S-411

Ice Information Product Specification

Edition 1.2.1 – March 2025

IHO

International Hydrographic Organization

Published by the
International Hydrographic Organization
4b quai Antoine 1 er
Principauté de Monaco
Tel: (377) 93.10.81.00
Fax: (377) 93.10.81.40
info@iho.int
\www.iho.int

© Copyright International Hydrographic Organization 2025

This work is copyright. Apart from any use permitted in accordance with the Berne Convention for the Protection of Literary and Artistic Works (1886), and except in the circumstances described below, no part may be translated, reproduced by any process, adapted, communicated or commercially exploited without prior written permission from the International Hydrographic Organization (IHO). Copyright in some of the material in this publication may be owned by another party and permission for the translation and/or reproduction of that material must be obtained from the owner.

This document or partial material from this document may be translated, reproduced or distributed for general information, on no more than a cost recovery basis. Copies may not be sold or distributed for profit or gain without prior written agreement of the IHO Secretariat and any other copyright holders.

In the event that this document or partial material from this document is reproduced, translated or distributed under the terms described above, the following statements are to be included:

"Material from IHO publication [reference to extract: Title, Edition] is reproduced with the permission of the IHO Secretariat (Permission No ……./…) acting for the International Hydrographic Organization (IHO), which does not accept responsibility for the correctness of the material as reproduced: in case of doubt, the IHO's authentic text shall prevail. The incorporation of material sourced from IHO shall not be construed as constituting an endorsement by IHO of this product."

"This [document/publication] is a translation of IHO [document/publication] [name]. The IHO has not checked this translation and therefore takes no responsibility for its accuracy. In case of doubt the source version of [name] in [language] should be consulted."

The IHO Logo or other identifiers shall not be used in any derived product without prior written permission from the IHO Secretariat.

Contents

1 Overview 1
1.1 Introduction 1
1.2 Scope 1
1.3 References 1
1.4 References 1
1.4.1 Normative 2
1.4.2 Informative 2
1.5 Terms, definitions and abbreviations 2
1.5.1 Use of language 2
1.5.2 Terms and definitions 2
1.5.3 Abbreviations 4
1.6 General data product description 5
1.7 Product Specification metadata 5
1.8 WMO Product Specification Maintenance 5
1.8.1 Introduction 5
1.8.2 New Edition 6
1.8.3 Revision 6
1.8.4 Clarification 6
1.8.5 Version Numbers 6
2 Specification Scope 6
3 Data Product Identification 6
4 Data Content and Structure 7
4.1 Introduction 7
4.2 Application Schema 7
4.2.1 Domain model 8
4.2.2 S-411 Features 8
4.2.3 Attributes 14
4.3 Feature Catalogue 14
4.3.1 Introduction 14
4.3.2 Feature types 14
4.3.3 Geographic 14
4.3.4 Meta 14
4.3.5 Attributes 15
4.3.6 Application Schema implementation 15
4.3.7 Feature Types Summary 15
5 Coordinate Reference Systems (CRS) 17
5.1 Introduction 17
5.2 Horizontal Coordinate Reference System 18
5.3 Vertical Coordinate Reference System 18
5.4 Temporal reference system 18
6 Data Quality 18
6.1 Completeness 19
6.1.1 Commission 19
6.1.2 Omission 19
6.2 Logical consistency 19
6.2.1 Conceptual consistency 19
6.2.2 Domain consistency 19
6.2.3 Format consistency 19
6.3 Positional accuracy 19
6.4 Temporal accuracy 19
6.5 Thematic accuracy 19
6.5.1 Thematic classification correctness 19
6.5.2 Non-quantitative attribute accuracy 19
6.5.3 Quantitative attribute accuracy 19
7 Data Capture and Classification 19
8 Data Maintenance 20
8.1 Maintenance and Update Frequency 20
9 Portrayal 20

9.1 Rules....20
9.2 Symbols....20
9.2.1 Polygon Features....20
9.2.2 Line Features....22
9.2.3 Point Features....22
9.2.4 Draw order....25
10 Data Product Format (encoding)....26
10.1 Introduction....26
10.2 Encoding Rules....26
10.2.1 Longitude / Latitude....26
10.3 Encoding Examples....26
10.3.1 Polygon Feature....26
10.3.2 LineString Feature....27
10.3.3 Point Feature....27
11 Data Product Delivery....27
11.1 Format Specification....27
11.2 Introduction....27
11.3 Exchange Set....27
11.4 Exchange Catalogue....28
11.4.1 Exchange Catalogue Naming....28
11.5 Datasets....28
11.5.1 Dataset size....28
11.5.2 Dataset file naming....28
11.6 Exchange Set....29
11.7 Support Files....29
11.8 Exchange Catalogue....29
11.9 Data integrity and encryption....29
11.9.1 Use of compression....29
11.9.2 Use of digital signatures....29
12 Metadata....30
12.1 Introduction....30
12.1.1 ISO 19139 Metadata....30
12.2 Language....36
12.3 Exchange Set metadata....36
12.4 S100_ExchangeCatalogue....37
12.4.1 S100_ExchangeCatalogueIdentifier....37
12.4.2 S100_CataloguePointOfContact....37
12.5 S100_DatasetDiscoveryMetadata....37
12.5.1 S100_NavigationPurpose....39
12.5.2 S100_DataCoverage....39
12.5.3 S100_Purpose....40
12.5.4 S100_EncodingFormat....40
12.5.5 S100_ProductSpecification....41
12.5.6 S100_ProtectionScheme....42
12.6 S100_CatalogueDiscoveryMetadata....42
12.6.1 S100_CatalogueScope....42
12.6.2 PT_Locale....42
12.7 Certificates and Digital Signatures....42
13 Dataset Encoding....43
13.1 Introduction....43
13.2 Dataset Rules....43
13.3 Data Coverage rules....43
14 Display Scale Range....43
15 Geometry....44
15.1 S-411 Geometry....44
16 List of annexes....44

Document History

Changes to this Specification are coordinated by WMO/IOC Joint Technical Commission for Oceanography and Marine Meteorology (JCOMM). New editions will be made available via the IHO web site.

Version Number	Date	Approved By	Purpose
1.0.0	2 February 2014	Alexander Benke	Initial edition of S-411
1.1.0	15 June 2014	Jürgen Holfort	Clarifications based on ETSI Meeting 2014 and new color for 10/10.
1.2.0	01 January 2025	IIC technologies	Initial version created
1.2.1	13 March 2025	IIC Technologies	Updated following reviews with WMO

Page intentionally left blank

1 Overview

1.1 Introduction

S-411 is the Ice Information Product Specification, produced by the World Meteorological Organization (WMO)/Intergovernmental Oceanographic Commission Technical Commission for Oceanography and Marine Meteorology (JCOMM) Expert Team on Sea Ice (ETSI).
This document has been produced in response to a requirement to produce a data product that can be used as an Information Overlay within an Electronic Chart Display and Information Systems (ECDIS). It is based on the IHO S-100 framework specification, the ISO 19100 series of standards and Geography Markup Language (GML). It is a vector product specification that is intended for encoding the extent and nature of Sea Ice for navigational purpose in ice covered regions.

1.2 Scope

This document describes an S-100 compliant Product Specification for Ice Information, which will form an overlay layer for an S-100 based marine navigation system. It specifies the content, structure, and metadata needed for creating a fully compliant S-411 product and for its portrayal within an S-100 system. This Product Specification includes the content model, the encoding, the Feature Catalogue, Portrayal Catalogue, and metadata.

1.3 References

1.4 References

[1] S-100 edition 5.2.0: IHO Universal Hydrographic Data Model, International Hydrographic Organization (https://iho.int/uploads/user/pubs/standards/s-100/S-100_5.2.0_Final_Clean.pdf).

[2] S-44 edition 6.1.0: IHO Standards for Hydrographic Surveys, International Hydrographic Organization (https://iho.int/uploads/user/pubs/standards/s-44/S-44_5E.pdf).

[3] S-49 edition 2.1.0: STANDARDIZATION of MARINERS' ROUTEING GUIDES, International Hydrographic Organization (https://iho.int/uploads/user/pubs/standards/s-49/S-49_Ed.2.1.0_Standardization%20of%20Mariners%20Routeing%20Guides_EN.pdf).

[4] S-32 edition 1.0.0: Hydrographic Dictionary — Glossary of ECDIS Related Terms, International Hydrographic Organization (http://hd.iho.int/en/index.php/Main_Page).

[5] ISO 8601:2004: Data elements and interchange formats — Information interchange — Representation of dates and times, International Organization for Standardization (https://www.iso.org/standard/40874.html).

[6] ISO 19103:2015: Geographic information — Conceptual schema language, International Organization for Standardization (https://www.iso.org/standard/56734.html).

[7] ISO 19111:2007: Geographic information — Spatial referencing by coordinates, International Organization for Standardization (https://www.iso.org/standard/41126.html).

[8] ISO 19115-1:2014/Amd 1:2018: Geographic information — Metadata — Part 1: Fundamentals — Amendment 1, International Organization for Standardization (https://www.iso.org/standard/73118.html).

[9] ISO 19115-2:2009: Geographic information — Metadata — Part 2: Extensions for imagery and gridded data, International Organization for Standardization (https://www.iso.org/standard/39229.html).

[10] ISO/TS 19115-3:2016: Geographic information — Metadata — Part 3: XML schema implementation for fundamental concepts, International Organization for Standardization (https://www.iso.org/standard/32579.html).

1.4.1 Normative

GML OpenGIS® *Geography Markup Language (GML) Encoding Standard* (Version 3.2.1)

S-97 *IHO Guidelines for Creating S-100 Product Specifications*, Edition 1.1.0, June 2020.

S-100 *IHO Universal Hydrographic Data Model*, Edition 5.2.0, June 2024

WMO-No. 574 *Sea-ice Information and Services*, 2024 edition

1.4.2 Informative

ISO 19101 *Geographic Information – Reference Model*, 2003

ISO 19103 *Geographic Information – Conceptual Schema Language*, 2005

ISO 19103-2 *Geographic Information – Conceptual Schema Language – Part 2*, 2005

ISO 19109 *Geographic Information – Rules for Application Schema*, 2005

ISO 19110 *Geographic Information – Methodology for Feature Cataloguing*, 2005

ISO 19111 *Geographic Information – Spatial Referencing by Coordinates*, 2007

ISO 19115-1 *Geographic information — Metadata — Part 1: Fundamentals* — 2014/Amd 1: 2018

ISO 19115-3 *Geographic information — Metadata — Part 3: XML Schema implementation for fundamental concepts* — 2016

ISO 19117 *Geographic Information – Portrayal*, 2012

ISO 19131 *Geographic Information – Data Product Specifications*, 2008

ISO 19139-1 *Geographic information — XML schema implementation — Part 1: Encoding rules* — 2019

MANICE *Manual of Standard Procedures for Observing and Reporting Ice Conditions*, Meteorological Service of Canada, 2005

1.5 Terms, definitions and abbreviations

1.5.1 Use of language

Within this document:

- “Must” indicates a mandatory requirement.
- “Should” indicates an optional requirement, that is the recommended process to be followed, but is not mandatory.
- “May” means “allowed to” or “could possibly” and is not mandatory.

1.5.2 Terms and definitions

Application Schema

Conceptual schema for data required by one or more applications.

Attribute

(1) Named property of an entity.

NOTE Describes a geometrical, thematic, or other characteristic of an entity.

(2) Feature within a classifier that describes a range of values that instances of the classifier may hold.

NOTE An attribute is semantically equivalent to a composition association; however, the intent and usage is normally different.

NOTE "Feature" used in this definition is the UML meaning of the term.

Boundary

Set that represents the limit of an entity.

NOTE Boundary is most commonly used in the context of geometry, where the set is a collection of points or a collection of objects that represent those points.

Coordinate

One of a sequence of *n* numbers designating the position of a **point** in N-dimensional space.

NOTE In a **coordinate reference system**, the coordinate numbers are qualified by units.

Coordinate Reference System

Coordinate system which is related to an object by a datum.

Curve

1-dimensional geometric primitive, representing the continuous image of a line.

NOTE The boundary of a curve is the set of points at either end of the curve. If the curve is a cycle, the two ends are identical, and the curve (if topologically closed) is considered to not have a boundary. The first point is called the start point, and the last is the end point. Connectivity of the curve is guaranteed by the "continuous image of a line" clause. A topological theorem states that a continuous image of a connected set is connected.

Data Quality

A set of elements describing aspects of quality, including a measure of quality, an evaluation procedure, a quality result, and a scope.

Data Type

Specification of a value domain with operations allowed on values in this domain.

NOTE Data types include primitive predefined types and user-definable types.

NOTE A data type is identified by a term, for example Integer.

Dataset

An identifiable collection of data.

NOTE A dataset may be a smaller grouping of data which, though limited by some constraint such as spatial extent or feature type, is located physically within a larger dataset. Theoretically, a dataset may be as small as a single feature contained within a larger dataset. A hardcopy map or chart may be considered a dataset.

Datum

Parameter or set of parameters that define the position of the origin, the scale, and the orientation of a **coordinate** system.

ECDIS

A navigation information system which with adequate back-up arrangements can be accepted as complying with the up-to-date chart required by regulations V/19 and V/27 of the 1974 SOLAS Convention, as amended, by displaying selected information from a System Electronic Navigational Chart (System Database) with positional information from navigation sensors to assist the Mariner in route planning and route monitoring, and if required display additional navigation-related information.

Enumeration

A fixed list of valid identifiers of named literal values. Attributes of an enumerated type may only take values from this list.

Feature

Abstraction of real-world phenomena.

NOTE A feature may occur as a type or an instance. Feature type or feature instance should be used when only one is meant.

Feature

Abstraction of real world phenomena.

NOTE A feature may occur as a type or an instance. Feature type or feature instance should be used when only one is meant.

Feature Attribute

Characteristic of a **feature**.

NOTE A feature attribute type has a name, a data type, and a domain associated to it. A feature attribute instance has an attribute value taken from the value domain of the feature attribute type.

Feature Catalogue

A catalogue containing definitions and descriptions of the **feature** types, **feature attributes** occurring in one or more sets of geographic data.

Geometric Primitive

Geometric object representing a single, connected, homogeneous element of geometry.

NOTE Geometric primitives are non-decomposed objects that present information about geometric configuration. They include points, curves and surfaces.

Multiplicity

Specification of the number of possible occurrences of a property, or the number of allowable elements that may participate in a given relationship.

EXAMPLES: 1..* (one to many); 1 (exactly one); 0..1 (zero or one)

Point

0-dimensional geometric primitive, representing a position.

NOTE The boundary of a point is the empty set.

Portrayal Catalogue

Collection of defined portrayals for a feature catalogue.

NOTE Content of a portrayal catalogue includes portrayal functions, symbols, and portrayal context.

1.5.3 Abbreviations

This Product Specification adopts the following convention for presentation purposes:

BSH	Bundesamt für Seeschifffahrt und Hydrographie (Germany)
CRS	Coordinate Reference System
ECDIS	Electronic Chart Display and Information System
ENC	Electronic Navigational Chart
EPSG	European Petroleum Survey Group
ETSI	Expert Team on Sea Ice
GML	Geography Markup Language
IHO	International Hydrographic Organization
ISO	International Organization for Standardization
JCOMM	Joint Technical Commission for Oceanography and Marine Meteorology

UTF-8	Unicode Transformation Format-8
WMO	World Meteorological Organization
XML	eXtensible Markup Language

1.6 General data product description

Title	Ice Information Product Specification.
Abstract	Ice Information for ship navigation
Acronym	S-411
Content	Ice features as vector data
Spatial Extent	**Description**: Areas specific to navigation in ice covered regions. **East Bounding Longitude**: 180° **West Bounding Longitude**: -180° **North Bounding Latitude**: 90° **South Bounding Latitude**: -90°
Purpose	Navigation in ice covered regions

1.7 Product Specification metadata

Title	Ice Information Product Specification
S-100 Version	5.2.0
S-411 Version	1.2.1
Date	13 March 2025
Language	English (optional additional)
Classification	Unclassified
Contact	
Identifier	JCOMM S-411
Maintenance	Changes to this product specification are coordinated by JCOMM ETSI.

World Meteorological Organization (WMO)
7 bis, avenue de la Paix
P.O. Box 2300
CH-1211 Geneva 2, Switzerland
Telephone: +41 (0) 22 730 84 03
Email: publications@wmo.int

URL	www.wmo.int
Identifier	S-411
Maintenance	Changes to the Product Specification S-411 are coordinated by the JCOMM, and must be made available via the IHO web site.

1.8 WMO Product Specification Maintenance

1.8.1 Introduction

Changes to S-411 will be released by the WMO as a New Edition, revision, or clarification.

1.8.2 New Edition

New Editions of S-411 introduce significant changes. *New Editions* enable new concepts, such as the ability to support new functions or applications, or the introduction of new constructs or data types. *New Editions* are likely to have a significant impact on either existing users or future users of S-122. All cumulative *revisions* and *clarifications* must be included with the release of approved New Editions.

1.8.3 Revision

Revisions are defined as substantive semantic changes to S-411. Typically, *revisions* will change S-411 to correct factual errors; introduce necessary changes that have become evident as a result of practical experience or changing circumstances. A *revision* must not be classified as a clarification. Revisions could have an impact on either existing users or future users of S-411. All cumulative *clarifications* must be included with the release of approved *revisions*.

Changes in a revision are minor and ensure backward compatibility with the previous versions within the same Edition. Newer revisions, for example, introduce new features and attributes. Within the same Edition, a dataset of one version could always be processed with a later version of the Feature and Portrayal Catalogues.

In most cases a new feature or portrayal catalogue will result in a *revision* of S-411.

1.8.4 Clarification

Clarifications are non-substantive changes to S-122. Typically, *clarifications*: remove ambiguity; correct grammatical and spelling errors; amend or update cross references; insert improved graphics in spelling, punctuation and grammar. A *clarification* must not cause any substantive semantic change to S-411.

Changes in a *clarification* are minor and ensure backward compatibility with the previous versions within the same Edition. Within the same Edition, a dataset of one clarification version could always be processed with a later version of the Feature and Portrayal Catalogues, and a Portrayal Catalogue can always rely on earlier versions of the Feature Catalogue.

1.8.5 Version Numbers

The associated version control numbering to identify changes (n) to S-411 must be as follows:

New Editions denoted as **n**.0.0

Revisions denoted as n.**n**.0

Clarifications denoted as n.n.**n**

2 Specification Scope

This product specification defines only one general scope which applies to all its sections.

Scope Identification	JCOMM S-411 dataset
Hierarchical Lelvel	MD_ScopeCode -005
Hierarchical Level Name	Dataset

Extent

EX_GeographicExtent — Global coverage of maritime areas.

EX_TemporalExtent — Not defined for this product specification.

EX_VerticalExtent -Not defined for this product specification.

3 Data Product Identification

A dataset that conforms to this Product Specification may be identified by its discovery metadata as defined in clause 12.

Title	Ice Information

Abstract	S-411 datasets must be produced in accordance with the rules defined in the S-411 Product Specification. The S-411 Product Specification contains all the information necessary to enable producers to produce a consistent Ice Information dataset; and manufacturers to use that data efficiently within navigation systems.
Topic Category	Transportation, climatology, meteorology, atmosphere
Geographic Description	Ice covered regions
Spatial Resolution	Each Data Coverage feature of an Ice Information dataset must indicate a value for an optimum viewing scale. Recommended values for scales can be found in the S-101 ENC Product Specification. Producers should note that at the smaller scales, geographic details will have no perceptible visual separation on a graphic display, and are therefore encouraged to determine display scales taking into account the content and intended navigation purpose of the dataset.
Purpose	Navigation in ice covered regions
Language	English (Mandatory), other (Optional)
Classification	Data may be classified as one of the following: 1) Unclassified; 2) Restricted; 3) Confidential; 4) Secret; 5) Top Secret; 6) Sensitive but Unclassified; 7) For official Use Only; 8) Protected; 9) Limited Distribution.
Spatial Representation Type	Vector
Point of Contact	Producing Agency
Use Limitation	Not for sole use in navigation; must be used with an ENC.

4 Data Content and Structure

4.1 Introduction

The S-411 product is based on the S-100 General Feature Model (GFM), and is a feature-based vector product. Figure 4.1 shows how the S-411 application schema is realised from the S-100 GFM. All S-411 feature classes are derived from the abstract class FeatureType defined in the S-411 application schema, which realize the GFM meta-classes S100_GF_FeatureType.

The application schema of Ice Information product contains 28 feature types with their attributes, enumerations etc. It is based on the ice objects catalogue (Version 5.3) and can also be found in the ICE domain of the IHO Registry. Because of this it is not possible to describe the full schema in suitable form in this specification. More information can be found as XML Schema File in Annex B – Data Product format (encoding).

4.2 Application Schema

S-411 conforms to the General Feature Model (GFM) from S-100 Part 3. The GFM is the conceptual model and the implementation is defined in the Feature Catalogue which is included as a separate Annex

(Annex C) and provides a full specification of all types including feature types, their attributes, allowed and values. The S-411 Product Specification only contains specific examples.

The following conventions are used in the UML diagrams depicting the application schema:

- Standard UML conventions for classes, associations, inheritance, roles, and multiplicities apply. These conventions are described in Part 1 of S-100.
- Italic font for a class name indicates an abstract class.
- Feature classes are depicted with green background; the dark shade for abstract feature classes and the light shade for ordinary (non-abstract) feature classes.
- Complex attributes are depicted with a pink background.
- Enumeration lists and codelists are depicted with a tan background. The numeric code corresponding to each listed value is shown to its right following an '=' sign.

4.2.1 Domain model

The S-411 domain model has one base class ('root class') from which all the domain-specific geographic features type classes are derived. The base class is shown in the figure below. The base class for geographic features is FeatureType which has a set of attributes which are therefore inherited by all domain-specific features. The approximate area features in S-411 are also derived from the geographic feature root class. Base classes are abstract classes and do not have direct instances in S-411 data – instead, S-411 feature type data objects are instantiations of all non-abstract classes.

S-411 meta-features are also derived from the base class – S-411 incorporates meta-feature definitions originally prepared for S-101 in the interests of harmonization and interoperability with other S-100-based data products, especially S-101 ENCs.

4.2.2 S-411 Features

4.2.2.1 Meta Features

S-411 provides a single meta-feature, **DataCoverage**. **DataCoverage** is for describing areas in the dataset that are populated with data. The dataset may include multiple **DataCoverage** features to describe different contiguous (i.e. non-overlapping) areas.

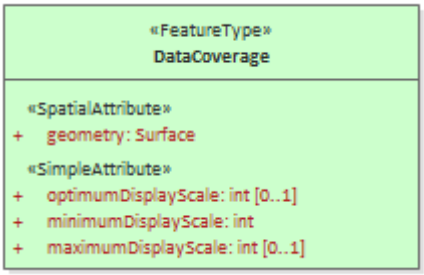

Figure 4-1 — Data Coverage

4.2.2.2 Geographic Features

Geographic (geo) feature types form the principal content of the S-411 product and are fully defined by their associated attributes.

The following figure shows all the major ice features and a simplified view of their attributes in the S-411 Application Schema. The abstract Ice class is introduced to simplify the UML model of the features.

Figure 4-2 — All Ice Features

The ice features contains a number of attributes defined as enumerations. The following diagram shows the main ice (surface) feature classes complete with the details of these enumerations and their values.

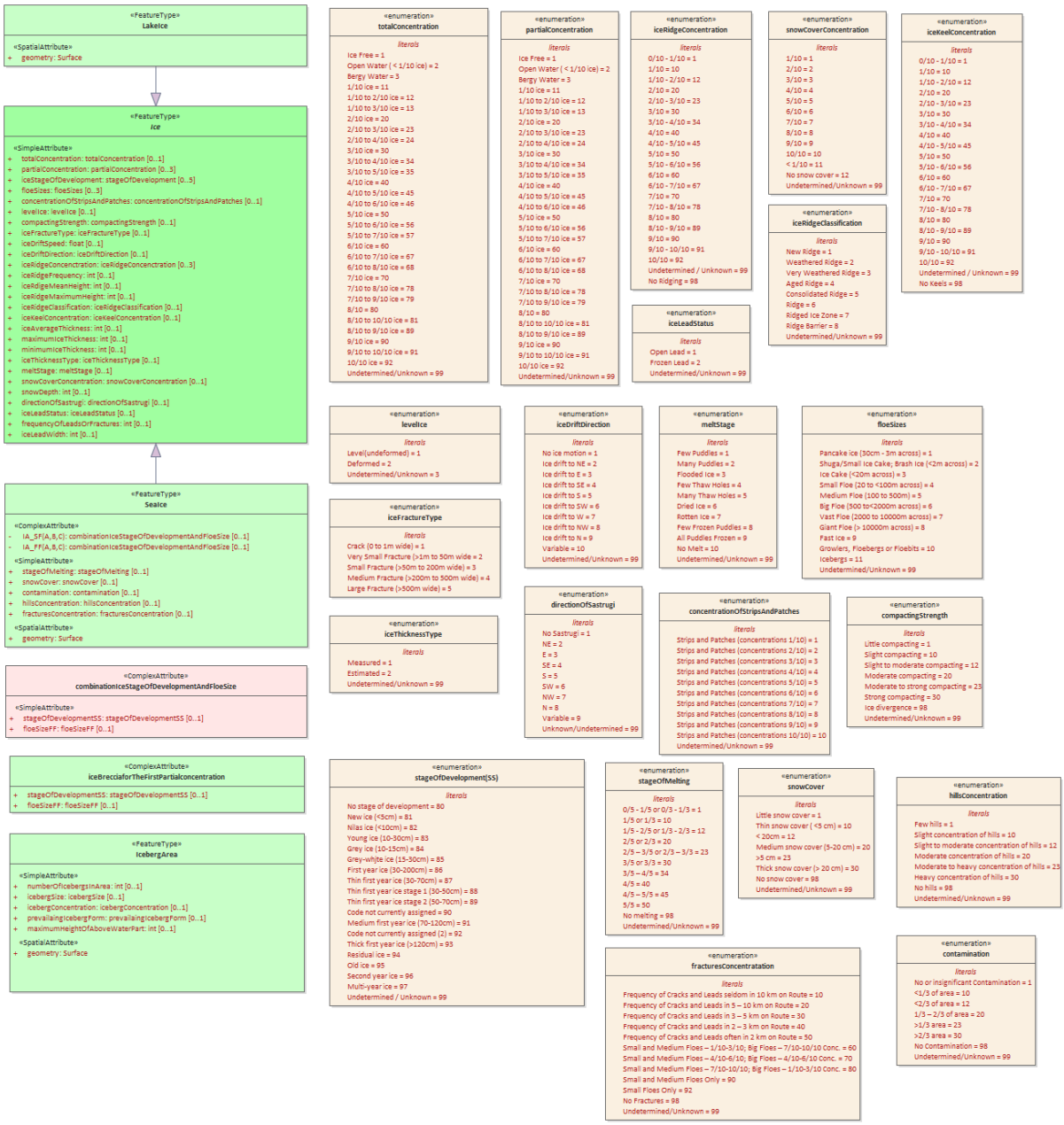

Figure 4-3 — Detailed Ice Features

All Limit and Line curve features and their attributes are shown in the following diagram

Figure 4-4 — All Curve Features

There are a number of point features shown in the following diagrams

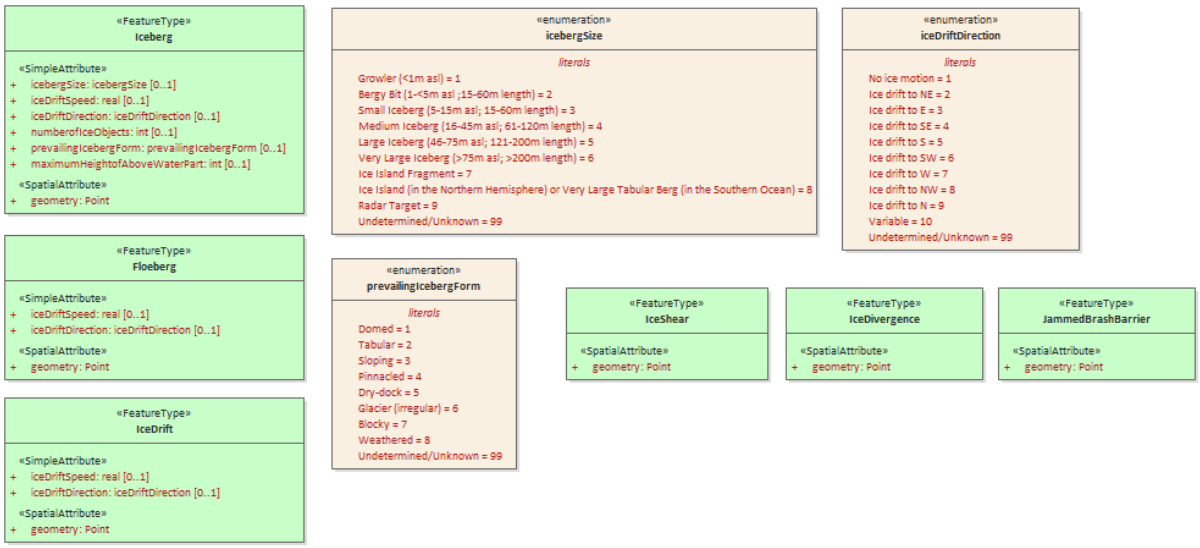

Figure 4-5 — Point Features

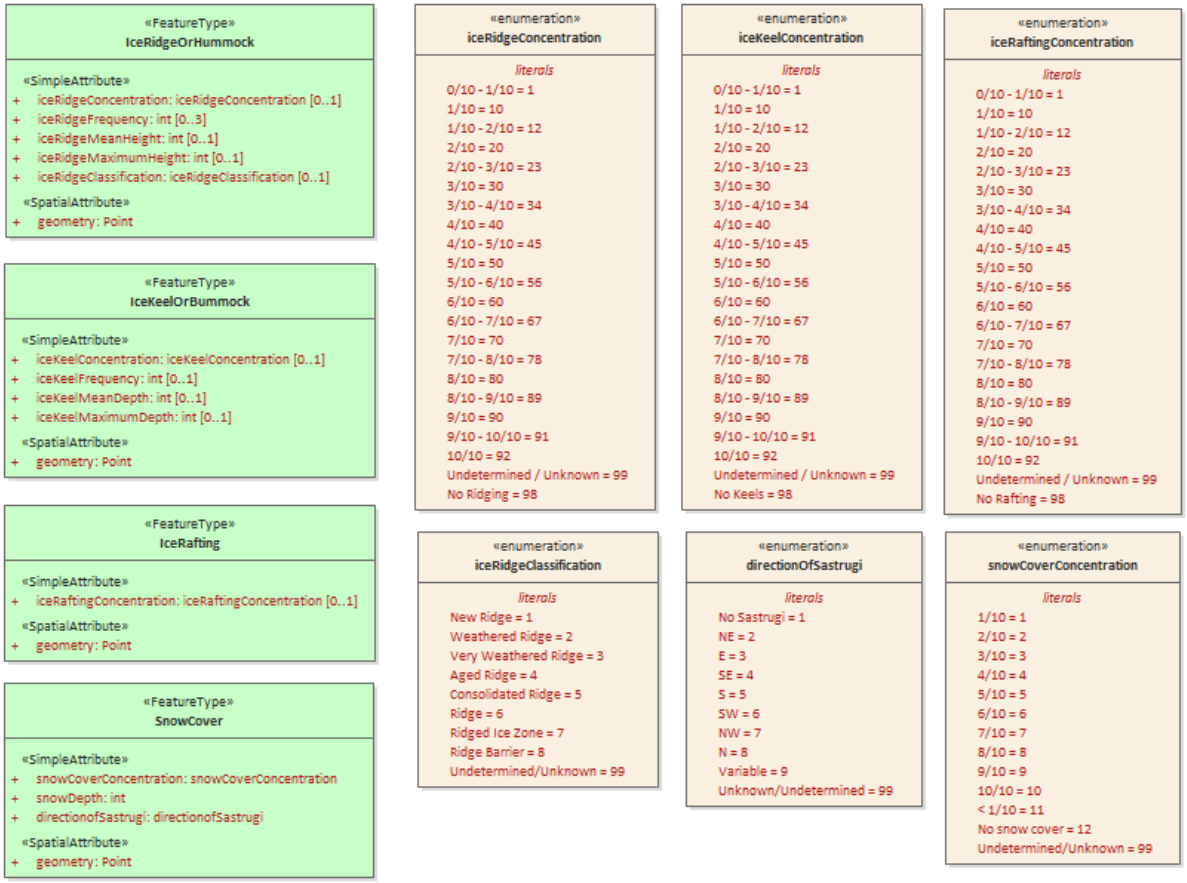

Figure 4-6 — Point Features

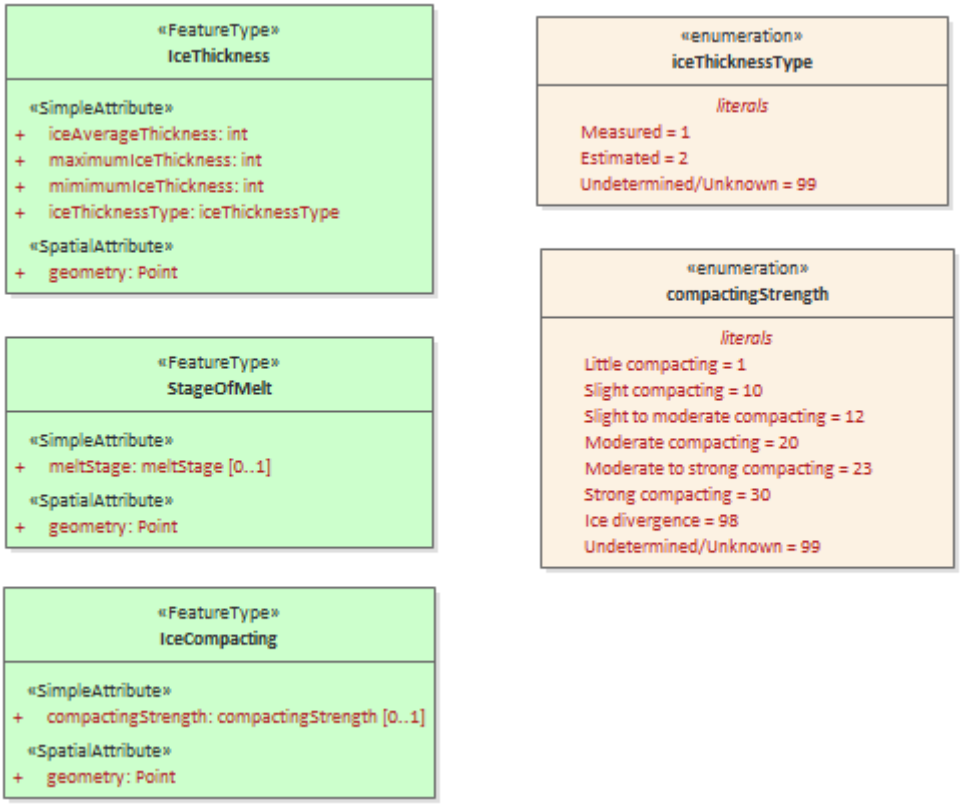

Figure 4-7 — Point Features

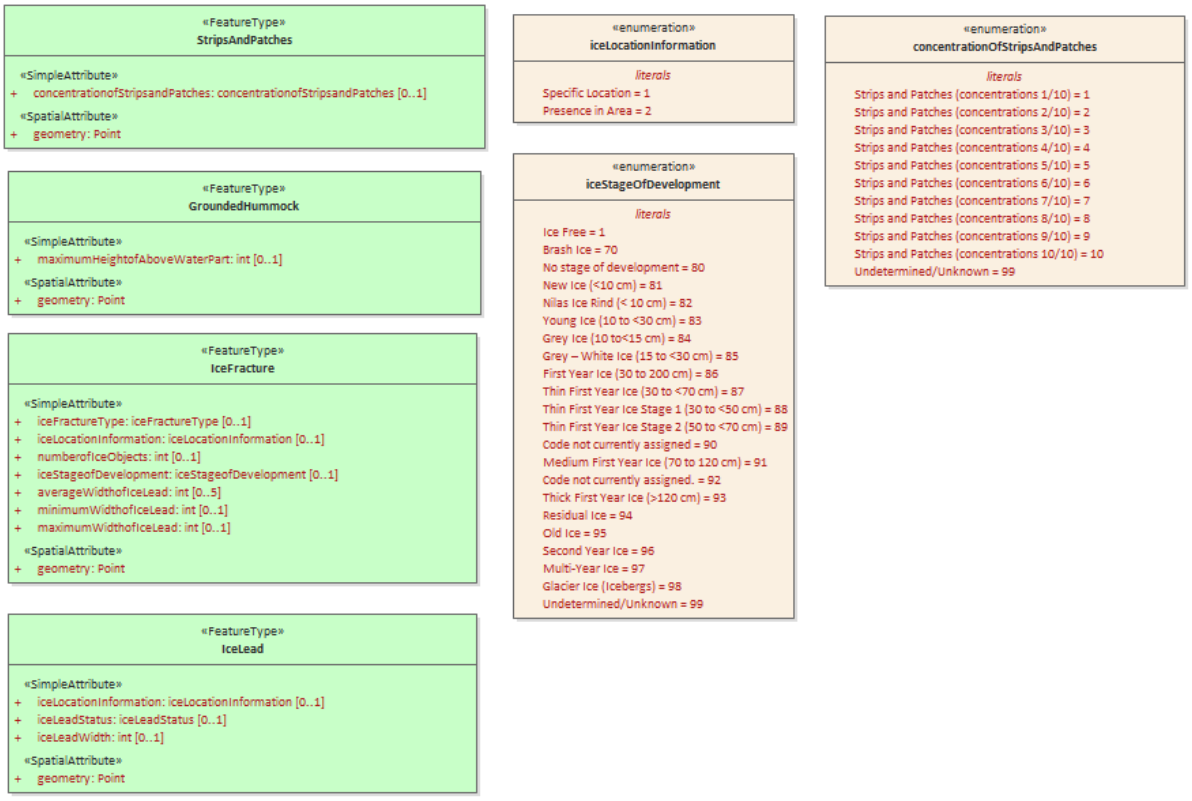

Figure 4-8 — Point Features

Full details of all geographic feature types can be found in Annex A – Data Classification and Encoding Guide, clause 2.1 and Sections 4-22.

4.2.3 Attributes

S-411 defines attributes as either simple or complex in line with the S-100 GFM.

4.2.3.1 Simple attributes

S-411 uses 3 types of simple attributes; these types are listed in Annex A – Data Classification and Encoding Guide, clause 2.4.2. Descriptions of the simple attributes included in S-411 can be found in Annex A, Sections 27, 28 and 30.

4.2.3.2 Complex attributes

Complex attributes are aggregations of other attributes that are either simple or complex. The aggregation is defined by means of attribute bindings. Examples of modelling complex attributes can be found in S-100 Part 2a, Appendix 2a-A. Descriptions of the complex attributes included in S-411 can be found in Annex A – Data Classification and Encoding Guide

4.3 Feature Catalogue

4.3.1 Introduction

The S-411 Feature Catalogue describes the feature types, attributes and attribute values which may be used in an S-411 product.

The S-411 Feature Catalogue is available as an XML document which conforms to the S-100 XML Feature Catalogue Schema and can be downloaded from the IHO website (https://registry.iho.int/). S-411 Annex A – Data Classification and Encoding Guide, constitutes a human readable interpretation of the Feature Catalogue along with information on how features should be encoded.

The feature Catalogue for Ice Information contains only geographic and meta features. The ice features which can be used in ECDIS are defined within the ICE domain of the IHO Registry.

4.3.2 Feature types

Feature types contain descriptive attributes that characterize real-world entities. The word ‘feature’ may be used in one of two senses – feature type and feature instance. A feature type is a class and is defined in a Feature Catalogue. A feature instance is a single occurrence of the feature type and represented as an object in a dataset. A feature instance is located by a relationship to one or more spatial instances. A feature instance may exist without referencing a spatial instance.

4.3.3 Geographic

Geographic (geo) feature types carry the descriptive characteristics of a real-world entity (a location or place on the surface of the Earth). In the context of Ice Information products, this comprises most of the features (with the exception of DataCoverage) and represents those features with a real-world existence.

4.3.4 Meta

Only one metadata feature is defined, DataCoverage. This defines the area of coverage bounded by the dataset, and any features within it. DataCoverage contains a mandatory optimumDisplayScale attribute and two optional maximum, and minimum display scale attributes.

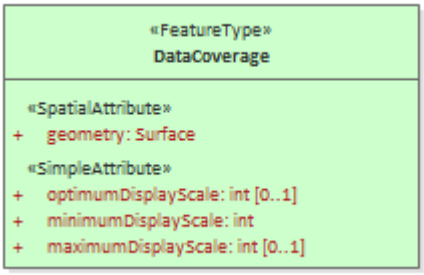

Figure 4-9 — Data Coverage

4.3.5 Attributes

S-411 defines attributes as either simple or complex in line with the S-100 GFM.

4.3.5.1 Simple attributes

S-411 uses three types of simple attributes; they are listed in the following Table:

Table 4-1

Type	Definition
Integer	An integer number.
Real	A floating point number.
Enumeration	One or more of a list of predefined values.

4.3.6 Application Schema implementation

4.3.6.1 Implementation description

4.3.6.2 Ice DataSets

Ice Data Sets contains an unlimited number of Ice Features, for example (SeaIce, LakeIce, Iceberg, etc.).

4.3.7 Feature Types Summary

1) Summary of Types in the WMO Ice Domain Register

Table 4-2

Index	Alias	Name
Feature	SEAICE	Sea Ice
Feature	LACICE	Lake Ice
Feature	BRGARE	Iceberg Area
Feature	ICELNE	Ice Edge
Feature	BRGLNE	Iceberg Limit
Feature	OPNLNE	Limit of Open Water
Feature	LKILNE	Limit of All Known Ice
Feature	I_RIDG	Line of Ice Ridge
Feature	I_LEAD	Line of Ice Lead
Feature	I_FRAL	Line of Ice Fracture
Feature	I_CRAC	Line of Ice Crack
Feature	ICECOM	Ice Compacting
Feature	ICELEA	Ice Lead
Feature	ICEBRG	Iceberg
Feature	FLOBRG	Floeberg
Feature	ICETHK	Ice Thickness
Feature	ICESHR	Ice Shear
Feature	ICEDIV	Ice Divergence

Index	Alias	Name
Feature	ICERDG	Ice Ridge/Hummock
Feature	ICEKEL	Ice Keel/Bummock
Feature	ICEDFT	Ice Drift
Feature	ICEFRA	Ice Fracture
Feature	ICERFT	Ice Rafting
Feature	JMDBRR	Jammed Brash Barrier
Feature	STGMLT	Stage of Melt
Feature	SNWCVR	Snow Cover
Feature	STRPTC	Strips and Patches
Feature	I_GRHM	Grounded Hummock
Attribute	ICEACT	Total Concentration
Attribute	ICEAPC	Partial Concentration
Attribute	ICESOD	Ice Stage of Development
Attribute	ICELSO	Lake Ice Stage of Development
Attribute	ICEFLZ	Floe Sizes
Attribute	ICEMLT	Melt Stage
Attribute	ICESPC	Concentration of Strips and Patches
Attribute	ICEBNM	Number of Icebergs in Area
Attribute	ICELVL	Level Ice
Attribute	ICECST	Compacting Strength
Attribute	ICEFTY	Ice Fracture Type
Attribute	ICELST	Ice Lead Status
Attribute	ICELFQ	Frequency of Leads or Fractures
Attribute	ICELOR	Orientation of Leads or Fractures
Attribute	ICELWD	Ice Lead (or Fracture or Crack) Width
Attribute	ICELOC	Ice Location Information
Attribute	ICEBSZ	Iceberg Size
Attribute	ICEDDR	Ice Drift Direction
Attribute	ICEDSP	Ice Drift Speed
Attribute	ICETCK	Ice Average Thickness
Attribute	ICEMAX	Maximum Ice Thickness
Attribute	ICEMIN	Minimum Ice Thickness
Attribute	ICETTY	Ice Thickness Type
Attribute	ICESCT	Snow Depth

Index	Alias	Name
Attribute	ICESCN	Snow Cover Concentration
Attribute	ICEDOS	Direction Of Sastrugi
Attribute	ICERCN	Ice Ridge Concentration
Attribute	ICERDV	Ice Ridge Classification
Attribute	ICERMH	Ice Ridge Mean Height
Attribute	ICERFQ	Ice Ridge Frequency
Attribute	ICERXH	Ice Ridge Maximum Height
Attribute	ICEKCN	Ice Keel Concentration
Attribute	ICEKFQ	Ice Keel Frequency
Attribute	ICEKMD	Ice Keel Mean Depth
Attribute	ICEKXD	Ice Keel Maximum Depth
Attribute	ICEFCN	Ice Rafting Concentration
Attribute	IA_SFA	Ice Stage of Development and Floe Size for the 1st p.c.
Attribute	IA_SFB	Ice Stage of Development and Floe Size for the 2nd p.c.
Attribute	IA_SFC	Ice Stage of Development and Floe Size for the 3rd p.c.
Attribute	IA_FFA	Ice Breccia for the 1st partial concentration
Attribute	ICEFCN	Ice Breccia for the 2nd partial concentration
Attribute	IA_FFC	Ice Breccia for the 3rd partial concentration
Attribute	IA_SNG	Snow concentration
Attribute	IA_MLT	Stage of melting
Attribute	IA_PLG	Contamination
Attribute	IA_HLG	Hills concentration
Attribute	IA_DUG	Fractures concentration
Attribute	IA_BCN	Icebergs concentration
Attribute	IA_BFM	Prevailing iceberg form
Attribute	IA_BUH	Max. height of the above-water part (iceberg / grounded hummock)
Attribute	IA_OBN	Number of ice objects
Attribute	IA_DXW	Max. width of ice lead (or fracture or crack)
Attribute	IA_DMW	Min. width of ice lead (or fracture or crack)
Attribute	ICEBRS	Brash Ice

5 Coordinate Reference Systems (CRS)

5.1 Introduction

For exchange of ice data WGS84 (EPSG:4326) must be used

5.2 Horizontal Coordinate Reference System

Table 5-1 — S-411 Coordinate Reference Systems (EPSG Codes)

EPSG Code	Coordinate Reference System
4326	WGS84
The full reference to EPSG can be found at https://epsg.org.	

Horizontal Coordinate Reference System	EPSG: 4326
Projection	NONE (*although use of projected coordinates in datasets for future editions will be considered*)
Temporal reference system	Gregorian Calendar
Coordinate Reference System registry	EPSG Geodetic Parameter Dataset
Date type (according to ISO 19115-1:2014/Amd 1:2018)	002 — publication
Responsible party	Technical Commission for Oceanography and Marine Meteorology (JCOMM)
URL	https://wmo.int//

5.3 Vertical Coordinate Reference System

In this product there are no direct vertical coordinates which require the use of a vertical coordinate reference system.

5.4 Temporal reference system

The temporal reference system is the Gregorian calendar for date and UTC for time. Time is measured by reference to Calendar dates and Clock time in accordance with ISO 8601:2004, Clause 5.4.4. A date-time variable will have the following 16-character format: *yyyymmddThhmmssZ*.

6 Data Quality

As ice charts are done for different purposes (from weekly overview to tactical charts and further to model forecasts) data quality can differ.

Differences can also be found between ice charts of the same region and same nominal date resulting from different issuing agencies or also from different forecasts models.

Further information can be found in the WMO publication 574.

A fuller review of data quality requirements for S-411 may be carried out in the future. The headings within this section reflect those within other IHO product specifications and, following such a review, will either be populated or deleted as appropriate.

6.1 Completeness

6.1.1 Commission

6.1.2 Omission

6.2 Logical consistency

6.2.1 Conceptual consistency

Conceptual Consistency is applicable for S-411 and follows the guidelines from S-100, Part 1.

Data Producers must verify that the dataset conforms to the S-100 General Feature Model.

If the dataset conforms to the S-100 General Feature Model, the dataset PASSES this test.

6.2.2 Domain consistency

Domain consistency is applicable for S-411 and follows the guidelines from S-100, Part 5.

Data Producers must verify that the dataset conforms to the S-411 Feature Catalogue and to [annex-data-classification-and-encoding-guide].

If the dataset conforms to the S-411 Feature Catalogue and to [annex-data-classification-and-encoding-guide], the dataset PASSES this test.

6.2.3 Format consistency

Format Consistency is applicable for S-411 and follows the guidelines from S-100, Part 10c.

Data Producers must verify that the dataset conforms to Section 10 of this Product Specification.

If the dataset conforms to Section 10, the dataset PASSES this test.

6.3 Positional accuracy

6.4 Temporal accuracy

6.5 Thematic accuracy

6.5.1 Thematic classification correctness

6.5.2 Non-quantitative attribute accuracy

6.5.3 Quantitative attribute accuracy

7 Data Capture and Classification

The data will be captured normally from satellite data. The extraction and classification will be done by ice analysts. In some areas of the world (e.g. the Baltic Sea) in addition also some direct shore and ship based observations and textual ice reports from ice authorities will be used. Further information can be found in the WMO publication 574 in Appendix A.

8 Data Maintenance

8.1 Maintenance and Update Frequency

Ice information datasets should be maintained if a new dataset of region and provider is available. There is no updating mechanism used, with datasets being re-issued as appropriate. future editions may use the updating mechanism for GML datasets contained in S-100, Part 10b

9 Portrayal

9.1 Rules

`main.xsl` includes all the rules for single feature types. It manages the selection of the right rule, depending on current feature type in `dataset and parameters in `iceDisplayParameters.xml`.

`iceDisplayParameters.xml` contains parameters important for display of ice features:

- String `iceclass`
- Boolean `encoverlay`
- String `Display Mode`

Depending on the `iceclass` parameter the right `seaice` or `lacice` rule can be selected. The default is `*_class_III.xsl`

The `encoverlay` parameter helps to calculate the priority for display of single ice feature types. If `encoverlay` is true, the priority will be calculated, depending on priority of land area feature in ENC. The area objects of ice features should be displayed under the land area polygons, because they are usually drawn over the land.

9.2 Symbols

9.2.1 Polygon Features

9.2.1.1 IceNavigationalDisplayMode (Traffic Light Principle, depends on Ice Class)

Table 9-1

Object Class	Acronym						
Sea Ice	seaice						
Lake Ice	lacice						
Iceberg Area	icebrg						

9.2.1.2 IceScientificIceactDisplayMode

Table 9-2

iceact	Description	rgb	colour
1	Ice Free	000 100 255	
2	Open Water (<1/10 ice)	150 200 255	
3	Bergy Water	150 200 255	
10	1/10 ice	140 255 160	
12	1/10 to 2/10 ice	140 255 160	
13	1/10 to 3/10 ice	140 255 160	

20	2/10 ice	140 255 160	
23	2/10 to 3/10 ice	140 255 160	
24	2/10 to 4/10 ice	140 255 160	
30	3/10 ice	140 255 160	
34	3/10 to 4/10 ice	140 255 160	
35	3/10 to 5/10 ice	255 255 000	
40	4/10 ice	255 255 000	
45	4/10 to 5/10 ice	255 255 000	
46	4/10 to 6/10 ice	255 255 000	
50	5/10 ice	255 255 000	
56	5/10 to 6/10 ice	255 255 000	
57	5/10 to 7/10 ice	255 255 000	
60	6/10 ice	255 255 000	
67	6/10 to 7/10 ice	255 255 000	
68	6/10 to 8/10 ice	255 125 007	
70	7/10 ice	255 125 007	
78	7/10 to 8/10 ice	255 125 007	
79	7/10 to 9/10 ice	255 125 007	
80	8/10 ice	255 125 007	
81	8/10 to 10/10 ice	255 000 000	
89	8/10 to 9/10 ice	255 125 007	
90	9/10 ice	255 255 000	
91	9/10 to 10 or 9+/10 ice	255 255 000	
92	10/10 ice	145 000 000	
99	Undertermined/Unknown	SymbolFill	

9.2.1.3 IceNavigationalDisplayMode

Table 9-3

icesod	Description	rgb	Colour
1	Ice Free	150 200 255	
70	Brash Ice	150 200 255	
80	No Stage Development	150 200 255	
81	New Ice (<10 cm)	240 210 250	
82	Nilas Ice Rind (<10 cm)	255 100 255	
83	Young Ice (10 to <30 cm)	170 040 240	

84	Grey Ice (10 to <15 cm)	135 060 215	
85	Grey — White Ice (15 to <30 cm)	220 080 235	
86	First Year Ice (30 to 200 cm)	255 255 000	
87	Thin First Year Ice (30 to <70 cm)	175 250 000	
88	Thin First Year Ice Stage 1 (30 to <50 cm)	215 250 130	
89	Thin First Year Ice Stage 2 (50 to <70 cm)	175 250 000	
91	Medium First Year Ice (70 to 120 cm)	000 120 000	
93	Thick First Year Ice (>120 cm)	000 120 000	
94	Residual Ice	000 120 000	
95	Old Ice	180 100 050	
96	Second Year Ice	255 120 010	
97	Multi-Year Ice	200 000 000	
98	Glacier Ice (Icebergs)	Symbolfill	
99	Undertermined/Unknown	SymbolFill	

9.2.2 Line Features

Table 9-4

Feature Class	Acronym	Symbol
Iceberg Limit	brglne	**Figure 9-1**
Line of Ice Ridge	i_ridg	**Figure 9-2**
Line of Ice Lead	i_lead	**Figure 9-3**
Line of Ice Fracture	i_fral	**Figure 9-4**
Line of Ice Crack	i_crac	**Figure 9-5**

9.2.3 Point Features

Table 9-5

Feature Class	Acronym	Symbol
Ice Compacting	icecom	**Figure 9-6**

Ice Lead	icelea	**Figure 9-7**
Ice Shear	iceshr	**Figure 9-8**
Ice Divergence	icediv	**Figure 9-9**
Ice Ridge / Hummock	icerdg	**Figure 9-10**
Ice Keel / Bummock	icekel	**Figure 9-11**
Ice Fracture	flobrg	**Figure 9-12**
Ice Rafting	icerft	**Figure 9-13**
Jammed Brash Barrier	jmdbrr	**Figure 9-14**
Stage of Mell	stgmlt	**Figure 9-15**
Snow Cover	snwcvr	**Figure 9-16**
Strips and patches	strptc	**Figure 9-17**
Grounded Hummock	i_grhm	**Figure 9-18**
Iceberg	icebrg	
	icebrg 01 (Growler)	**Figure 9-19**
	icebrg 02 (Bergy Bit)	**Figure 9-20**
	icebrg 03 (Small Iceberg)	**Figure 9-21**
	icebrg 04 (Medium Iceberg)	**Figure 9-22**

	icebrg 05 (Large Iceberg)	**Figure 9-23**
	icebrg 06 (Very Large Iceberg)	**Figure 9-24**
	icebrg 07 (Ice Island Fragment)	**Figure 9-25**
	icebrg 08 (Ice Island)	**Figure 9-26**
	icebrg 09 (Radar Target)	**Figure 9-27**
	icebrg 99 (Unknown)	**Figure 9-28**
Ice Drift	icedft	
	icedft 01 (No Ice Motion)	**Figure 9-29**
	icedft 02 (NE)	**Figure 9-30**
	icedft 03 (E)	**Figure 9-31**
	icedft 04 (SE)	**Figure 9-32**
	icedft 05 (S)	**Figure 9-33**
	icedft 06 (SW)	**Figure 9-34**
	icedft 07 (W)	**Figure 9-35**
	icedft 08 (NW)	**Figure 9-36**

	icedft 09 (N)	**Figure 9-37**
	icedft 10 (Variable)	**Figure 9-38**
	icedft 99 (Unknown)	**Figure 9-39**

9.2.4 Draw order

The highest number will be drawn on the top.

Table 9-6

No	Name	Acronym
1	Sea Ice	seacie
1	Lake Ice	lacice
2	Iceberg Area	seacie
1	Sea Ice	icebrg
3	Ice Edge	icelne
4	Iceberg Limit	brglne
5	Limit of Open Water	opnlne
6	Limit of All Known Ice	lkilne
7	Line of Ice Ridge	i_ridg
8	Line of Ice Lead	i_lead
9	Line of Ice Fracture	i_fral
10	Line of Ice Crack	i_crac
11	Ice Compacting	icecom
12	Ice Lead	icelea
13	Iceberg	icebrg
14	Floeberg	flobrg
15	Ice Thickness	icethk
16	Ice Shea	iceshr
17	Ice Divergence	icediv
18	Ice Ridge / Hummock	icerdg
19	Ice Keel / Bummock	icekel
20	Ice Drift	icedft
21	Ice Fracture	icefra

No	Name	Acronym
22	Ice Rafting	icerft
23	Jammed Brash Barrier	jmdbrr
24	Stage of Melt	stgmlt
25	Snow Cover	snwcvr
26	Strips and Patches	strptc
27	Grounded Hummock	i_grhm

10 Data Product Format (encoding)

10.1 Introduction

This clause describes encoding rules for S-100 base ice datasets. For the encoding of ice datasets GML 3.2.1 is used as per S-100, Part 10b.

10.2 Encoding Rules

10.2.1 Longitude / Latitude

- Longitude and latitude must be encoded in decimal degrees, e.g.: 12.567 56.765
- Number of decimals is not specified.

10.3 Encoding Examples

Below are three examples of the encoding of various ice features using different geometric primitives, the encoding of other ice objects can be done in a similar way. Encoding is defined by the S-411 GML Schema.

10.3.1 Polygon Feature

```
        <SeaIce gml:id="ID1">
            <snowDepth>10</snowDepth>
            <geometry>
                <S100:surfaceProperty>
                    <S100:Surface gml:id="SID1">
                        <gml:patches>
                            <gml:PolygonPatch>
                                <gml:exterior>
                                    <gml:LinearRing>
                                        <gml:posList>-40.13354268036668
69.92359353498672 -39.69638964635833 69.92155176448463 -39.723154117828216
69.82433805372922 -40.148411831183296 69.82638929895934 -40.13354268036668
69.92359353498672</gml:posList>
                                    </gml:LinearRing>
                                </gml:exterior>
                            </gml:PolygonPatch>
                        </gml:patches>
                    </S100:Surface>
                </S100:surfaceProperty>
            </geometry>
        </SeaIce>
```

Figure 10-1

10.3.2 LineString Feature

```
        <IcebergLimit gml:id="ID8">
            <geometry>
                <S100:curveProperty>
                    <S100:Curve gml:id="CID8">
                        <gml:segments>
                            <gml:LineStringSegment>
                                <gml:posList>-40.118673529550065
69.50813272244953 -39.19381234875688 69.50813272244953</gml:posList>
                            </gml:LineStringSegment>
                        </gml:segments>
                    </S100:Curve>
                </S100:curveProperty>
            </geometry>
        </IcebergLimit>
```

Figure 10-2

10.3.3 Point Feature

```
        <IceThickness gml:id="ID5">
            <iceAverageThickness>10</iceAverageThickness>
            <geometry>
                <S100:pointProperty>
                    <S100:Point gml:id="PID5">
                        <gml:pos>-39.84661453570196 69.7617050074188</gml:pos>
                    </S100:Point>
                </S100:pointProperty>
            </geometry>
        </IceThickness>
```

Figure 10-3

11 Data Product Delivery

11.1 Format Specification

At the moment there is only one type of dataset supported. This is GML encoded ice feature collections according to S-100 Part 10b.

11.2 Introduction

Ice Information Product will be delivered as an S-100 Exchange Set, containing datasets, metadata, etc. It is also possible that several datasets are available for an area. The decision which one to use, once installed in the system database is the responsibility of the navigator on the vessel.

11.3 Exchange Set

The exchange set for the Ice Information Product has following structure (from S-100 Part 17):

Placeholder

Figure 11-1 — : Exchange set Structure

An Ice Information exchange set must conform to the structure laid out in S-100 Part 17 and may comprise datasets and S-411 catalogue files.

11.4 Exchange Catalogue

11.4.1 Exchange Catalogue Naming

Name of Exchange Catalogue is `CATALOG.XML` as per S-100 Part 17

The clauses in italic below come from S-102 PS. JCOMM ETSI to confirm what has to be retained/ deleted/adapted

Each dataset must be contained in a physically separate, uniquely identified file on the transfer medium.

Each exchange set has a single exchange catalogue which contains the discovery metadata for each dataset.

An exchange set is encapsulated into a form suitable for transmission by a mapping called an encoding. An encoding translates each of the elements of the exchange set into a logical form suitable for writing to media and for transmission online. An encoding may also define other elements in addition to the exchange set contents (This is media identification, data extents etc. …) and may define commercial constructs such as encryption and compression methods.

If the data is transformed in S-411 it must not be changed.

This Product Specification defines the encoding which must be used as a default for transmission of data between parties.

The encoding encapsulates exchange set elements as follows:

Mandatory Elements

- S-411 datasets — GML encoding
- Exchange Catalogue — the XML encoded representation of exchange set catalogue features [discovery metadata].

Optional Elements

- S-411 Feature Catalogue — If it is necessary to deliver the latest Feature Catalogue to the end user it may be done using the S-411 exchange set mechanism for datasets
- S-411 Portrayal Catalogue — If it is necessary to deliver the latest Portrayal Catalogue to the end user it may be done using the S-411 exchange set mechanism for datasets.

11.5 Datasets

11.5.1 Dataset size

No requirements for maximum dataset size are specified.

11.5.2 Dataset file naming

Dataset naming must follow a standard pattern to give implementers greater predictability of incoming datasets (see S-100, Part 17, Clause 4.3). S-411 dataset naming conventions must follow these rules and no further restrictions are made in this product specification.

411YYYYØØØØØØØØØØØØ.GML

411	the first 3 characters identify the dataset as an S-411 dataset (mandatory).
YYYY	the fourth to seventh characters identify the producer code according to the Producer Code Register.
ØØØØ	the eighth to the maximum nineteenth characters are optional and may be used in any way by the producer to provide the unique file name. The following characters are allowed in the dataset name: A to Z, 0 to 9 and the special character _ (underscore).
GML	denotes a GML file (according to S-100, Part 10b).

11.6 Exchange Set

The structure of an S-411 Exchange Set must be according to the structure described below, which is based on S-100, Part 17, Clause 4.2.

1) An S-411 Exchange Set must contain an Exchange Set Catalogue, CATALOG.XML, its digital signature CATALOG.SIGN, and may contain any number of S-411 conformant dataset files and Catalogue files.
2) All content must be placed inside a top root folder named S100_ROOT. This is the only top level root folder in an Exchange Set containing only S-100 products.
3) The S100_ROOT folder must contain a subfolder named S-411. This subfolder holds content specific to the S-411 Product Specification.
4) The S-411 subfolder must contain subfolders for the component dataset files (DATASET_FILES) and Catalogues (CATALOGUES) as required.
5) The required Exchange Set Catalogue XML document instance must be named CATALOG.XML and placed in the S100_ROOT folder, together with its digital signature (CATALOG.SIGN) file. All other digital signatures are included within their corresponding resource metadata records in the CATALOG.XML.

11.7 Support Files

No support files are included in any of the S-411 features currently. If they are supported in the future then their specification and delivery will be added to this section.

11.8 Exchange Catalogue

The Exchange Catalogue acts as the table of contents for the Exchange Set. The Catalogue file of the Exchange Set must be named CATALOG.XML. No other file in the Exchange Set may be named CATALOG.XML. The contents of the Exchange Catalogue are described in Section 12.

11.9 Data integrity and encryption

S-100, Part 15 defines the algorithms for compression, encrypting and digitally signing datasets based on the S-100 Data Model. Use of encryption is optional. Digital Signatures are mandatory for all datasets.

11.9.1 Use of compression

The data producer decides if compression will be used on the S-411 product files (GML). It is expected that a hydrographic office will make a policy decision and that all the S-411 datasets from the producer will be either compressed or uncompressed.

It is recommended to compress all the dataset files. The ZIP compression method defined in S-100, Part 15, Clause 5.2 should be used where applicable.

11.9.2 Use of digital signatures

Digital signatures must be used on all files included in a S-411 compliant Exchange Set to meet the requirements of IMO resolution MSC.428(98) to reduce cyber security risks among users, especially when used in navigations systems at sea. The recommended signature method is defined in S-100, Part 15.

The digital signature information is encoded in the corresponding discovery block in the exchange catalogue for each file included in the Exchange Set as defined in S-100, Part 17.

12 Metadata

12.1 Introduction

There are two kinds of metadata to prepare:

- ISO 19139 Metadata
  This kind of metadata implementation can be read by broad range of software.
- S100 Metadata
  The S100 metadata are for describing the structure of Exchange Catalogue

12.1.1 ISO 19139 Metadata

For the description of ice data following metadata are necessary:

Table 12-1

Element Name	Description	Namespace
MD_Metadata	root element	gmd
fileIdentifier	Id for dataset	gmd
language	Product language	gmd
characterSet	Used characterset	gmd
contact	Contact data	gmd
dateStamp	date of publishing	gmd
identificationInfo	Specific info about product	gmd

```
<?xml version="1.0" encoding="UTF-8"?>
<gmd:MD_Metadata    xmlns:gmd="http://www.isotc211.org/2005/gmd"
                    xmlns:gco="http://www.isotc211.org/2005/gco"
                    xmlns:gml="http://www.opengis.net/gml/3.2">
        <gmd:fileIdentifier> ... </gmd:fileIdentifier>
        <gmd:language> ... </gmd:language>
        <gmd:characterSet> ... </gmd:characterSet>
        <gmd:contact> ... </gmd:contact>
        <gmd:dateStamp> ... </gmd:dateStamp>
        <gmd:identificationInfo> ... </gmd:identificationInfo>
</gmd:MD_Metadata>
```

Figure 12-1

12.1.1.1 fileIdentifier

Table 12-2

Element Name	Description	Namespace
fileIdentifier	Id for dataset	gmd
CharacterString	String contained id value	gmd

12.1.1.2 language

Table 12-3

Element Name	Description	Namespace
language	Language of dataset	gmd

Element Name	Description	Namespace
LanguageCode	Code for language	gmd

```
<gmd:language>
    <gmd:LanguageCode
        codeList="http://www.isotc211.org/2005/resources/Codelist/ML_
gmxCodelists.xml#LanguageCode"
        codeListValue="eng">English
    </gmd:LanguageCode>
</gmd:language>
```

Figure 12-2

12.1.1.3 characterSet

Table 12-4

Element Name	Description	Namespace
characterSet	characterSet of dataset	gmd
MD_CharacterSetCode	Code for characterSet	gmd

LanguageCode element contains two attributes:

- codeList Link to the list containing the codes for languages
- codeListValue value from the list defining the used language

```
<gmd:characterSet>
    <gmd:MD_CharacterSetCode
        codeList="http://www.isotc211.org/2005/resources/Codelist/ML_
gmxCodelists.xml#MD_CharacterSetCode"
        codeListValue="utf8">UTF 8
    </gmd:MD_CharacterSetCode>
</gmd:characterSet>
```

Figure 12-3

12.1.1.4 contact

Table 12-5

Element Name	Description	Namespace
contact	Contact for questions to dataset	gmd
CI_ResponsibleParty	ISO Element for contact data	gmd
individualName	Name of responsible person	gmd
CharacterString	individualName value (text)	gco
organisationName	Name of responsible organisation	gmd
CharacterString	organisationName value (text)	gco
contactInfo	Contact information	gmd
CI_Contact	ISO Element for contact information	gmd
phone	phone	gmd
CI_Telephone		gmd
voice		gmd

Element Name	Description	Namespace
CharacterString	Voice telephone value (text)	gco
facsimile		gmd
CharacterString	Fax number value (text)	gco
address		gmd
deliveryPoint		gmd
CharacterString	Postal Address (street, house number)	gco
city		gmd
CharacterString	City name value (text)	gco
administrativeArea		gmd
CharacterString	Administrative Area name value (text)	gco
postalCode		gmd
CharacterString		gco
electronicMailAddress		gmd
CharacterString	Email value (text)	gco
role		gmd
CI_RoleCode		gmd

CI_RoleCode element contains two attributes:

- codeList: link to the list containing the codes for roles
- codeListValue: value from the list defining the used roles

```
<gmd:contact>
    <gmd:CI_ResponsibleParty>
        <gmd:individualName>
            <gco:CharacterString>Jürgen Holfort</gco:CharacterString>
        </gmd:individualName>
        <gmd:organisationName>
            <gco:CharacterString>FMHA Germany (BSH)</gco:CharacterString>
        </gmd:organisationName>
        <gmd:contactInfo>
            <gmd:CI_Contact>
                <gmd:phone>
                    <gmd:CI_Telephone>
                        <gmd:voice>
                            <gco:CharacterString>+49 (0) 381 4563-782</gco:
CharacterString>
                        </gmd:voice>
                        <gmd:facsimile>
                            <gco:CharacterString>+49 (0) 381 4563-949</gco:
CharacterString>
                        </gmd:facsimile>
                    </gmd:CI_Telephone>
                </gmd:phone>
                <gmd:address>
                    <gmd:CI_Address>
                        <gmd:deliveryPoint>
                            <gco:CharacterString>Neptunallee 5</gco:
CharacterString>
                        </gmd:deliveryPoint>
```

```
                        <gmd:administrativeArea>
                            <gco:CharacterString>Rostock</gco:CharacterString>
                        </gmd:administrativeArea>
                        <gmd:postalCode>
                            <gco:CharacterString>18057</gco:CharacterString>
                        </gmd:postalCode>
                        <gmd:electronicMailAddress>
                            <gco:CharacterString>ice@bsh.de</gco:
CharacterString>
                        </gmd:electronicMailAddress>
                    </gmd:CI_Address>
                </gmd:address>
            </gmd:CI_Contact>
        </gmd:contactInfo>
        <gmd:role>
            <gmd:CI_RoleCode
                codeList="http://www.isotc211.org/2005/resources/Codelist/
gmxCodelists.xml#CI_RoleCode" codeListValue="originator">originator</gmd:CI_
RoleCode>
            </gmd:role>
    </gmd:CI_ResponsibleParty>
</gmd:contact>
```

Figure 12-4

12.1.1.5 dateStamp

Table 12-6

Element Name	Description	Namespace
dataStamp	Date Stamp	gmd
Date	Formatted String (yyyy-MM-dd)	gco

The dateStamp should be used for the publication date (just day using gco:date or including the time using gco:datetime). The date and time where the ice chart is considered valid should be given in identificationinfo (see 10.1.1.6). Classic operational ice charts should have a time stamp within the temporal extent given in identificationinfo, a dateStamp preceding the temporal extent denotes a prognosis chart, a dateStamp that is more recent then the temporal extent denotes an historic reanalysis or a climatological chart.

```
<gmd:dateStamp>
  <gco:Date>2013-02-25</gco:Date>
</gmd:dateStamp>
```

Figure 12-5

12.1.1.6 identificationInfo

Table 12-7

Element Name	Description	Namespace
identificationInfo		gmd
MD_DataIdentification		
citation		
CI_Citation		
title		
CharacterString		gco

Element Name	Description	Namespace
date		
CI_Date		
date		gco
dateType		
CI_DateTypeCode		
abstract		
CharacterString		gco
language		
LanguageCode		
characterSet		
MD_CharacterSetCode		
topicCategory		
MD_TopicCategoryCode		
extent		
EX_Extent		
geographicElement		
EX_GeographicBoundingBox		
westBoundLongitude		
Decimal		gco
eastBoundLongitude		
Decimal		gco
southBoundLatitude		
Decimal		gco
northBoundLatitude		gmd
Decimal		gco
temporalElement		gmd
EX_TemporalExtent		gmd
extent		gmd
TimePeriod		gml
beginPosition		gml
endPosition		gml

```
<gmd:identificationInfo>
  <gmd:MD_DataIdentification>
    <gmd:citation>
      <gmd:CI_Citation>
```

```
        <gmd:title>
          <gco:CharacterString>IceArea25022013.shp</gco:CharacterString>
        </gmd:title>
        <gmd:date>
          <gmd:CI_Date>
            <gmd:date>
              <gco:Date>2013-02-25</gco:Date>
            </gmd:date>
          <gmd:dateType>
            <gmd:CI_DateTypeCode
codeList="http://www.isotc211.org/2005/resources/Codelist/ML_gmxCodelists.
xml#CI_DateTypeCode" codeListValue="creation">creation</gmd:CI_DateTypeCode>
          </gmd:dateType>
        </gmd:CI_Date>
      </gmd:date>
    </gmd:CI_Citation>
  </gmd:citation>
  <gmd:abstract>
    <gco:CharacterString>Ice Chart for Baltic sea</gco:CharacterString>
  </gmd:abstract>
  <gmd:language>
    <gmd:LanguageCode
codeList="http://www.isotc211.org/2005/resources/Codelist/ML_gmxCodelists.
xml#LanguageCode" codeListValue="eng">English</gmd:LanguageCode>
  </gmd:language>
  <gmd:characterSet>
    <gmd:MD_CharacterSetCode
codeList="http://www.isotc211.org/2005/resources/Codelist/ML_gmxCodelists.
xml#MD_CharacterSetCode"
codeListValue="utf8">UTF 8</gmd:MD_CharacterSetCode>
  </gmd:characterSet>
  <gmd:topicCategory>
    <gmd:MD_TopicCategoryCode>geoscientificInformation</gmd:MD_
TopicCategoryCode>
  </gmd:topicCategory>
  <gmd:extent>
    <gmd:EX_Extent>
      <gmd:geographicElement>
        <gmd:EX_GeographicBoundingBox>
          <gmd:westBoundLongitude>
            <gco:Decimal>8.963</gco:Decimal>
          </gmd:westBoundLongitude>
        <gmd:eastBoundLongitude>
          <gco:Decimal>30.353</gco:Decimal>
        </gmd:eastBoundLongitude>
        <gmd:southBoundLatitude>
          <gco:Decimal>53.613</gco:Decimal>
        </gmd:southBoundLatitude>
        <gmd:northBoundLatitude>
          <gco:Decimal>65.0</gco:Decimal>
        </gmd:northBoundLatitude>
      </gmd:EX_GeographicBoundingBox>
    </gmd:geographicElement>
    <gmd:temporalElement>
          <gmd:EX_TemporalExtent>
            <gmd:extent>
              <gml:TimePeriod gml:id="ek1-20130225-16">
                <gml:beginPosition>2013-02-25</gml:beginPosition>
                <gml:endPosition>2013-02-27</gml:endPosition>
              </gml:TimePeriod>
            </gmd:extent>
          </gmd:EX_TemporalExtent>
        </gmd:temporalElement>
      </gmd:EX_Extent>
    </gmd:extent>
```

```
  </gmd:MD_DataIdentification>
</gmd:identificationInfo>
```

Figure 12-6

12.2 Language

The language used in metadata must be English. Other languages are optional and only as addition to the English version.

Metadata used for the discovery, identification, and use of S-411 datasets in S-100-based navigation systems (specifically, an S-100 capable ECDIS) is encoded in the exchange catalogue. This metadata conforms to S-100, Part 17, with any product-specific restrictions noted in this section.

12.3 Exchange Set metadata

For information exchange, there are several categories of metadata required: metadata about the overall Exchange Catalogue, metadata about each of the datasets contained in the Catalogue.

The discovery metadata classes have numerous attributes which enable important information about the datasets to be examined without the need to process the data (e.g., decryption, decompression, loading). Other Catalogues can be included in the Exchange Set in support of the datasets such as Feature and Portrayal.

The following clauses define the mandatory and optional metadata needed for S-411. In some cases, the metadata may be repeated in a national language. If this is the case it is noted in the Remarks column.

The XML schemas for S-411 exchange catalogues will be available from the IHO Geospatial Information (GI) Registry and/or the S-100 GitHub site (https://github.com/IHO-S100WG).

The S-411 exchange catalogue uses the S-100 exchange catalogue schemas which are available from the S-100 schema server at https://schemas.s100dev.net (downloadable archives are also available on the site for offline use). Implementation of the S-411-specific constraints described in following clauses below is left to developer decision as it can be done in various ways depending on implementation frameworks and the requirements of production or application software.

12.4 S100_ExchangeCatalogue

Each Exchange Set has a single S100_ExchangeCatalogue which contains meta information for the data in the Exchange Set.

S-411 uses S100_ExchangeCatalogue without modification.

12.4.1 S100_ExchangeCatalogueIdentifier

S-411 uses S100_ExchangeCatalogueIdentifier without modification.

12.4.2 S100_CataloguePointOfContact

S-411 uses S100_CataloguePointOfContact without modification.

12.5 S100_DatasetDiscoveryMetadata

Dataset discovery metadata in S-411 restricts certain attributes and roles as described in Table 12-8. Optional S-100 attributes which are mandatory in S-411 are indicated in the Remarks column.

Table 12-8 — S100_DatasetDiscoveryMetadata parameters

Role name	Name	Description	Mult	Type	Remarks
Class	S100_ DatasetDiscoveryMetadata	Metadata about the individual datasets in the Exchange Catalogue	-	-	**The optional S-100 attributes *updateNumber*, *updateApplicationDate*, *referenceID*, and *temporalExtent* are not used in S-411.** **References to support file discovery metadata are not permitted because S-411 does not use support files.**
Attribute	fileName	Dataset file name	1	URI	See S-100, Part 1, Clause 4.6 **Format: file:/S-411/DATASET_FILES/<dsname>** **Dataset file name <dsname> must be according to format defined in Clause 11.5.2.**
Attribute	datasetID	Dataset ID expressed as a Maritime Resource Name	0..1	URN	The URN must be an MRN. **See S-100, Part 3, Clause 10**
Attribute	editionNumber	The edition number of the dataset	**1**	Integer	When a data set is initially created, the Edition number 1 is assigned to it. The Edition number is increased by 1 at each new Edition. Edition number remains the same for a re-issue.

Role name	Name	Description	Mult	Type	Remarks
					Mandatory in S-411
Attribute	issueDate	Date on which the data was made available by the Data Producer	1	Date	-
Attribute	issueTime	Time of day at which the data was made available by the Data Producer	0..1	Time	The S-100 datatype Time **May be required if multiple instances of a product are issued on the same day.**
Attribute	boundingBox	The extent of the dataset limits	**1**	EX_ GeographicBoundingBox	**Mandatory in S-411** **Defined as a rectangle coincident with the outermost cell boundaries of the dataset.**
Attribute	productSpecification	The Product Specification used to create this dataset	1	S100_ ProductSpecification	**Table 12-12**
Attribute	producingAgency	Agency responsible for producing the data	1	CI_Responsibility>CI_ Organisation	See S-100, Part 17, Table 17–3
Attribute	producerCode	The official IHO Producer Code from S-62	1	CharacterString	**Mandatory in S-411**
Attribute	encodingFormat	The encoding format of the dataset	1	S100_EncodingFormat	**The only allowed value is GML** **Table 12-11**
Attribute	dataCoverage	Provides information about data coverages within the dataset	**1**..*	S100_DataCoverage	**Mandatory in S-411** **Table 12-9**
Attribute	comment	Any additional information	0..1	CharacterString	-
Attribute	defaultLocale	Default language and character set used in the dataset	0..1	PT_Locale	In absence of defaultLocale, the language is English, and the character set is UTF-8.
Attribute	otherLocale	Other languages and character sets used in the dataset	0..*	PT_Locale	
Attribute	metadataPointOfContact	Point of contact for metadata	0..1	CI_Responsibility>CI_ Individual	Only if metadataPointOfContact differs from producingAgency

Role name	Name	Description	Mult	Type	Remarks
				or CI_Responsibility>CI_ Organisation	
Attribute	metadataDateStamp	Date stamp for metadata	0..1	Date	May or may not be the issue date
Attribute	replacedData	Indicates if a cancelled dataset is replaced by another data file(s)	0..1	Boolean	See note following S-100, Part 17, Table S100_ DatasetDiscoveryMetadata **Mandatory when purpose = cancellation**
Attribute	dataReplacement	Dataset name	0..*	CharacterString	A dataset may be replaced by 1 or more datasets. **Dataset name must be according to format defined in Clause 11.5.2.** **For example, *411DE00KD54.GML*** See note following S-100, Part 17, Table S100_ DatasetDiscoveryMetadata **Mandatory when replacedData = true**
Attribute	navigationPurpose	Classification of intended navigation purpose (for Catalogue indexing purposes)	**1**..3	S100_NavigationPurpose	If Product Specification is intended for creation of navigational products, this attribute should be mandatory. **Mandatory in S-411**

12.5.1 S100_NavigationPurpose

S-411 uses S100_NavigationPurpose without modification.

12.5.2 S100_DataCoverage

S-411 uses S100_DataCoverage without modification, but with additional remarks and changes to the multiplicity.

Table 12-9 — S100_DataCoverage parameters

Role name	Name	Description	Mult	Type	Remarks
Class	S100_DataCoverage	A spatial extent where data is provided along with the display scale information for the provided data	-	-	This field is used by user systems as part of the data loading and unloading algorithms, and it is strongly encouraged that Product Specifications mandate the use of one or more of the displayScale provided as part of S100_DataCoverage.

Role name	Name	Description	Mult	Type	Remarks
Attribute	boundingPolygon	A polygon which defines the actual data limit	1	EX_ BoundingPolygon	Clause 12.5.2, Note
Attribute	temporalExtent	Specification of the temporal extent of the coverage	**0**	S100_ TemporalExtent	**The *temporalExtent* is not used in S-411.**
Attribute	optimumDisplayScale	The scale at which the data is optimally displayed	1	Integer	Example: A scale of 1:25000 is encoded as 25000
Attribute	maximumDisplayScale	The maximum scale at which the data is displayed	0..1	Integer	
Attribute	minimumDisplayScale	The minimum scale at which the data is displayed	0..1	Integer	
NOTE *boundingPolygon* is restricted to a single GML Polygon with one exterior and 0 or more interiors expressed as Linear Rings using SRS EPSG:4326. The exterior and optional interiors shall be composed of a closed sequence of >=4 coordinate positions expressed individually or as a list (posList). The GML polygon shall have a valid GML identifier.					

12.5.3 S100_Purpose

S-411 uses S100_Purpose without modification, but with a restriction on the allowed values.

Table 12-10 — S100_Purpose

Role name	Name	Description	Code	Remarks
Enumeration	S100_Purpose	The purpose of the dataset	-	**The S-100 values *update*, *reissue*, and *delta* are not used in S-411.**
Value	newDataset	Brand new dataset	1	No data has previously been produced for this area.
Value	newEdition	New edition of the dataset or Catalogue	2	Includes new information which has not been previously distributed by updates.
Value	cancellation	Dataset or Catalogue that has been cancelled	5	Indicates the dataset or Catalogue should no longer be used and can be deleted.

12.5.4 S100_EncodingFormat

S-411 uses S100_EncodingFormat with a restriction on the allowed values to permit only the S-100 GML format for S-411 datasets.

Table 12-11 — S100_EncodingFormat parameters

Role name	Name	Description	Code	Remarks
Enumeration	S100_EncodingFormat	The encoding format	-	**The only value allowed in S-411 is "GML".**
Value	GML	The GML data format as defined in S-100, Part 10b	3	-

12.5.5 S100_ProductSpecification

S-411 uses S100_ProductSpecification without modification, but with additional remarks and changes to the multiplicity.

Table 12-12 — S100_ProductSpecification parameters

Role name	Name	Description	Mult	Type	Remarks
Class	S100_ ProductSpecification	The Product Specification contains the information needed to build the specified product.	-	-	-
Attribute	name	The name of the Product Specification used to create the datasets	**1**	CharacterString	The name in the GI Registry should be used for this field. **For S-411, this name is "Ice Information" (as of 25 June 2024).**
Attribute	version	The version number of the Product Specification	**1**	CharacterString	TR 2/2007 specifies versioning of Product Specifications **Example: 1.2.1 for S-411 Edition 1.2.1**
Attribute	date	The version date of the Product Specification	**1**	Date	-
Attribute	productIdentifier	Machine readable unique identifier of a product type	1	CharacterString (Restricted to Product ID values from the IHO Product Specification Register in the IHO Geospatial Information (GI) Registry)	**For S-411, this identifier is "S-411" (without quotes).**
Attribute	number	The number used to lookup the product in the Product Specification Register of the IHO GI registry	1	Integer	For IHO Product Specifications, these numbers should be taken from the IHO Product Specification Register in the IHO GI Registry.

Role name	Name	Description	Mult	Type	Remarks
					The corresponding Idx-number of the IHO Registry for S-411 is numbered *xxx*.

12.5.6 S100_ProtectionScheme

S-411 uses S100_ProtectionScheme without modification.

12.6 S100_CatalogueDiscoveryMetadata

S-411 uses S100_CatalogueDiscoveryMetadata without modification.

12.6.1 S100_CatalogueScope

S-411 uses S100_CatalogueScope without modification.

12.6.2 PT_Locale

S-411 uses PT_Locale without modification. The class PT_Locale is defined in ISO 19115-1:2014/Amd 1:2018. LanguageCode, CountryCode, and MD_CharacterSetCode are ISO codelists which are defined in a codelists file which is part of the S-100 Edition 5.2.0 schema distribution.

12.7 Certificates and Digital Signatures

The classes S100_SE_CertificateContainerType (S-100, Part 15, Clause 8.11.1), S100_SE_DigitalSignatureReference (S-100, Part 15, Clause 8.11.7), and S100_SE_DigitalSignature are defined in S-100, Part 15 and implemented in the S-100 generic schemas.

In accordance with S-100, Part 15, only the ECDSA algorithm is allowed from the S100_SE_DigitalSignatureReference enumeration.

S-411 uses S100_SE_DigitalSignature without modification. As stated in S-100, Part 15, Clause 15–8.11.3:

“The class S100_SE_DigitalSignature is realized as one of either S100_SE_SignatureOnData (a digital signature of a particular identified resource) or an additional digital signature defined using the class S100_SE_AdditionalSignature, each of which is either a S100_SE_SignatureOnData or S100_SE_SignatureOnSignature element as described in S-100, Part 15, Clause 8.8. S-100, Part 17 metadata thus allows for multiple digital signatures, a single mandatory S100_SE_SignatureOnData and any number of additional signatures, either of the data or other signatures.”

13 Dataset Encoding

13.1 Introduction

A dataset is a grouping of features, attributes, geometry and metadata which comprises a specific coverage.

13.2 Dataset Rules

In order to facilitate the efficient processing of S-411 data the geographic coverage of a given **maximum display** scale may be split into multiple datasets.

The discovery metadata of a dataset must list all the **Data Coverage** features contained within that dataset and their assigned scale attributions.

Datasets must not cross the 180° meridian; this includes both the **Data Coverage** features and the bounding box for the dataset.

13.3 Data Coverage rules

- All base datasets (new dataset, new edition) must contain at least one **Data Coverage** feature.
- The data boundary of the base dataset is defined by the extent of the **Data Coverage** features and must be contained within the bounding box.
- The **Data Coverage** features within a dataset must not overlap, however **Data Coverage** features from different datasets may overlap if they have differing **maximum display scales**.
- Datasets may overlap, however there must be no overlapping **Data Coverage** features of the same **maximum display scale**, except at the agreed adjoining national data limits, where, if it is difficult to achieve a perfect join, a 5 metre overlapping buffer zone may be used; and for this situation, there must be no gaps in data.
- When a dataset has multiple **Data Coverage** features, then the **minimum display scale** must be the same for all **Data Coverage** features within the dataset. The **maximum display scale** for multiple **Data Coverage** features within a dataset may be different.
- When a dataset has multiple **Data Coverage features** then the **maximum display scale** of the dataset must be equal to the largest **maximum display scale** of the **Data Coverage** features.
- The **maximum display scale** is considered to be the equivalent of the compilation scale of the data.

14 Display Scale Range

A scale range of a dataset is used to indicate a range of scales between which a producer considers the data is intended for use. The smallest scale is defined by the **minimum display scale** and the largest scale by the **maximum display scale**. These scales must be set at one of the scales specified elsewhere in this product specification.

When the system's viewing scale is smaller than the value indicated by **minimum display scale**, features within the **Data Coverage** feature are not displayed.

15 Geometry

15.1 S-411 Geometry

S-411 Ice Information features are encoded as vector entities which conform to S-100 geometry configuration level 3a (S-100 clause 7-4.3).

Level 3a is described by the following constraints:

- Each curve must reference a start and end point (they may be the same).
- Curves must not self intersect. See S-100 Figure 7-5.
- Areas are represented by a closed loop of curves beginning and ending at a common point.
- In the case of areas with holes, all internal boundaries must be completely contained within the external boundary and the internal boundaries must not intersect each other or the external boundary. Internal boundaries may touch other internal boundaries or the external boundary tangentially (that is at one point) as shown in S-100 Figure 7-6.
- The outer boundary of a surface must be in a clockwise direction (surface to the right of the curve) and the curve orientation positive. The inner boundary of a surface must be in a counter-clockwise direction (surface to the right of the curve) and the curve orientation negative. See S-100 Figure 7-7.

16 List of annexes

These Annexes are separate files and can be found either in the S-411 Product Specification distribution package or at the locations indicated.

Annex A Data Classification and Encoding Guide. Separate document. IHO Geospatial Information Registry, https://registry.iho.int

Annex B Encoding Format. GML schema, Schematron rule files, and schema documentation. S-100 schema server, https://schemas.s100dev.net **TBC**

Annex C Feature catalogue. XML file. IHO Geospatial Information Registry, https://registry.iho.int

Annex D Validation Checks. Separate document. IHO Geospatial Information Registry, https://registry.iho.int **TBC**

Annex E Portrayal Catalogue. Zip archive of portrayal catalogue. IHO Geospatial Information Registry, https://registry.iho.int