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JCOMM Expert Team on Sea Ice

SIGRID-3: A VECTOR ARCHIVE FORMAT FOR SEA ICE GEOREFERENCED INFORMATION AND DATA

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1. Introduction

This document describes Version 3.0 of SIGRID-3 (Sea Ice GeoReferenced Information and Data), an evolution of the SIGRID series of standards for coding, exchange and archiving of digital ice charts. Version 3.0 retains the essential structure of its predecessor and is backwards compatible with earlier versions of SIGRID-3. The important extension of Version 3 is to incorporate the features, attributes and encoding of the Ice Objects Catalogue for Electronic Navigation Charts (ENCs). The purpose of this extension is to facilitate the automatic translation of digital ice charts into S-57 and S-10x ENC formats.

1.1. Background

SIGRID ("Sea Ice Grid") was originally proposed in 1981 (Ref: Thompson 1981) as a way of digitizing sea ice charts to aid climatological analysis and improve operational ice chart production. Ice characteristics, as defined by a number of code tables, were described at grid points. SIGRID was adopted by the World Meteorological Organization (WMO) in 1989 (Ref: WMO 1989b) as the international standard for ice chart data in digital form.

After several years of use by ice services, SIGRID was revised in a substantial way to address a number of operational difficulties. SIGRID-2, which simplified the code tables and gridding mechanism, was approved by the WMO in 1994 (Ref: WMO 1994) as the new standard for digital ice chart information. The emphasis of SIGRID-2 was on the exchange of ice chart information for archiving and climatological analysis.

With advances in Geographic Information System (GIS) technology and the adoption of GIS by ice services for chart production, it became much easier to describe ice chart information in vector format, rather than at grid points, with significant advantages. The vector format preserves all of the information in the original chart and charts can be reproduced, re-projected or re-scaled without loss of information. Vector format can easily be converted to raster on any arbitrary grid when desired. SIGRID-3, a vector archive format for sea ice charts (Ref: JCOMM 2010b), was originally adopted by the JCOMM Expert Team on Sea Ice in 2004. It was revised in 2007 and 2010 to harmonize it with the WMO Sea Ice Nomenclature (Ref: WMO 1989a) and the Electronic Navigation Chart Ice Objects Catalogue (Ref: JCOMM 2010a).

In 2012, several ice services developed software to convert SIGRID-3 directly into the S-57 format that is the standard for exchange of data for Electronic Navigation Chart Systems (ENCS), of which Electronic Chart Display and Information Systems (ECDIS) are the subset approved for ship navigation. This was a major step forward in making ice information available in ENCS, a major goal of the ice services. However, previous versions of SIGRID-3 support only area features – polygons with attributes describing the ice in the polygon. Attributes are limited to those contained in the WMO international ice symbology – the "egg" code. There is no support for line or point features such as are described in the Ice Objects Catalogue.

At the 13th meeting of the International Ice Charting Working Group in 2012, it was agreed that SIGRID-3 should be developed as the "parent" standard for digital ice chart information – a standard from which S-57 and the future S-10x formats could be derived (Ref: IICWG 2012). This means that SIGRID is no longer just a format for archiving ice chart data for climatology. Version 3.0 of SIGRID-3 extends support to all ENCS objects including line and point features. Feature attributes are adopted from the Ice Objects Catalogue.

Version 3.0 of SIGRID-3 was approved by the Expert Team on Sea Ice at its 5th meeting in March 2014.

1.2. Overview of the SIGRID-3 Version 3.0 format

Version 3.0 retains the essential components of SIGRID-3. The shapefile basis and file structure are unchanged. The major changes are to the database file as described below.

Version 3.0 (like earlier versions) is based on a format called "shapefile." The shapefile format is an open source, vector file format originally developed by Environmental Systems Research Institute (Ref: ESRI 1998, ESRI 2011). A description of shapefiles can be found at http://en.wikipedia.org/wiki/Shapefile. Vector formats represent features (such as areas of ice outlined on a chart) as a series of vertices that define the outline of the feature in space. An associated list of

attributes (such as the concentration, stage of development, and form of ice) characterizes ice within the outlined area.

Shapefiles can be read and produced by most GIS software including public domain programs such as Quantum GIS and commercial software such ESRI's ArcGIS. It is, therefore, a de facto standard for the exchange of GIS information among different software platforms.

A basic understanding of GIS software packages on the part of producers and users of shapefiles is assumed and details are not given here. For detailed descriptions of tools and functions in GIS software, the user should refer to the relevant software documentation.

2. SIGRID-3 Version 3.0 Shapefiles

This section provides an overview of the shapefile format as implemented in Version 3.0.

2.1. File Naming Convention

File names are divided into five parts, plus an extension, containing information on the issuing organization, region covered, date, feature type and version, as follows:

organization-code_region-name_valid-date_feature-type_version.ext

An underscore separates each division. The file name is not case sensitive.

- *organization*-code is a unique identifier adopted by each issuing organization (for example, CIS, DMI, AARI, NIC). The number of characters to be used for the organization code is not prescribed but should be kept reasonably short for practical purposes.
- *region*-name is a descriptive name assigned by the issuing organization to identify the geographic region described by the file (for example, Baffin, Baltic, Chukchi, Hudson Bay, Arctic, Antarctic). The number of characters to be used for the region name is not prescribed but should be kept reasonably short for practical purposes.
- *valid*-date is eight characters representing the date for which the information in the file is valid, in the format "yyyymmdd". If the information in the file is valid for more than one date, the issuing organization should assign the date that is most representative. More precise date information can be contained in the metadata (see Appendix D).
- *feature-type* is two characters identifying the type of features contained in the shapefile set – "pl" for polygons, "ln" for lines, or "pt" for points. (see Section 2.2)
- *version i*s a single character used to distinguish between charts that would otherwise have the same name or to facilitate versioning. The first or only chart will use "a". Additional charts, if any, will use "b", "c", and so on.
- The extension, represented by "ext" above, is shp, shx, dbf, prj or xml depending on the file type (see Section 2.3).

Examples:

CIS_Foxe_20120114_ln_a.shp

NIC_antarc_20030210_pl_a.dbf

AARI_kar_20111030_pt_b.prj

2.2. Feature Type Shapefiles

In accordance with the shapefile standard, feature types (polygons, lines, points) cannot be intermingled in the same shapefile. Each type requires a separate shapefile. To describe an ice chart containing polygons (e.g. ice areas), lines (e.g. ice edge) and points (e.g. ice drift), requires three separate, but related, root file names.

2.3. Mandatory Files

A "shapefile" is actually a set of related files, each with the same root name but with different extensions. Five files are mandatory for each shapefile in Version 3.0:

- *.shp – the main file containing the geographic reference points that define each of the features. The shapefile portrays the continental shoreline, islands, and all the ice lines as drawn by the analyst. Each record describes a shape as a list of latitude/longitude vertices.
- *.shx – an index file that links shapes to their attributes.
- *.dbf – a dBase IV file containing the attributes for each feature. Attributes are stored in a one-to-one relationship with shapes.
- *.prj – a projection file giving the geographic coordinate system of the data in the *.shp file. Note that a projection file is not mandatory for generic shapefiles but is required for SIGRID-3 to make it easier for users to display the shapefile.
- *.xml – an XML file containing the metadata that describes the ice chart information in the shapefile.

2.4. Examples

To describe an ice chart containing polygons, lines and points requires a total of fifteen separate files – five mandatory files for the polygon shapefile, five for the line shapefile and five for the point shapefile.

The table below gives an example of a full list of files in a complete shapefile set describing an ice chart containing polygons, lines and points. This file was produced by the Canadian Ice Service on August 21, 2012 and covers the Baffin Bay region.

CIS_Baffin_20120821_pl_a.shp	Main geographic reference file for polygon features
CIS_Baffin_20120821_pl_a.shx	Index file linking polygon features to database attributes
CIS_Baffin_20120821_pl_a.dbf	Database file containing attribute information for each polygon
CIS_Baffin_20120821_pl_a.prj	Projection file describing the projection of the polygon file
CIS_Baffin_20120821_pl_a.xml	Metadata file describing the polygon feature fileset
CIS_Baffin_20120821_ln_a.shp	Main geographic reference file for line features
CIS_Baffin_20120821_ln_a.shx	Index file linking line features to database attributes
CIS_Baffin_20120821_ln_a.dbf	Database file containing attribute information for each line
CIS_Baffin_20120821_ln_a.prj	Projection file describing the projection of the line file
CIS_Baffin_20120821_ln_a.xml	Metadata file describing the line feature fileset
CIS_Baffin_20120821_pt_a.shp	Main geographic reference file for point features
CIS_Baffin_20120821_pt_a.shx	Index file linking point features to database attributes
CIS_Baffin_20120821_pt_a.dbf	Database file containing attribute information for each point
CIS_Baffin_20120821_pt_a.prj	Projection file describing the projection of the point file
CIS_Baffin_20120821_pt_a.xml	Metadata file describing the point feature fileset

Note that the three projection files would be identical since they describe the projection of the ice chart that originally contained the three different feature types. Similarly, the three metadata files might be identical unless information specific to the different feature types was included.

3. SIGRID-3 Version 3.0 Shapefile Details

3.1. Main File (*.shp)

The *.shp file is created by the GIS software and is common for all shapefiles so it can be read by GIS software. There is nothing unique about the format for SIGRID-3. It is well documented in the references and will not be further described here.

SIGRID-3 *.shp files should be in geographic coordinates (latitude, longitude).

3.2. Index File (*.shx)

Similarly, the *.shx file is created by the GIS software and is common for all shapefiles so it can be read by GIS software. There is nothing unique about the format for SIGRID-3. It is well documented in the references and will not be further described here.

3.3. Projection File (*.prj)

The *.prj file is a small text file created by the GIS software and is common for all shapefiles so it can be read by GIS software. The information contained in the *.prj file specifies the geographic coordinate system of the geometric data in the *.shp file. Although not mandatory in the shapefile standard, it has been required for SIGRID-3 since 2012 to make it easier for users to view the shapefile and this requirement is carried forward to Version 3.0. The file contains a single record in "well-known text" (WKT) format containing:

- Name of Geographic coordinate system or Map projection
- Datum (geodesy)
- Spheroid
- Prime meridian
- Units used
- Parameters necessary to define the map projection, for example: Latitude of origin
- Scale factor
- Central meridian
- False northing
- False easting
- Standard parallels

Examples:

GEOGCS["GCS_WGS_1984",DATUM["D_WGS_1984",SPHEROID["WGS_1984",6378137.0,298.257223563]],PRIMEM["Greenwich",0.0],UNIT["Degree",0.0174532925199433]]

PROJCS["WGS_1984_Stereographic_North_Pole",GEOGCS["GCS_WGS_1984",DATUM["D_WGS_1984",SPHEROID["WGS_1984",6378137.0,298.257223563]],PRIMEM["Greenwich",0.0],UNIT["Degree",0.0174532925199433]],PROJECTION["Stereographic_North_Pole"],PARAMETER["False_Easting",0.0],PARAMETER["False_Northing",0.0],PARAMETER["Central_Meridian",180.0],PARAMETER["Standard_Parallel_1",60.0],UNIT["Meter",1.0]]

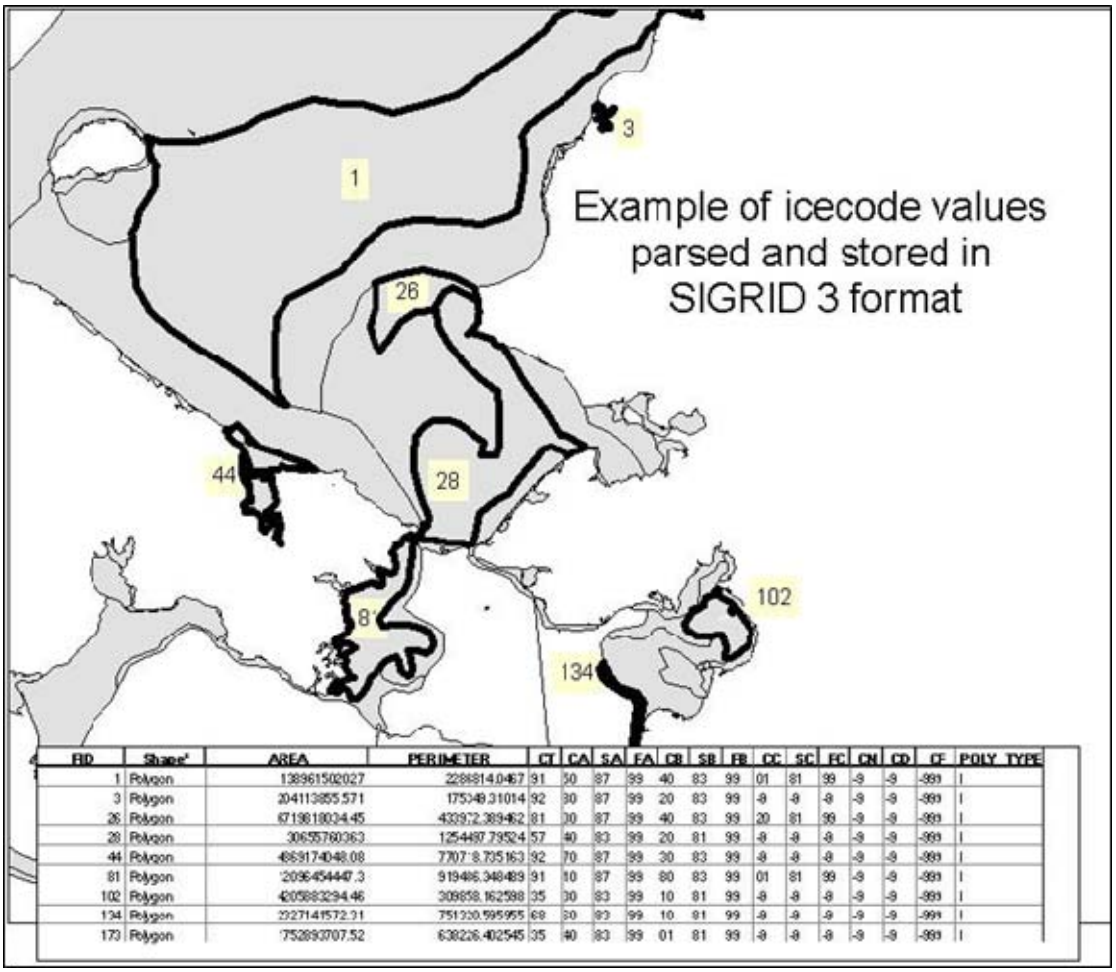
3.4. Database File (*.dbf)

The database file (*.dbf) stores the attribute information for each feature. This file is in dBase format, a format originally held by Borland, Inc. and used in shapefile production (Ref: dBASE 2012). This file contains two records – a header record and an attribute record. The header record describes the contents of the attribute record which contains all of the attribute information for every feature. Conceptually, it is easiest to think of the *.dbf file as a table in which every row corresponds to a different feature on the ice chart and columns (fields) contain attributes describing the feature in the form of SIGRID variables. The *.dbf file can be directly accessed by reading the header record and using it to decode the attribute record. More easily, it can be viewed in a table format using GIS software, Microsoft Excel, OpenOffice Base (providing also direct editing) or other relational database software packages. The *.dbf file must have the same root name as the *.shp, *.shx, *.prj and *.xml files and it must contain a record of SIGRID-3 attributes for each feature. These records must be in the same order as their corresponding features in the main (*.shp) file.

The details of the inner structure of the *.dbf file are described in reference dBASE 2012. Figure 1 illustrates the structure of a dBase file and its relationship to ice chart features.

As noted, a shapefile can contain only one type of feature – polygons, lines or points. The mandatory and optional database fields are different for each feature type. Appendix A specifies the fields for SIGRID-3 Version 3.0 shapefiles containing polygons. Appendix B specifies the fields for line shapefiles and Appendix C specifies the fields for point shapefiles.

Note: "field", "column" and "attribute" are used interchangeably in this document to mean the same thing. "Field" comes from dBase terminology. "Column" comes from table or spreadsheet terminology. "Attribute" comes from geodata terminology.



FID	Shape*	AREA	PERIMETER	CT	CA	SA	FA	CB	SB	FB	CC	SC	FC	CN	CD	CF	POLY_TYPE
1	Polygon	138961502027	2288814.04467	91	50	87	99	40	83	99	01	81	99	-9	-9	-999	I
3	Polygon	204113855.571	175349.31014	92	30	87	99	20	83	99	-9	-9	-9	-9	-9	-999	I
26	Polygon	671981803445	4339?2.389462	81	30	87	99	40	83	99	20	81	99	-9	-9	-999	I
28	Polygon	30655760363	1254497.79524	57	40	83	99	20	81	99	-9	-9	-9	-9	-9	-999	I
44	Polygon	486917404808	7707?8.735163	92	70	87	99	30	83	99	-9	-9	-9	-9	-9	-999	I
81	Polygon	'2096454447.3	919486.348489	91	10	87	99	80	83	99	01	81	99	-9	-9	-999	I
102	Polygon	420588294.46	309858.162588	35	30	83	99	10	81	99	-9	-9	-9	-9	-9	-999	I
134	Polygon	2927141572.31	751320.595955	69	30	83	99	10	81	99	-9	-9	-9	-9	-9	-999	I
173	Polygon	'752893707.52	638226.402545	35	40	83	99	01	81	99	-9	-9	-9	-9	-9	-999	I

Figure 1: Illustration of the linkage between records in a dBase file and polygon attributes.

3.5. Metadata File (*.xml)

Background

Metadata files contain important descriptive information about associated chart data. SIGRID-3 uses a format that is sanctioned by the U.S. Federal Geographic Data Committee (FGDC): the Content Standard for Digital Geospatial Metadata (CSDGM) (Ref: FGDC 2012). The FGDC reference provides up to date information about the evolution of the standard as well as software tools to create, edit and validate metadata files against the standard.

FGDC coordinates the development of the U.S. National Spatial Data Infrastructure which develops policies, standards and procedures for U.S. organizations to produce and share geographic data. The U.S. National Ice Center and National Snow and Ice Data Center must follow the FGDC format. The International Organization for Standardization (ISO) coordinates the international development of policies, standards, and procedures for the production and distribution of geographic data. ISO members are continuing to develop the standardization of geographic data and ISO Project 19115 specifically deals with metadata. Since the United States is a member of ISO, FGDC metadata will eventually be harmonized with the ISO standard. Adopting the FGDC standard for SIGRID-3 will minimize the steps needed to make SIGRID-3 ISO compliant in future.

Metadata Structure

SIGRID-3 uses the widely accepted, public domain XML structure (Ref: XML) for metadata. A file in XML can be read using a web browser and made easily available for searches via the Internet. XML

is text based and can be read by both humans and machines. It can be created with a standard text editor or with software tools that simplify the task.

XML uses unique “tags” to organize a metadata document while at the same time describing that document’s content. These tags will always be the same for each ice chart and must be unique from every other tag used in the XML document. For example, projection information will always be located within the same set of XML tags *(Note that projection information in the metadata file duplicates that information in the *.prj file. The *.prj file is required in SIGRID-3 because not all GIS software can process the metadata.)*

Appendix D gives the details of metadata contents and structure.

4. Using SIGRID-3 for coding ice observations

SIGRID-3 format may be used to code coastal, shipborne or airborne visual observations of ice parameters. It is proposed to use an ‘egg-code’ scheme and follow instructions from Appendix A (“Database file Contents for Polygon Shapefiles”) for coding ice parameters regardless of their geometry (polygon, line or point). Field name T1 (RECDAT) in a valid date and time format should be used to define date and time of observation.

5. Using SIGRID-3 for coding prognostic information

SIGRID-3 format may be used to code prognostic ice information presented in vector format: polygon, linear or point. Field name T2 (SORDAT) in a valid date and time format should be used to define date and time of validity of information.

6. Conclusion

SIGRID-3 is issued under the authority of the JCOMM Expert Team on Sea Ice (ETSI). ETSI is also recognized by the International Hydrographic Organization as the responsible authority for the Electronic Navigation Chart Ice Objects Catalogue. It will be important to keep both of these mutually dependent standard up to date as users’ needs and technologies evolve. A review of these standards should be a standing agenda item for ETSI meetings.

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Appendix A - Database File Contents for Polygon Shapefiles

1. Introduction

As noted earlier, it is in the database file that the major differences between Version 3.0 and earlier versions of SIGRID-3 are found. To provide backwards compatibility, all of the earlier SIGRID-3 fields are retained. To simplify the production of S-57/S-10x files, fields from the Ice Objects Catalogue are added to Version 3.0. Most of these new fields can be used in place of the previous fields and, over time, it is expected that use of the older fields will be phased out.

The *.dbf file for polygon shapefiles consists of a set of fields (attributes) that describe each polygon feature in the shapefile. Visualizing the database file as a table of rows and columns, there is one row for each polygon and one column for each field. The rows must be in the same order as features in the main (*.shp) file. All mandatory fields must be present in the database file and the naming, type and length of the fields must follow the layout defined in Table A-2. The easiest way to create the database file is with GIS software capable of creating shapefiles but it is also possible to create them with database or custom software.

Note that all fields present in the database file must also be described in the metadata file (Appendix D).

2. Fields (Attributes) in SIGRID-3 Version 3.0 vs Earlier Versions

Field names in SIGRID-3 were carried forward from earlier versions of SIGRID and mostly consist of 2-character identifiers (CT, CA, etc.). Version 3.0 retains support for these fields but also adds of the fields found in the Ice Objects Catalogue. The Ice Objects Catalogue fields replace earlier SIGRID-3 fields but not necessarily on a one-to-one basis. For example, the Ice Objects Catalogue field ICEACT is a direct one-to-one replacement for the SIGRID-3 field CT. However, the single Catalogue field ICEAPC replaces the three SIGRID-3 fields CA, CB and CC. Table A-1 provides a mapping of the SIGRID-3 fields to those from the Ice Objects Catalogue. Note that, in some cases, there is no Ice Objects Catalogue field corresponding to a SIGRID-3 field. These cases will have to be examined in future to determine if missing fields are still required.

It is permissible to mix fields from SIGRID-3 and fields from the Ice Objects Catalogue *provided* that they do not come from the same row in Table A-1. For example, both CT and ICEACT may not be used in the same database file since they appear in the same row. Similarly, if ICEAPC is used, then none of CA, CB or CC may be used. However, it is permissible to use ICEACT and CA, CB or CC. There is no confusion between which set of fields is being used since every field in the database file must be described in the file header record, as defined by the dBase format.

3. Mandatory Fields

There are three mandatory fields for polygon features: AREA, PERIMETER and POLY_TYPE. The area and perimeter of each polygon are typically computed by GIS software. POLY_TYPE is a one-character code that defines the type of the polygon feature.

4. Optional Fields

Previous versions of SIGRID-3 identified 17 mandatory fields (including the three described above) that were required in every polygon database file. Additionally, a number of optional fields were identified and there was provision for producers to define additional optional fields.

In contrast to earlier versions, all fields in Version 3.0, except for the three identified above, are optional. This is a practical measure dictated by the flexibility to use either SIGRID-3 fields or Ice Objects Catalogue fields since some of these are mutually exclusive. It is left to producers to incorporate as many fields as necessary to describe the ice chart as completely as possible. The list of SIGRID-3 mandatory fields or their Ice Objects Catalogue counterparts is a good starting point.

Table A-1 identifies the SIGRID-3 Version 3.0 mandatory and optional fields together with their Ice Objects Catalogue counterparts.

Database fields may be placed in any order and any number of fields may be used subject to dBase format limitations. The dBase format places limitations on size: the maximum number of fields is 255, maximum length of a field name is 10 characters, and the maximum length of a string is 254 characters. The dBase header record defines the name, length and location of the fields. Database fields must also be defined in the XML metadata.

5. Polygon Field Enumerations

Each field in a database file can contain only the values specified in Table A-2. Free-format strings are not allowed. Table A-2 specifies whether a field contains a number or text. In all cases, when text is indicated, there is a reference to a code table that lists the permissible text values. References to “SIGRID Code Tables” denote codes used in earlier SIGRID versions and are re-produced in Appendix 5 for convenience. References to “IOC Codes” refer to the attribute code numbers in the Ice Objects Catalogue. The Catalogue is not copied here for sake of brevity. Usage should be consistent with the description in the Catalogue with one exception: no field separators (e.g. commas, brackets) are used in the dBase file.

All fields have the fixed length as described below. If a field or a portion of a field is not used, it should be padded with ASCII blanks on the right. For example, if there are only two types of ice present, then the fields for ICEAPC would have two ASCII blanks padded on the right (e.g. ICEAPC=6010bb). In this same example, ICESOD would have the value bb9381bbbb and ICEFLZ would be 0502bb *(where bb represents two ASCII blanks).*

6. Unused Fields

Note that, because of the structure of the dBase file, if a field is used for any polygon feature, then it must be included for all polygon features in the database (i.e. it forms a “column” of the database array). Fields not used for a feature shall be filled with blanks.

Table A-1 – SIGRID-3 Version 3.0 Polygon Database Fields

SIGRID-3 Field Name	SIGRID-3 Field Definition	Ice Objects Catalogue Field Name	Ice Objects Catalogue Field Definition
FIELDS MANDATORY IN ALL VERSIONS OF SIGRID-3			
AREA	Area of polygon feature	AREA	Area of polygon feature
PERIMETER	Perimeter length of polygon feature	PERIMETER	Perimeter length of polygon feature
POLY_TYPE	Type of polygon feature	POLY_TYPE	Type of polygon feature
FIELDS MANDATORY ONLY IN EARLIER VERSIONS OF SIGRID-3; OPTIONAL IN VERSION 3.0			
CT	Total concentration	ICEACT	Total concentration
CA	Partial concentration of thickest ice	ICEAPC	Partial concentrations of up to three types of ice (Ca,Cb,Cc)
CB	Partial concentration of second thickest ice		
CC	Partial concentration of the third thickest ice		
CN	Stage of development of ice thicker than SA but with concentration less than 1/10 (corresponds to So)	ICESOD	Stage of development of up to five types of ice (So,Sa,Sb,Sc,Sd)
SA	Stage of development of thickest ice		
SB	Stage of development of second thickest Ice		
SC	Stage of development of third thickest ice		
CD	Stage of development of any remaining class of ice (corresponds to Sd)		
FA	Form of thickest ice	ICEFLZ	Form of up to three types of ice (Fa,Fb,Fc)
FB	Form of second thickest ice		
FC	Form of third thickest ice		
FP	Predominant form of ice	No corresponding attribute	
FS	Secondary form of ice	No corresponding attribute	
FIELDS OPTIONAL IN ALL VERSIONS OF SIGRID-3			
DP	Dynamic processes	ICECST	Compacting Strength
DD	Direction of dynamic processes	ICEDDR	Ice Drift Direction
DR	Rate of ice drift in tenths of knots	ICEDSP	Speed of an ice mass in knots (floating point)
DO	Observational Method	No corresponding attribute	
WF	Form of water openings	ICEFTY ICELST	Ice Fracture Type Ice Lead Status
WN	Number of water openings	ICELFQ	Frequency of Leads or Fractures

SIGRID-3 Field Name	SIGRID-3 Field Definition	Ice Objects Catalogue Field Name	Ice Objects Catalogue Field Definition
WD	Orientation (direction) of water openings	ICELOR	Orientation of Leads or Fractures
WW	Width of water openings in hundreds of meters	ICELWD	Ice Lead (or Fracture or Crack) Width (integer number of meters)
WO	Observational Method	No corresponding attribute	
RN	Nature of topography feature	ICELVL	Level Ice
RA	Age of topography feature	ICERDV	Ice Ridge Classification
RD	Orientation of topography feature	No corresponding attribute	
RC	Concentration of topography feature	ICERCN ICEFCN IA_HLG	Ice Ridge Concentration Ice Rafting Concentration Ice Hillock Concentration
RF	Frequency of topography feature; number per nautical mile	ICERFQ	Ice Ridge Frequency (integer number per nautical mile)
RH	Mean height of topography feature in tenths of meters	ICERMH	Ice Ridge Mean Height (integer number of decimeters)
RX	Maximum height of topography feature in tenths of meters	ICERXH	Ice Ridge Maximum Height (integer number of decimeters)
RO	Observational Method	No corresponding attribute	
EM	Mean thickness of level ice in cm	ICETCK	Ice Average Thickness (integer number of cm)
EX	Maximum thickness of level ice in cm	ICEMAX	Maximum Ice Thickness (integer number of cm)
EI	Thickness interval (range); tntntntxtxtx, where tntntn is minimum thickness and txtxtx is maximum thickness, in cm	ICEMAX ICEMIN	There is no single attribute corresponding to EI. The two attributes ICEMAX and ICEMIN can be used to provide the thickness range
EO	Observational Method	ICETTY	Ice Thickness Type
AV	Concentration of very thick brash ice (>4 metres)	ICEBRS	Brash Ice
AK	Concentration of thick brash ice (>2-4 metres)		
AM	Concentration of medium brash ice (1-2 metres)		
AT	Concentration of thin brash ice (<1 metre)		
SC	Concentration of snow	ICESCN	Snow Cover Concentration
SN	Snow depth	ICESCT	Snow Depth
SD	Orientation (direction) of sastrugi	ICEDOS	Direction of Sastrugi
SM	Melting forms	ICEMLT	Melt Stage

SIGRID-3 Field Name	SIGRID-3 Field Definition	Ice Objects Catalogue Field Name	Ice Objects Catalogue Field Definition
SW[1]	Area coverage of water on ice in tenths	No corresponding attribute	
SO	Observational Method	No corresponding attribute	
BL	Type of iceberg (Form,Size)	IA_BFM ICEBSZ	Prevailing Iceberg Form Iceberg Size
BD	Direction of drift of iceberg	ICEDDR	Ice Drift Direction
BE	Rate of drift in tenths of knots	ICEDSP	Speed of an ice mass in knots (floating point)
BN	Number of icebergs	IA_OBN	Number of Ice Objects
BY	Day of month	No corresponding attribute	
BO	Observational Method	No corresponding attribute	
TT	Sea surface temperature in tenths of degrees Celsius	No corresponding attribute	
TO	Observational Method	No corresponding attribute	
OP	Primary source of information on which the chart is based	No corresponding attribute	
OS	Secondary source of information on which the chart is based	No corresponding attribute	
OT	Tertiary source of information on which the chart is based	No corresponding attribute	
T1	Date and time when the object was observed	RECDAT	The date when the object was captured, edited or deleted
T2	Date and time when the object is valid	SORDAT	The production date of the source, i.e. the date of measurement

[1] This parameter was “SA” in earlier versions of SIGRID. It has been re-named to avoid confusion with SA – Stage of development of thickest ice.

Table A-2: Polygon Field Enumeration References

Field or Column Name	Data Type	Length (bytes)	Code Table Reference	Field Definition
AREA	Double precision binary	20		Area of polygon feature
PERIMETER	Double precision binary	20		Perimeter length of polygon feature
POLY_TYPE	Text	1	SIGRID Table 4	Type of polygon feature
ICEACT	Text	2	IOC Code 30300	Total Concentration
ICEAPC	Text	6	IOC Code 30301	Partial Concentration
ICESOD	Text	10	IOC Code 30302	Ice Stage of Development
ICEFLZ	Text	6	IOC Code 30304	Floe Sizes
ICEMLT	Text	2	IOC Code 30305	Melt Stage
ICELVL	Text	2	IOC Code 30308	Level Ice
ICECST	Text	2	IOC Code 30309	Compacting Strength
ICEFTY	Text	2	IOC Code 30310	Ice Fracture Type
ICELST	Text	2	IOC Code 30311	Ice Lead Status
ICELFQ	Integer	2	IOC Code 30312	Frequency of Leads or Fractures
ICELOR	Text	2	IOC Code 30313	Orientation of Leads of Fractures
ICELWD	Integer	2	IOC Code 30314	Ice Lead (or Fracture or Crack) Width (integer number of meters)
ICEBSZ	Text	2	IOC Code 30316	Iceberg Size
ICEDDR	Text	2	IOC Code 30317	Ice Drift Direction
ICEDSP	Floating Point	4	IOC Code 30318	Speed of an ice mass in knots (floating point)
ICETCK	Integer	2	IOC Code 30319	Ice Average Thickness (integer number of cm)

Field or Column Name	Data Type	Length (bytes)	Code Table Reference	Field Definition
ICEMAX	Integer	2	IOC Code 30320	Maximum Ice Thickness (integer number of cm)
ICEMIN	Integer	2	IOC Code 30321	Minimum Ice Thickness (integer number of cm)
ICETTY	Text	2	IOC Code 30322	Ice Thickness Type
ICESCT	Integer	2	IOC Code 30323	Snow Depth
ICESCN	Text	2	IOC Code 30324	Snow Cover Concentration
ICEDOS	Text	2	IOC Code 30325	Direction of Sastrugi
ICERCN	Text	2	IOC Code 30326	Ice Ridge Concentration
ICERDV	Text	2	IOC Code 30327	Ice Ridge Classification
ICERMH	Integer	2	IOC Code 30328	Ice Ridge Mean Height (integer number of decimeters)
ICERFQ	Integer	2	IOC Code 30329	Ice Ridge Frequency (number per nautical mile)
ICERXH	Integer	2	IOC Code 30330	Ice Ridge Maximum Height (integer number of decimeters)
ICEKCN	Text	2	IOC Code 30331	Ice Keel Concentration
ICEKFQ	Integer	2	IOC Code 30332	Ice Keel Frequency (number per nautical mile)
ICEKMD	Integer	2	IOC Code 30333	Ice Keel Mean Depth (integer number of decimeters)
ICEKXD	Integer	2	IOC Code 30334	Ice Keel Maximum Depth (integer number of decimeters)
ICEFCN	Text	2	IOC Code 30335	Ice Rafting Concentration
IA_SFA	Text	12	IOC Code 30336	Combination Ice Stage of Development and Floe Size for the 1st partial concentration
IA_SFB	Text	12	IOC Code 30337	Combination Ice Stage of Development and Floe Size for the 2nd partial concentration
IA_SFC	Text	12	IOC Code 30338	Combination Ice Stage of Development and Floe Size for the 3rd partial concentration
IA_FFA	Text	14	IOC Code 30339	Ice Breccia for the first partial concentration

Field or Column Name	Data Type	Length (bytes)	Code Table Reference	Field Definition
IA_FFB	Text	14	IOC Code 30340	Ice Breccia for the second partial concentration
IA_FFC	Text	14	IOC Code 30341	Ice Breccia for the third partial concentration
IA_SNG	Text	2	IOC Code 30344	Snow Cover
IA_PLG	Text	2	IOC Code 30346	Contamination
IC_HLG	Text	2	IOC Code 30347	Ice Hillock Concentration
IA_BFM	Text	2	IOC Code 30354	Prevailing Iceberg Form
IA_OBN	Integer	2	IOC Code 30358	Number of Ice Objects
ICEBRS	Text	8	IOC Code 30362	Brash Ice
RECDAT	Date and Time	10-22	ISO 8601	Date and time of observation
SORDAT	Date and Time	10-22	ISO 8601	Date and time of validity
CT	Text	2	SIGRID Table 1	Total concentration
CA	Text	2	SIGRID Table 1	Partial concentration of thickest ice
CB	Text	2	SIGRID Table 1	Partial concentration of second thickest ice
CC	Text	2	SIGRID Table 1	Partial concentration of the third thickest ice
CN	Text	2	SIGRID Table 1	Stage of development of ice thicker than SA but with concentration less then 1/10
SA	Text	2	SIGRID Table 2	Stage of development of thickest ice
SB	Text	2	SIGRID Table 2	Stage of development of second thickest Ice
SC	Text	2	SIGRID Table 2	Stage of development of third thickest ice
CD	Text	2	SIGRID Table 1	Stage of development of any remaining class of ice
FA	Text	2	SIGRID Table 3	Form of thickest ice
FB	Text	2	SIGRID	Form of second thickest ice

Field or Column Name	Data Type	Length (bytes)	Code Table Reference	Field Definition
			Table 3	
FC	Text	2	SIGRID Table 3	Form of third thickest ice
FP	Text	2	SIGRID Table 3	Predominant form of ice
FS	Text	2	SIGRID Table 3	Secondary form of ice
DP	Text	1	SIGRID Table 5	Dynamic processes
DD	Text	1	SIGRID Table 6	Direction of dynamic processes
DR	Integer	2		Rate of ice drift in tenths of knots
DO	Text	1	SIGRID Table 15	Observational Method
WF	Text	1	SIGRID Table 7	Form of water openings
WN	Text	1	SIGRID Table 8	Number of water openings
WD	Text	1	SIGRID Table 6	Orientation (direction) of water openings
WW	Integer	2		Width of water openings in hundreds of meters
WO	Text	1	SIGRID Table 15	Observational Method
RN	Text	1	SIGRID Table 9	Nature of topography feature
RA	Text	1	SIGRID Table 10	Age of topography feature
RD	Text	1	SIGRID Table 6	Orientation of topography feature
RC	Text	2	SIGRID Table 1	Concentration of topography feature
RF	Integer	2		Frequency of topography feature; number per nautical mile
RH	Integer	2		Mean height of topography feature in tenths of meters

Field or Column Name	Data Type	Length (bytes)	Code Table Reference	Field Definition
RX	Integer	2		Maximum height of topography feature in tenths of meters
RO	Text	1	SIGRID Table 15	Observational Method
EM	Integer	2		Mean thickness of level ice in cm
EX	Integer	2		Maximum thickness of level ice in cm
EI	Integer	2		Thickness interval (range); tntntntxtxtx, where tntntn is minimum thickness and txtxtx is maximum thickness, in cm
EO	Text	1	SIGRID Table 15	Observational Method
AV	Text	2	SIGRID Table 1	Concentration of very thick brash ice (>4 metres)
AK	Text	2	SIGRID Table 1	Concentration of thick brash ice (>2-4 metres)
AM	Text	2	SIGRID Table 1	Concentration of medium brash ice (1-2 metres)
AT	Text	2	SIGRID Table 1	Concentration of thin brash ice (<1 metre)
SD	Text	1	SIGRID Table 6	Orientation (direction) of sastrugies
SM	Text	1	SIGRID Table 11	Melting forms
SW[2]	Text	2	Pad with preceding blanks	Area coverage of water on ice in tenths
SO	Text	1	SIGRID Table 15	Observational Method
BL	Text	2	SIGRID Table 13	Type of iceberg (Form, Size)
BD	Text	1	SIGRID Table 6	Direction of drift of iceberg
BE	Integer	2		Rate of drift in tenths of knots
BN	Text	2	SIGRID	Number of icebergs

[2] This parameter was “SA” in earlier versions of SIGRID. It has been re-named to avoid confusion with SA – Stage of development of thickest ice.

Field or Column Name	Data Type	Length (bytes)	Code Table Reference	Field Definition
			Table 14	
BY	Integer	2		Day of month
BO	Text	1	SIGRID Table 15	Observational Method
TT	Integer	2		Sea surface temperature in tenths of degrees Celsius
TO	Text	1	SIGRID Table 15	Observational Method
OP	Text	1	SIGRID Table 15	Primary source of information on which the chart is based
OS	Text	1	SIGRID Table 15	Secondary source of information on which the chart is based
OT	Text	1	SIGRID Table 15	Tertiary source of information on which the chart is based
T1	Date and Time	10-22	ISO 8601	Date and time of observation
T2	Date and Time	10-22	ISO 8601	Date and time of validity

Appendix B - Database File Contents for Line Shapefiles

1. Introduction

The *.dbf file for line (also called “polyline”) shapefiles consists of a set of mandatory and optional fields (attributes) that describe each line feature in the shapefile. Visualizing the database file as a table of rows and columns, there is one row for each line feature and one column for each field. The rows must be in the same order as features in the main (*.shp) file. All mandatory fields must be present in the database file and the naming, type and length of the fields must follow the layout defined in Table B-1. The easiest way to create the database file is with GIS software capable of creating shapefiles but it is also possible to create them with database or custom software.

Note that all fields present in the database file must also be described in the metadata file (Appendix D).

2. Mandatory Fields

The mandatory fields for line features are LENGTH, LINE_TYPE and ICE_LOC. The length of each line is typically computed by GIS software. LINE_TYPE is a six-character code that defines the type of the line feature. ICE_LOC is a two-character code that indicates where the ice lies relative to an ice edge, iceberg limit, limit of open water or limit of all known ice. If the value of LINE_TYPE is I_RIDG, I_LEAD, I-FRAL or I_CRAC, then ICE_LOC is not relevant and should be filled with blanks.

3. Optional Fields

The fields (attributes) listed in Table B-3 may be used to further describe ridge, lead, fracture or crack line features. References to “IOC Codes” refer to the attribute code numbers in the Ice Objects Catalogue. Usage should be consistent with the description in the Catalogue with one exception: no field separators (e.g. commas, brackets) are used in the dBase file.

All fields have the fixed length given in Table B-3. If a field or a portion of a field is not used, it should be padded with ASCII blanks on the right.

4. Unused Fields

Note that, because of the structure of the dBase file, if an optional field is used for any line feature, then it must be included for all line features in the database (i.e. it forms a “column” of the database array). Fields not used for any feature shall be filled with blanks.

Table B-1: Mandatory Fields in a SIGRID-3 Version 3.0 Line Database File

Field or Column Name	Data Type	Length (bytes)	Code Table Reference	Field Definition
LENGTH	Double precision binary	20		Length of line feature
LINE_TYPE	Text	3	Table B-2	Type of line feature
ICE_LOC	Text	2	SIGRID Table 6a	Location of ice relative to line feature

Table B-2: List of LINE_TYPE Character Variables

Name from Ice Objects Catalogue	LINE_TYPE
Ice Edge	ICELNE
Iceberg Limit	BRGLNE
Limit of Open Water	OPNLNE
Limit of All Known Ice	LKILNE
Line of Ice Ridge	I_RIDG
Line of Ice Lead	I_LEAD
Line of Ice Fracture	I_FRAL
Line of Ice Crack	I_CRAC

Table B-3: Optional Fields for Line Features

Field or Column Name	Data Type	Length (bytes)	Code Table Reference	Field Definition
ICERDV	Text	2	IOC Code 30327	Ice Ridge Classification
ICERMH	Integer	2		Ice Ridge Mean Height in decimetres
ICERXH	Integer	2		Ice Ridge Maximum Height in decimetres
ICELWD	Integer	2		Mean Width: mean width of a lead, fracture or crack in metres
IA_DMW	Integer	2		Minimum Width: minimum width of a lead, fracture or crack in metres
IA_DXW	Integer	2		Maximum Width: maximum width of a lead, fracture or crack in metres
ICESOD	Text	2	IOC Code 30302	Ice Stage of Development; used with Line of Ice Lead (I_LEAD) to indicate the Stage of Development of ice on the lead
IA_OBN	Integer	2		Number of Ice Objects; used with Line of Ice Lead (I_LEAD) to indicate the Number of Objects associated with the lead
RECDAT	Date and Time	10-22	ISO 8601	Date and time of observation
SORDAT	Date and Time	10-22	ISO 8601	Date and time of validity

Appendix C - Database File Contents for Point Shapefiles

1. Introduction

The *.dbf file for point shapefiles consists of a set of mandatory and optional fields (attributes) that describe each point feature in the shapefile. Visualizing the database file as a table of rows and columns, there is one row for each point feature and one column for each field. The rows must be in the same order as features in the main (*.shp) file. All mandatory fields must be present in the database file and the naming, type and length of the fields must follow the layout defined in Table C-1. The easiest way to create the database file is with GIS software capable of creating shapefiles but it is also possible to create them with database or custom software.

Note that all fields present in the database file must also be described in the metadata file (Appendix D).

2. Mandatory Fields

The only mandatory field for point features is POINT_TYPE. POINT_TYPE is a six-character code taken from the Ice Objects Catalogue that defines the type of the point feature. Usage should be consistent with the Ice Objects Catalogue.

3. Optional Fields

The fields (attributes) listed in Table C-3 may be used to further describe point features. References to “IOC Codes” refer to the attribute code numbers in the Ice Objects Catalogue. Usage should be consistent with the description in the Catalogue with one exception: no field separators (e.g. commas, brackets) are used in the dBase file.

All fields have the fixed length as described below. If a field or a portion of a field is not used, it should be padded with ASCII blanks on the right.

4. Unused Fields

Note that, because of the structure of the dBase file, if an optional field is used for any point feature, then it must be included for all point features in the database (i.e. it forms a “column” of the database array). Fields not used for any feature shall be filled with blanks.

Table C-1: Mandatory Fields in a SIGRID-3 Version 3.0 Point Database File

Field or Column Name	Data Type	Length (bytes)	Code Table Reference	Field Definition
POINT_TYPE	Text	3	Table C-2	Type of point feature

Table C-2: List of POINT_TYPE Character Variables

Name from Ice Objects Catalogue	POINT_TYPE
Ice Compacting	ICECOM
Ice Lead	ICELEA
Iceberg	ICEBRG
Floeberg	FLOBRG
Ice Thickness	ICETHK
Ice Shear	ICESHR
Ice Divergence	ICEDIV
Ice Ridge/Hummock	ICERDG
Ice Keel/Bummock	ICEKEL
Ice Drift	ICEDFT
Ice Fracture	ICEFRA
Ice Rafting	ICERFT
Jammed Brash Barrier	JMDBRR
Stage of Melt	STGMLT
Snow Cover	SNWCVR
Strips and Patches	STRPTC
Grounded Hummock	I_GRHM

Table C-3: Optional Fields for Point Features

Field or Column Name	Data Type	Length (bytes)	IOC Code Table Reference	Field Definition
ICESOD	Text	2	IOC Code 30302	Indicates stage of development of ice
ICEMLT	Text	2	IOC Code 30305	Indicates stage of ice melt
ICESPC	Text	2	IOC Code 30306	Indicates concentration of ice within the area of strips and patches
ICECST	Text	2	IOC Code 30309	Ice Compacting Strength
ICEFTY	Text	2	IOC Code 30310	Type of fracture based upon width
ICELST	Text	2	IOC Code 30311	Indicates the surface nature of a lead

Field or Column Name	Data Type	Length (bytes)	IOC Code Table Reference	Field Definition
ICELOC	Text	2	IOC Code 30315	Indicates whether a lead is at a specific location or whether there is a presence in the area
ICEBSZ	Text	2	IOC Code 30316	Iceberg Size
ICEDDR	Text	2	IOC Code 30317	Direction in which an ice mass or iceberg is drifting
ICETTY	Text	2	IOC Code 30322	Indicates whether ice thickness is measured or estimated
ICESCN	Text	2	IOC Code 30324	Indicates concentration of snow in tenths
ICEDOS	Text	2	IOC Code 30325	Bearing of a sastrugi
ICERCN	Text	2	IOC Code 30326	Concentration of ridges / hummocks
ICERDV	Text	2	IOC Code 30327	Predominant type of ice ridge(s) present
ICEKCN	Text	2	IOC Code 30331	Concentration of ice keels beneath an ice area
IA_BFM	Text	2	IOC Code 30354	Form of an iceberg or the prevailing form of icebergs in the vicinity
IA_BUH	Integer	2		Maximum height of an iceberg above the waterline in meters
IA_DMW	Integer	2		Minimum width of an ice lead or fracture or crack in meters.
IA_DXW	Integer	2		Maximum width of an ice lead or fracture or crack in meters.
IA_OBN	Integer	2		Number of ice objects (icebergs, leads, etc.)
ICEBNM	Integer	2		Number of icebergs in a one degree latitude by one degree longitude area; not to be used for latitudes greater than 80N or 80S
ICEDSP	Floating Point	10		Speed in knots at which an ice mass or iceberg is moving
ICEKFQ	Integer	2		Number of keels per nautical mile
ICEKMD	Integer	2		Mean depth of ice keels
ICEKXD	Integer	2		Maximum depth of ice keels
ICELWD	Integer	2		Width in meters of a lead, fracture or crack
ICEMAX	Integer	2		Maximum ice thickness in centimeters
ICEMIN	Integer	2		Minimum ice thickness in centimeters
ICERFQ	Integer	2		Frequency of ice ridges in number per nautical mile
ICERMH	Integer	2		Mean height of ice ridge(s) in decimetres
ICERXH	Integer	2		Maximum height of ice ridge(s) in decimetres
ICESCT	Integer	2		Depth of snow cover in centimeters
ICETCK	Integer	2		Average thickness of ice in centimeters
RECDAT	Date/Time	10-22	ISO 8601	Date and time of observation
SORDAT	Date/Time	10-22	ISO 8601	Date and time of validity

Appendix D - Metadata File Structure and Contents

1. Introduction

SIGRID-3 metadata files are compliant with the FGDC Content Standard for Digital Geospatial Metadata (CSDGM) which is available at http://www.fgdc.gov/metadata/csdgm. The details of this standard are well described in the reference so only a brief overview with examples pertinent to SIGRID-3 is given here.

As described in the reference, the CSDGM breaks metadata into seven major categories:

- Identification information
- Data Quality Information
- Spatial Data Organization Information
- Spatial Reference Information
- Entity and Attribute Information
- Distribution Information
- Metadata Reference Information

2. SIGRID-3 Version 3.0 Mandatory Metadata Content

While previous versions of SIGRID-3 identified a requirement for metadata, the standard was silent on the mandatory information to be included. Version 3.0 provides specific content requirements as described in this section. A complete xml metadata file from the Canadian Ice Service is attached at Annex 1 as an example. Note that these tags must appear within their proper hierarchy of tags. While only the lowest level xml tags are identified here for sake of brevity, all of the parent tags must also be present in the xml file. For example, <origin> is a child of four high order tags. To include <origin> as a tag, the higher order tags and all of the end tags must also be present:

```
<metadata>
    <idinfo>
        <citation>
            <citeinfo>
                <origin>name of producing organization</origin>
            </citeinfo>
        </citation>
    </idinfo>
</metadata>
```

2.1. Identification Information

Identification Information describes the higher order information about the shapefile and the chart it represents. Identification information attributes provide information on the producer, location of the coverage, date of origin, constraints on use, region, and associated theme keywords.

The following xml tags, as described in the CSDGM, must be completed for SIGRID-3 files. Organizations are encouraged to complete the content for other tags as much as possible.

<origin>	name of the organization that produced the ice chart
<pubdate>	date on which the chart was produced in *YYYYMMDD* format
<title>	shapefile name as specified in Section 2.1 of the SIGRID-3 specification
<caldate>	date for which the ice chart is valid in *YYYYMMDD* format
<time>	UTC time for which the ice chart is valid in *HHMM SS UTC* format
<westbc>	westernmost coordinate of the limit of coverage expressed in real degrees of longitude in the range -180.0 to 180.0 (west longitude is negative)
<eastbc)	easternmost coordinate of the limit of coverage expressed in real degrees of longitude

<northbc> northernmost coordinate of the limit of coverage expressed in real degrees of latitude in the range -90.0 to 90.0 (south latitude is negative)

<southbc> southernmost coordinate of the limit of coverage expressed in real degrees of latitude

<themekey> at least one theme keyword, “sea ice” or “iceberg” as appropriate, must be specified. Other theme keywords such as “pack ice”, “Ice concentration”, etc. may also be included

<placekey> at least one place keyword identifying the general area of coverage of the ice chart must be specified. Examples are “Arctic”, “Baltic Sea”, “Barents Sea”, etc. Additional place keywords may be used to further describe the area. Ice services should assemble a suitable list of place keywords that must be consistent to all charts in a series

<cntorg> name of the organization to contact for information about the dataset

<cntaddr> address of the contact organization

<cntvoice> telephone number of the contact organization

<cntfax> fax number of the contact organization

<cntemail> e-mail of the contact organization

2.2. Data Quality Information

Data quality elements describe the overall quality of the information so users can assess its suitability for their need. For ice analysis charts, the source of data used to produce a chart is a primary indicator of its quality. The data quality information can be repeated for the total number of different sources used, including in-situ observations and remotely sensed data. Additionally, the process used to produce the ice chart can be described to give users a sense of the quality.

The following xml tags, as described in the CSDGM, must be completed for SIGRID-3 files. Organizations are encouraged to complete the content for other tags as much as possible.

<logic> brief comments on the quality of the dataset

<complete> comments about unknown or unidentified features in the chart

(*The following tags should be repeated for each data source used in the chart)*

<origin> name of the data source

<source time period of content> date/time of the data source (e.g. date of satellite image or aircraft flight)

2.3. Spatial Data Organization Information

These elements describe how spatial data is organized in the dataset. It is useful for data discovery purposes by users not familiar with SIGRID-3 and producers are encouraged to complete the appropriate tags. However, because the shapefile standard pre-determines the organization of spatial data, this section is not mandatory for SIGRID-3.

2.4. Spatial Reference Information

The spatial reference information contains the projection name followed by all information needed to define the projection. This will generally include latitudes, longitudes, units, datum and ellipsoid. If the projection is not a common projection, the equations used to define the projection should be included in this section.

The following xml tags, as described in the CSDGM, must be completed for SIGRID-3 files. Organizations are encouraged to complete the content for other tags as much as possible.

<horizdn> name of the horizontal datum reference system

<ellips> name of the ellipsoid used to define the Earth’s shape

<semiaxis> radius of the equatorial axis of the ellipsoid

<denflat> denominator of the flattening ratio

<absres> abscissa resolution

<ordres> ordinate resolution

<plandu> planar distance units

<mapprojn> map projection name

Parameters, specific to the particular map projection are required to completely define it.
For example, for a Lambert Conformal Conic projection:
<stdparll> standard parallel (2 required)
<longcm> longitude of central meridian
<latprjo> latitude of the projection origin

For example, for a Polar Stereographic projection:
<stdparll> standard parallel (1 required)
<svlong> longitude to be oriented straight up from Pole

2.5. Entity and Attribute Information

This section is used to describe the contents of the individual fields in the database file. The following xml tags, as described in the CSDGM, must be completed for each field (column) in the *.dbf file. These must be in the same order as in the *.dbf file. Organizations are encouraged to complete the content for other tags as much as possible.

<attrlabl> attribute (field or column) name (as in Tables A-1, A-2, B-1, B-3, C-1, C-3)

<attrdef> attribute (field definition) definition (as in Tables A-1, A-2, B-1, B-3, C-1, C-3)

<attrdefs> attribute definition source – set to “JCOMM ETSI”

<codesetn> code set name – set to “SIGRID-3 Version 3.0”

<codesets> code set source – set to “JCOMM ETSI”

2.6. Distribution Information

The distribution information category is used to convey information to users about how the data can be obtained. The following xml tags, as described in the CSDGM, must be completed for SIGRID-3 files. Organizations are encouraged to complete the content for other tags as much as possible.

<formname> format name – set to “SIGRID-3”

<formvern> SIGRID-3 format version number

<formverd> SIGRID-3 format version date in format YYYYMMDD

2.7. Metadata Reference Information

Metadata reference information provides additional information about the creator of the SIGRID-3 shapefile.

The following xml tags, as described in the CSDGM must be completed for SIGRID-3 files. Organizations are encouraged to complete the content for other tags as much as possible.

<metd> date that the metadata were last updated

<metstdn> metadata standard name – set to “FGDC Content Standard for Digital Geospatial Metadata”

<metstdv> metadata standard version – set to “FGDC-STD-001-1998“ until a new version is adopted

Appendix E - Code Tables for SIGRID-3 Variables

Table 1: Concentration codes for variable identifiers CT, CA, CB, CC, AV, AK, AM and AT.

Definition	Code Figure
Ice Free	98
Less than 1/10 (open water)	01
Bergy Water	02
1/10	10
2/10	20
3/10	30
4/10	40
5/10	50
6/10	60
7/10	70
8/10	80
9/10	90
10/10	92
Concentration intervals (lowest concentration in interval followed by highest concentration in interval)	
9/10 –10/10 or 9+/10	91
8/10 – 9/10	89
8/10 – 10/10	81
7/10 – 9/10	79
7/10 – 8 /10	78
6/10 – 8/10	68
6/10 – 7/10	67
5/10 – 7/10	57
5/10 – 6/10	56
4/10 – 6/10	46
4/10 – 5/10	45
3/10 – 5/10	35
3/10 – 4/10	34
2/10 – 4/10	24
2/10 – 3/10	23
1/10 – 3/10	13
1/10 – 2/10	12
Undetermined / Unknown	99

Notes:

a) When AV, AK, AM and AT are used, the total of the concentrations represented by the values for AV, AK, AM and AT must sum to the concentration represented by the value for CA.

b) When this table is used for concentration of ridges,rafting, snow cover, etc (ICERCN, ICEFCN, ICESCN, etc), the code value 98 is interpreted as "*no ridging/rafting/snow/etc*"

Table 2: Thickness of ice or stage of development codes for variable identifiers SA, SB, SC, CN, and CD.

Stage of Development	Thickness	Code Figure
Ice Free		01
Ice Thickness in cm	1-2 cm	02
	3 cm	03
	4 cm	04
	…	…
	50 cm	50
Ice Thickness interval, 5 cm	55 cm	51
	60 cm	52
	65 cm	53
	…	…
	95 cm	59
Ice Thickness interval, 10 cm	100 cm	60
	110 cm	61
	120 cm	62
	…	…
	190 cm	69
Ice Thickness interval, 50 cm	200 cm	70
	250 cm	71
	300 cm	72
	350 cm	73
Ice Thickness interval, 100 cm	400 cm	74
	500 cm	75
	600 cm	76
	700 cm	77
	800 cm	78
Brash Ice	Given by AV, AT, AM, AT in Table 3.3	79
No Stage of Development		80
New Ice	< 10 cm	81
Nilas, Ice Rind	< 10 cm	82
Young Ice	10 - <30 cm	83
Grey Ice	10 - <15 cm	84
Grey - White Ice	15 - <30 cm	85
First Year Ice	≥30 cm	86

Thin First Year Ice	30 - <70 cm	87
Thin First Year Stage 1	30 - <50 cm	88
Thin First Year Stage 2	50 - <70 cm	89
For Later Use		90
Medium First Year Ice	70 - <120 cm	91
For Later Use		92
Thick First Year Ice	≥120 cm	93
Residual Ice		94
Old Ice		95
Second Year Ice		96
Multi-Year Ice		97
Glacier Ice		98
Undetermined/Unknown		99

Notes:

a) This table has been extended to conform with the original SIGRID (1981) specification with two exceptions:

- Code 01 has been used to represent Ice Free instead of an ice thickness of 1 cm. To conform with S-57 standards, code 00 is not used. There is little significant difference between an ice thickness of 1 cm and 2 cm.
- Code 79 has been used for brash ice instead of a thickness of 900 cm as in the original SIGRID. The maximum ice thickness that can be reported by this code is therefore 800 cm instead of 900 cm.

b) When used for ICESOD, the two-digit codes in this table are repeated up to five times for each partial concentration. If a partial concentration is not used, it should be blank-filled.

e.g. 4 ice types present – So=98, Sa=97, Sb=86, Sc=81 : ICEAPC = 98978681*bb*
3 ice types present – Sa=97, Sb=86, Sc=81 : ICEAPC = *bb*978681bb
2 ice types present – Sa=96, Sb=88 : ICEAPC = *bb*9688*bbbb*
1 ice type present – Sa= 95 : ICEAPC = *bb*95*bbbbbb*

c) To differentiate dark and light nilas gradations, use stage of development codes ‘03’ and ‘07’ respectively.

Table 3: Form of ice codes for variable identifiers FA, FB, FC, FP and FS.

Form	Size/Concentration	Code Figure
Pancake Ice	30 cm - 3 m	22
Shuga/Small Ice Cake, Brash Ice	< 2 m across	01
Ice Cake	< 20 m across	02
Small Floe	20 m - <100 m across	03
Medium Floe	100 m - <500 m across	04
Big Floe	500 m - <2 km across	05
Vast Floe	2 km - <10 km across	06
Giant Floe	≥10 km across	07
Fast Ice		08
Growlers, Floebergs or Floebits		09
Icebergs		10
Strips and Patches	concentrations 1/10	11
Strips and Patches	concentrations 2/10	12
Strips and Patches	concentrations 3/10	13
Strips and Patches	concentrations 4/10	14
Strips and Patches	concentrations 5/10	15
Strips and Patches	concentrations 6/10	16
Strips and Patches	concentrations 7/10	17
Strips and Patches	concentrations 8/10	18
Strips and Patches	concentrations 9/10	19
Strips and Patches	concentrations 9+/10	91
Strips and Patches	concentrations 10/10	20
Level Ice		21
Undetermined/Unknown		99

Notes:

a) When used for ICEFLZ, the two-digit codes in this table are repeated up to three times for each partial concentration. If a partial concentration is not used, it should be blank-filled.

e.g. 3 ice types present – Fa=06, Fb=03, Fc=22 : ICEFLZ = 060322
2 ice types present – Fa=06, Fb=01 : ICEFLZ = 0601*bb*
1 ice type present – Fa-02 : ICEFLZ = 02*bbbb*

Table 4: List of POLY_TYPE character variables

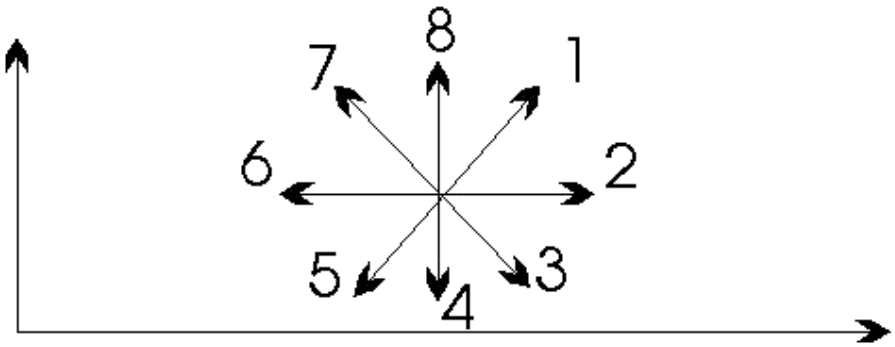
Land	L
Water – sea ice free	W
Ice – of any concentration	I
No Data	N
Ice Shelf / Ice of Land Origin	S

Table 5: Dynamic processes

Compacting ice, no intensity given	0
Compacting ice, slight	1
Compacting ice, considerable	2
Compacting ice, strong	3
Diverging ice	4
Shearing ice	5
Ice drift, rate 0,1 - 0,9 knots	6
Ice drift, rate 1,0 - 1,9 knots	7
Ice drift, rate 2,0 - 2,9 knots	7
Ice drift, rate 3,0 knots or more	9

Note: When actual rates of ice drift (ViVi) are given, code figure ViVi = 99 is used for rate unknown.

Table 6: Direction indicator



The direction is identified in relation to the grid. In a geographical grid, 1 would indicate northeast, 2 east, 3 southeast, etc.

Table 6a: Direction

NorthEast	01
East	02
Southeast	03
South	04
Southwest	05
West	06
Northwest	07
North	08
North and East	09
North and West	10
South and East	11
South and West	12
Within	13
Variable	97
No Feature	98
Undetermined / Unknown	99

Table 7: Form of water opening

Cracks	1
Crack at specific location	2
Lead	3
Frozen lead	4
Polynya	5
Ice edge	6

Table 8: Number of water openings

1	1
2	2
3-5	3
5-10	4
> 10	5

Table 9: Nature of topographic feature (deformation)

Rafting	1
Hummocks	2
Ridges	3
Jammed brash barrier	4

Table 10: Age of topographic feature

New	1
Weathered	2
very weathered	3
Aged	4
Consolidated	5

Table 11: Melting forms

No melt	0
Few puddles	1
Many puddles	2
Flooded ice	3
Few thaw holes	4
Many thaw holes	5
Dried ice	6
Rotten ice	7
Few frozen puddles	8
All frozen puddles	9

Table 12: Snow depth

WMO code 3889

3889

Sss ***Total depth of snow***

Code figure	
000	Not used
001	1 cm
etc.	etc.
996	996 cm
997	Less than 0.5 cm
998	Snow cover, not continuous
999	Measurement impossible or inaccurate

N o t e : See Regulations 12.4.6.1 and 12.4.6.2.

Table 13: Ice of land origin (type of iceberg)

Form (1st character)		Size (2nd character)	
Growler and or bergy bit	1	unspecified	0
Iceberg, unspecified	2	small	1
Iceberg, glacier berg	3	medium	2
Iceberg, domed	4	large	3
Iceberg, pinnacled	5	very large	4
Iceberg, tabular	6		
Ice island	7		
Radar target	9		

Table 14: Number of icebergs

WMO code 2877

2877

nBnB ***Number of icebergs within the area***
nGnG ***Number of growlers and bergy bits within the area***

Code Figure		Code figure	
00	None	15	15
01	1	16	16
02	2	17	17
03	3	18	18
04	4	19	19
05	5	20	1– 9
06	6	21	10– 19
07	7	22	20– 29
08	8	23	30– 39
09	9	24	40– 49
10	10	25	50– 99
11	11	26	100– 199
12	12	27	200– 499
13	13	28	500 or more
14	14	99	No indication because counting has been impossible

N o t e s :
(1) If the exact number, 1 to 19, is known, code figures 01 to 19 shall be used.
(2) If the number is more than 19, or if the exact number can only be estimated, code figures 20 to 28 shall be used.
(3) Code figure 99 shall only be used when it is absolutely impossible to make a reasonable estimate of the number.

Table 15: Observational method

Visual surface observation	1
Visual aircraft observation	2
Visual and infrared satellite observation	3
Passive microwave satellite observation	4
Radar satellite surface or airborne observation	5
Radar satellite observation (SAR)	6
Laser/scatterometer/sonar	7
Data buoys	8
Estimated (temporal and/or spatial)	9
Unknown	0