS followed the SIGRID-3 (IOC, 2010) instructions for decoding sea ice, but made a few modifications to the SIGRID-3 metadata files (.xml). Review CIS 2006 for a complete description of the differences between the CIS SIGRID-3 format and the official SIGRID-3 format (IOC, 2010). These deviations from the CIS SIGRID-3 metadata format (noted almost verbatim from CIS, 2006) are listed below:

- The Canadian Ice Service chose to exclude the style sheet reference to the `FGDC_V2.xsl` from the XML due to the possible problems, such as availability and updates, that can be encountered when referencing to offsite information.
- The `Time_Period_of_Content` is described using the Single Date/Time option since it better represents the valid date and time of the CIS scheduled products.
- The CIS `Contact_Address` section includes the Address and Country elements since they are required at CIS for mailing purposes.
- The CIS included `Contact_Facsimile` and `Contact_Electronic_Mail_Address` elements to offer more contacting options to their clients, since this is the only section in the metadata where contact information is found.

- Their `Spatial_reference_Information` refers to Geographic not Polar Stereographic along with its mandatory information as agreed at the last International Ice Charting Working Group meeting in Ottawa.
- The CIS included and defined the `COVSHP_` and the `COVSHP_ID` attribute labels after the Perimeter label, since they are automatically inserted when converting from coverage to shapefile using the ESRI application. (CIS, 2006)

There were also modifications made at the CIS to the coastlines as noted in CIS 2006:

SIGRID-3 files issued from CIS contain coastline vector features which are derived from the Digital Chart of the World (DCW) data set of 1993. The DCW was originally created by the Environmental Systems Research Institute (ESRI) at the request of the US Defense Mapping Agency (DMA) using aeronautical charts at a 1:1,000,000 scale as the primary data source.

CIS introduced a new coastline for the winter of 2008. This was a modified version of the 1:1,000,000 scale data set from World Vector Shoreline Plus (WVS+), 3rd Edition, 2004. WVS+ is a digital database product consisting of country, coastline, and ocean coverage for the entire world. WVS+ was produced by the National Geospatial-Intelligence Agency (NGA), formerly the National Imagery and Mapping Agency (NIMA). The coastline data used in WVS+ was developed using coastal nautical charts produced by the DMA.

The DCW and the WVS+ data set contains vector data which has been customized at CIS to correct gross errors, particularly in the Canadian Arctic and Greenland.

These modified coastlines for North America are incorporated into data products generated by CIS. The underlying reference frame for the data is the World Geodetic System of 1984 (WGS84) using the updated WGS Earth ellipsoid (2004) (CIS, 2006).

1.2.1 SIGRID-3 Defined

Originally, operational data centers denoted ice characteristics by grouping the ice with similar characteristics into polygons. Within each area or polygon, ice was identified by an egg code. The egg code, termed this way because of its shape, was a way to map the ice characteristics such as total ice concentration, partial concentrations, stage of development, and form of ice on a paper map. Figure 1 shows the ice categories included in the egg code. This method worked well, but then the digital era emerged and operational centers shifted their focus from paper charts to digital ice charts and used GIS techniques to process data and produce ice charts. With this digital transformation came a shift from the paper egg codes to a digital representation of sea ice conditions.

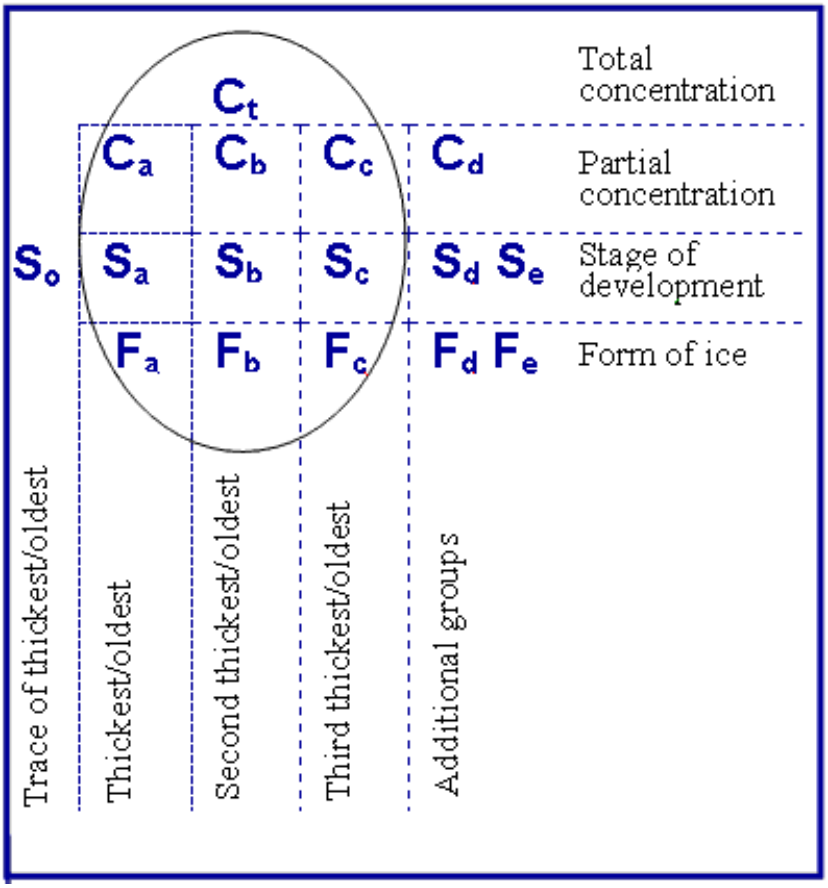

Figure 1. Ice Categories in Egg Code. Egg code that depicts ice in an area by total concentration, partial concentration, stage of development, and form of ice. Image courtesy of Environment Canada. Used with permission.

The operational data centers needed a way to incorporate the information from the paper charts to a digital format. In the 1980s, a Sea Ice Grid (SIGRID) format was developed (Thomson, 1981) and adopted as a World Meteorological Organization (WMO) standard shortly thereafter. This format has evolved over time with the latest version, which is now a vector format, called SIGRID-3 (IOC, 2010). For a more complete history of the egg code and ice chart digitization, including a summary of the SIGRID-3 format, see the History of Ice Chart Digitization section of the National Ice Center Arctic Sea Ice Charts and Climatologies in Gridded Format documentation and the material at the Global Digital Sea Ice Data Bank Special Report.

The SIGRID-3 look-up table converts the ice codes into meaningful sea ice characteristics. For example, in Figure 2, the Total Ice Concentration (CT) value of 80 translates to a CT of 8/10 (IOC, 2010).

AREA	PERIMETER	COVSHP_	COVSHP_ID	CT	CA	SA	FA	CB	SB	FB	CC	SC	FC	CN	CD	CF	POLY_TYPE
93.30627	158.01162	2	131	02	-9	98	10	-9	-9	-9	-9	-9	-9	-9	-9	10-9	I
15.68793	91.72706	3	155	80	-9	81	99	-9	-9	-9	-9	-9	-9	-9	-9	99-9	I
6.40045	17.97555	4	156	91	20	87	05	50	85	04	30	84	04	-9	-9	0405	I
4.04772	58.72482	5	199	91	10	85	04	60	84	04	30	81	99	-9	-9	0499	I
46.20265	207.98650	6	1														L
0.02647	0.79370	7	2														L
9.07543	21.66347	8	210	91	60	87	05	40	85	04	-9	-9	-9	-9	-9	0504	I
0.02386	1.15638	9	5														L

AREA	PERIMETER	CT	CA	SA	FA	CB	SB	FB	CC	SC	FC	CN	CD	CF	POLY_TYPE
931389128.70691	225040.48873	91	-9	91	08	-9	-9	-9	-9	-9	-9	-9	-9	08-9	I
937171.61343	4169.52116	92	-9	91	08	-9	-9	-9	-9	-9	-9	-9	-9	08-9	I
53687765.83263	37823.64415														L
99828318.27795	67168.88101	92	-9	91	08	-9	-9	-9	-9	-9	-9	-9	-9	08-9	I
381170617.70884	300649.51284	50	-9	91	05	-9	-9	-9	-9	-9	-9	-9	-9	05-9	I
89371795.70044	85664.10778														L
11715088.05277	42910.91173	92	-9	91	08	-9	-9	-9	-9	-9	-9	-9	-9	08-9	I
3329.64104	409.20556														L

Figure 2. Attributes Table from a data file before 30 May 2018 (top) and after 30 May 2018 (bottom). This example shows how the egg code parameters (CT, CA, CB) in Figure 1 are mapped to individual SIGRID-3 codes. Before 30 May 2018, the data files contained two extra columns called COVSHP and COVSHP_ID. These columns were not required to read the data, so they were removed from the data files beginning 30 May 2018.

1.3 File Size

Tar files range in size from 340 KB to 4.2 MB.

1.4 File and Directory Structure

The data files in this data set are available via HTTPS: https://noaadata.apps.nsidc.org/NOAA/G02171/. The top level of the directory structure, G02171, is divided into five main directories (one for each region of this data set): `East_Coast`, `Eastern_Arctic`, `Great_Lakes`, `Hudson_Bay`, and `Western_Arctic`. Refer to Figure 3. Each region directory is further broken down by the four-digit year. Refer to Figure 4. Within each year is the tar file that contains the shapefile and the associated metadata file.

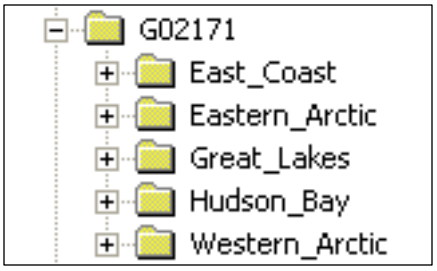

Figure 3. Top Level Directory Structure

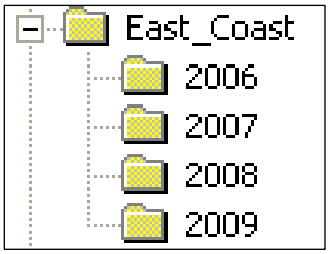

Figure 4. Directory Structure within a Region

1.5 File Naming Convention

1.5.1 Tar File

The tar files are named according to the following convention and as described in Table 1:

`cis_SGRDRXX_YYYYMMDD_pl_v.tar`

Within each tar (`.tar`) file, there are four files that constitute a shapefile (`.shp`, `.shx`, `.dbf`, and `.prj`) and an associated metadata file (`.xml`).

1.5.2 Shapefile and Metadata File

The shapefiles and their associated metadata files are named according to the following convention and as described in Table 1:

`cis_SGRDRXX_YYYYMMDD_pl_v.xxx`

Where:

Table 1. Naming Convention Description

Variable	Description
cis	Denotes that this file is from the Canadian Ice Service
SGRD	SIGRID-3 format

Variable	Description
RXX	Region name abbreviation GL: Great Lakes EC: East Coast WA: Western Arctic EA: Eastern Arctic HB: Hudson Bay)
YYYY	4-digit year
MM	2-digit month
DD	2-digit day
pl	Feature type (pl: polygon)
v	Version number. Permits multiple charts per day a: 1st version b: 2nd version and so forth
.xxx	File extension (`.shp, .shx, .dbf, .prj,` and `.xml`)

Note: In some cases, the original files needed to be replaced with newer files. These newer files have the following file naming convention: `cis_SGRDREA_YYYYMMDD_pl_v_YYYYMMDDTTTTTT.tar` The later variables (YYYYMMDDTTTTTT) contain a timestamp. The time stamp is GMT and corresponds to the time that the file was created.

1.6 Parameters

The parameters include total ice concentration, partial concentration, stage of development, and ice form. Sea ice thickness can be assessed using stage of development as a proxy for thickness (NIC, 2006).

1.6.1 Sample Data Record

This section contains some sample data records including a sample of two SIGRID-3 shapefiles: One for the Great Lakes Region (Figure 5) and one for the Hudson Bay Region (Figure 6). Further, the beginning portion of a metadata file is also displayed (Figure 7).

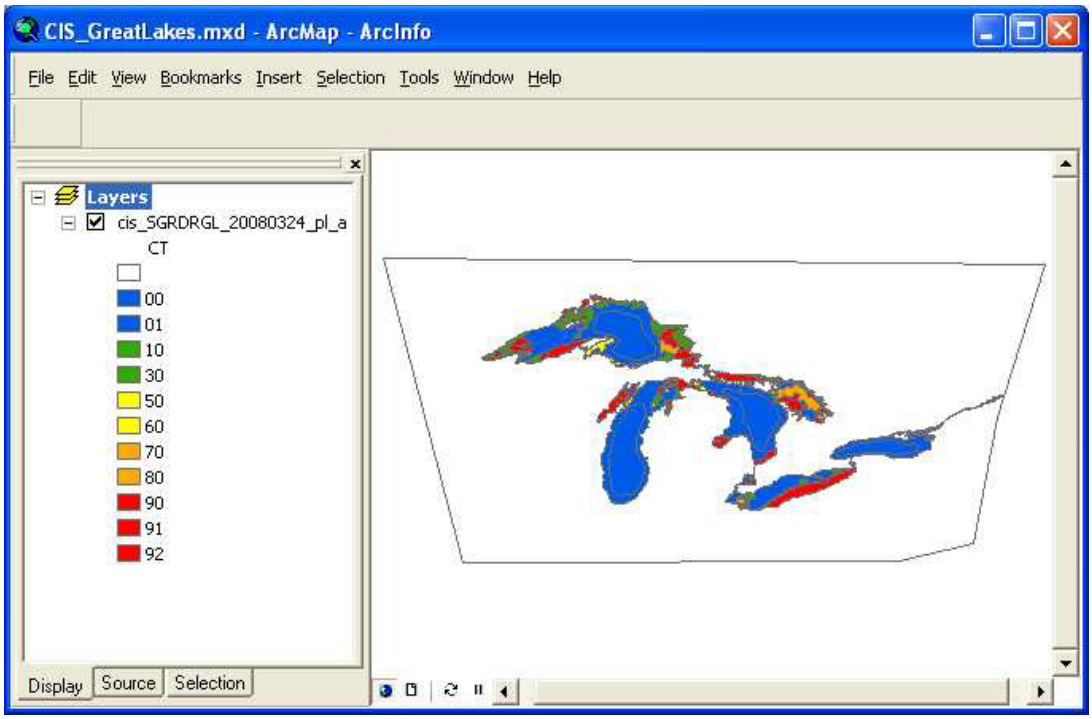

Figure 5. cis_SGRDRGL_20080324_pl_a.shp shapefile opened in ArcMap. The symbology was modified to correspond to some images in the National Ice Center Climatology data set. The results show the varying ice concentration around the Great Lakes

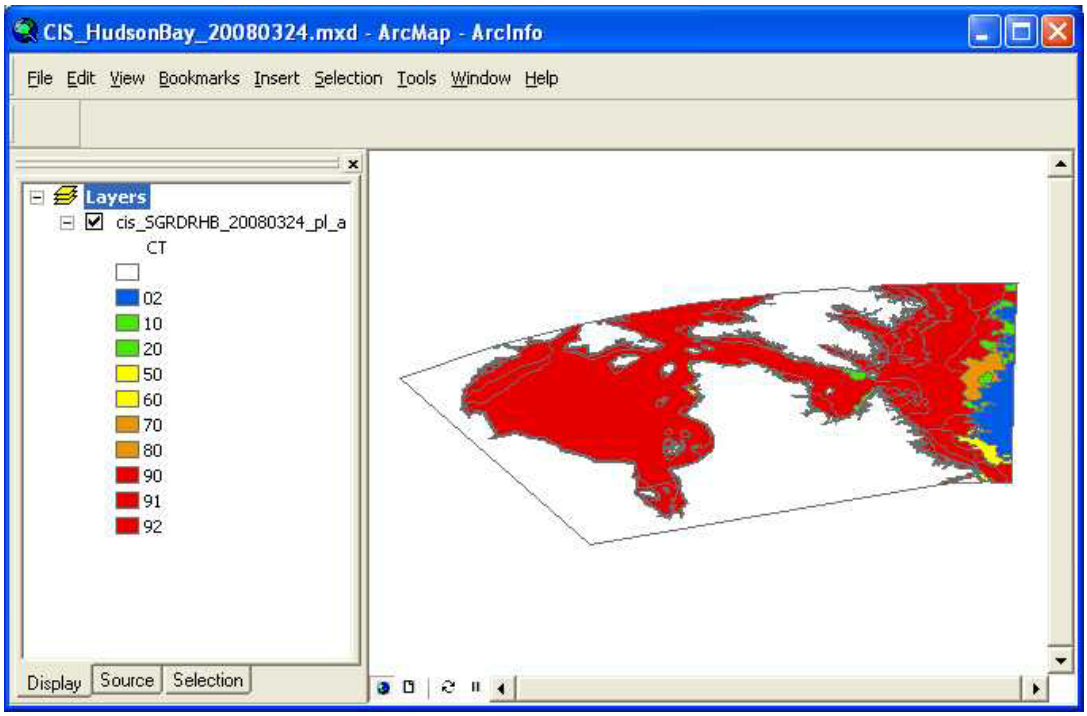

Figure 6. cis_SGRDRHB_20080324_pl_a.shp shapefile opened in ArcMap. The symbology was modified to correspond to some images in the National Ice Center Climatology data set. The results show the varying ice concentration in the Hudson Bay.

Each shapefile contains an associated metadata file. The metadata files for the various regions are similar. They differ only on these specific metadata fields: `<bounding> (coordinates)`, `<pubdate>`, `<title>`, and `<caldate>`. Here is the beginning portion of metadata from `cis_SGRDRHB_20080324_pl_a.xml` that corresponds to Figure 2.

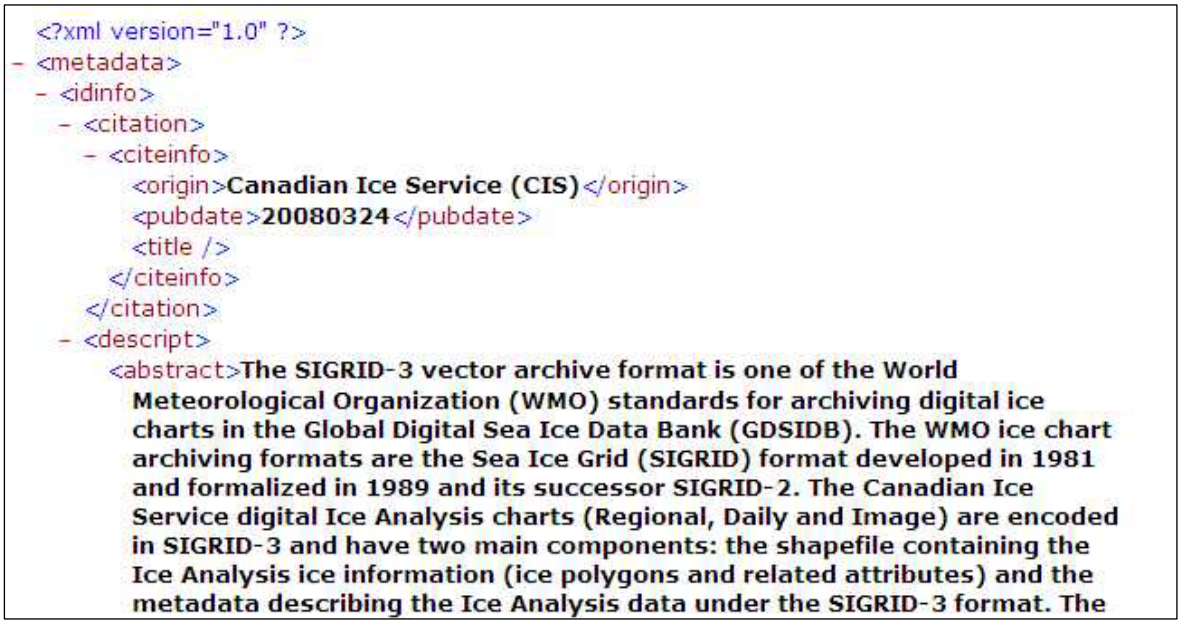

Figure 7. Sample Metadata Record for cis_SGRDRHB_20080324_pl_a.xml

1.7 Spatial Coverage and Resolution

This data set covers the Canadian Arctic regions including Northern Canadian waters (Western Arctic, Eastern Arctic, and Hudson Bay) and Southern Canadian waters (Great Lakes and East Coast). Figure 8 displays these regions.

Note: The specific geographic coordinates for each region are listed in the metadata associated with that region.

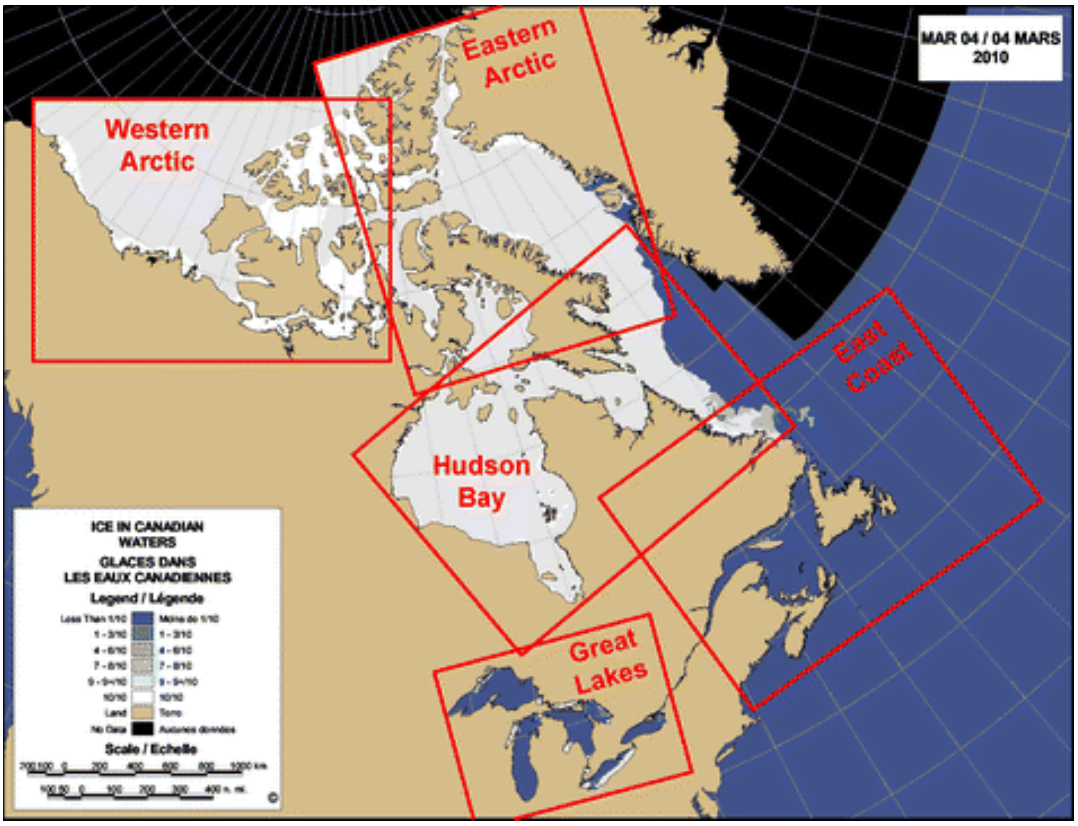

Figure 8. Spatial Coverage Map

This map shows the spatial coverage of the Canadian Arctic regions for both the Northern Canadian waters and the Southern Canadian waters. Image courtesy of the Canadian Ice Service.

Because this data set is provided as vector shapefiles, there is no inherent resolution.

1.7.1 Projection

NSIDC adds a projection (`.prj`) file to each tar file received from CIS. NSIDC renames the projection file to correspond to the shapefile file name in each tar file. For example: `cis_SGRDRHB_20061211_pl_a.shp and cis_SGRDRHB_20061211_pl_a.prj.`

Shapefiles from 01 March 2006 through 24 July 2011 are in Geographic Latitude/Longitude, which is described in the associated projection (`.prj`) file as::

```
GEOGCS["GCS_WGS_1984",DATUM["D_WGS_1984",SPHEROID["WGS_1984",6378137.0,29
8.257223563]],PRIMEM["Greenwich",0.0],

UNIT["Degree",0.0174532925199433]]
```

Shapefiles after 24 July 2011, are produced using the Lambert Conformal Conic map projection, which is described in the associated projection (`.prj`) file as:

```
PROJCS["WGS_1984_Lambert_Conformal_Conic",GEOGCS["GCS_WGS_1984",DATUM["D_
WGS_1984",SPHEROID["WGS_1984",6378137.0,298.257223563]],

PRIMEM["Greenwich",0.0],UNIT["Degree",0.0174532925199433]],PROJECTION["La
mbert_Conformal_Conic"],PARAMETER["False_Easting",0.0],

PARAMETER["False_Northing",0.0],PARAMETER["Central_Meridian",-
100.0],PARAMETER["Standard_Parallel_1",49.0],

PARAMETER["Standard_Parallel_2",77.0],PARAMETER["Latitude_Of_Origin",40.0
],UNIT["Meter",1.0]]
```

NOTE: The AREA field in the shapefiles is calculated automatically by the GIS software, so this change in projection affects the units of measurement for the AREA field. For shapefiles from 01 March 2006 through 24 July 2011 the AREA field is in square degrees. For shapefiles after 24 July 2011, the AREA field is in square meters. Since the area of a polygon depends on the map projection, if you wish to use a different projection, you should re-calculate the polygon areas under that different projection. Also, if you need to compare polygon areas, please ensure that the areas are calculated under the same map projection.

1.8 Temporal Coverage and Resolution

Temporal coverage spans from 2006 to the present. The start date of the data for each region differs. See Table 2 for a list of start dates by region. Data begin in 2006 when production of the ice charts in SIGRID-3 format began. Users should note that the CIS has produced regional ice charts since 1968 in `.e00` format, but these files are not included in this SIGRID-3 data set.

Information on temporal coverage can be found in the file metadata and is reproduced here:

> The Regional Ice Analyses are based on an analysis and integration of all available data on ice conditions, including weather and oceanographic information, visual observations from shore, ship and aircraft, airborne radar, satellite imagery and climatological information. The analyses show the estimated ice conditions at publication date (which corresponds to the valid date).

Table 2. Start Dates of Data by Region

Region	Start Date of Data
Western Arctic	May 2006
Eastern Arctic	June 2006
Hudson Bay	May 2006
Great Lakes	Dec 2006
East Coast	May 2006

The temporal resolution is as follows:

- Northern Canadian waters 2006-2011: Weekly (summer) and bi-weekly (winter)
- Northern Canadian waters, Fall 2011 on: Weekly year round
- Southern Canadian waters: Weekly (winter); files are not produced in the summer

Each ice chart contains up to 72 hours of input data. For example, a chart dated 16 October 2006 may contain data from the previous three days, as noted in each metadata file.

2 SOFTWARE AND TOOLS

The shapefiles can be read using GIS software and the tar files can be opened using tar extraction software.

3 DATA ACQUISITION AND PROCESSING

3.1 Data Processing

The CIS uses the operational Ice Service Integrated System (ISIS) to create the regional ice charts based on MANICE procedures (Environment Canada, 2005). The CIS takes input from various sources such as satellites, aerial reconnaissance, and ship reports based on data availability. They create coverages and then convert the coverages to shapefiles with corresponding metadata. Each metadata (.xml) file lists the sources used. Users should note that this list of sources is comprehensive and lists all possible data sources, not just the data sources that directly relate to that shapefile.

3.2 Error Sources

Not all potential sources of error have been identified. Users can look at MANICE (Environment Canada, 2005) for more information. There are potential errors introduced with the manual assimilation process. See the section on Other Related Data Collections and References and Related Publications for more information.

3.3 Quality Assessment

A full quality assessment of this data set was not completed. However, the metadata files state the following:

"The reliability and accuracy of the data set is directly related to the availability, resolution and the effects of atmospheric (cloud, daylight, etc.) and ground (snow, rain, sea state, etc.) conditions on the source information. The source information is incorporated in the Regional Ice Analysis if the source information publication or acquisition date is plus or minus three days of the Regional Ice Analysis publication date."

The temporal period for data collection is generally restricted to the 72 hours prior to publication date.

4 REFERENCES AND RELATED PUBLICATIONS

Canadian Ice Service. 2006. Canadian Ice Service SIGRID-3 Implementation 2006. Environment Canada, 14 pp. https://nsidc.org/sites/default/files/documents/other/cis_sigrid3_implementation.pdf.

Environment Canada. 2005. Manual of Standard Procedures for Observing and Reporting Ice Conditions (MANICE). Issuing authority: Assistant Deputy Minister, Meteorological Service of Canada: https://nsidc.org/sites/default/files/documents/technical-reference/manice.pdf.

Fetterer, F. (2022). The Global Digital Sea Ice Data Bank at NSIDC, 1986-2005. NSIDC Special Report 24. Boulder CO, USA: National Snow and Ice Data Center.

Intergovernmental Oceanographic Commission of UNESCO. 2010. SIGRID-3: A Vector Archive Format for Sea Ice Charts, Revision 2. JCOMM Technical Report No. 23, WMO/TD-No. 1214: https://library.wmo.int/index.php?lvl=notice_display&id=11295#.X9flJl5lCB0.

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Thompson, T. 1981. Proposed Format for Gridded Sea Ice Information (SIGRID). World Meteorological Organization, Geneva, Report, World Climate Program, 28 pp.

Tivy, A., S. E. L. Howell, B. Alt, S. McCourt, R. Chagnon, G. Crocker, T. Carrieres, and J. J. Yackel. 2011. Trends and variability in summer sea ice cover in the Canadian Arctic based on the Canadian Ice Service Digital Archive, 1960-2008 and 1968-2008. J. Geophys. Res. 116: C03007, doi:10.1029/2009JC005855.

4.1 Related NSIDC Data Collections

- Gridded Monthly Sea Ice Extent and Concentration, 1850 Onward
- Environmental Working Group Joint U.S.-Russian Arctic Sea Ice Atlas
- National Ice Center Arctic Sea Ice Charts and Climatologies in Gridded Format
- Sea Ice Charts of the Russian Arctic in Gridded Format, 1933-2006
- The Dehn Collection of Arctic Sea Ice Charts, 1953-1986

4.2 Other Related Data Collections

- An Electronic Atlas of Great Lakes Ice Cover, Winters 1973-2002
- Sea Ice Climatic Atlas: Northern Canadian Waters 1971-2000/Atlas climatique des glaces de mer: Eaux du nord canadien 1971-2000, Canadian Ice Service, ISBN 0-662-61973-3
- Historical Sea Ice Atlas
- The ice services of the International Ice Chart Working Group may also have collections.

4.3 Related Publications

Galley, R. J., Babb, D., Ogi, M., Else, B. G. T., Geilfus, N.-X., Crabeck, O., Barber, D. G., and Rysgaard, S. 2016. Replacement of multiyear sea ice and changes in the open water season duration in the Beaufort Sea since 2004. *J. Geophys. Res. Oceans* 121: 1806–1823. https://doi.org/10.1002/2015JC011583.

Gully, K., Iacozza, J., and Dunmall, K.M. 2022. Development of a small-scale approach to assess sea ice change using weekly ice charts, with application to Anguniaqvia Niqiqyuam Marine Protected Area. *Arctic Science* 9(1): 198-208. https://doi.org/10.1139/as-2021-0045.

Smith, O. P. 2000. Observers Guide to Sea Ice. National Oceanic and Atmospheric Administration, Hazardous Materials Response Division, Office of Response and Restoration: http://response.restoration.noaa.gov/sites/default/files/Sea_Ice_Guide.pdf.

5 CONTACTS AND ACKNOWLEDGMENTS

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6 DOCUMENT INFORMATION

6.1 Document Authors

L. Ballagh prepared this document based on SIGRID-3 guidelines (IOC, 2010), CIS SIGRID-3 implementation (CIS, 2006), the metadata files, and on correspondence with R. Chagnon and F. Fetterer. Document edited by A. Windnagel.

6.2 Publication Date

October 2009

6.3 Date Last Updated

July 2021: A. Windnagel made small edits to the summary, related data collections, and references.
May 2018: A. Windnagel updated Figure 2 to describe the change in format for data starting 30 May 2018.
January 2011: A. Windnagel implented changes requested by Dan Fequet.
July 2010: A. Windnagel added a paper to the related publications section.