"Electronic Chart Systems Ice Object Catalogue" and "S-411" Ice information product specifications status, perspectives and implementation (*Jürgen Holfort, BSH, Vasily Smolyanitsky, AARI, Ivan Sitnikov,NavDK*) (last edit 2018-08-28)

1   "Ice objects Catalogue" summary

"Electronic Chart Systems Ice Object Catalogue" (JCOMM-TR-080) is the basic building block of S-411 describing ice objects and attributes equivalent to codes of ice charting format SIGRID-3 and defining *what* ice information can be used in S411. The Catalogue is formally managed by the WMO-IOC JCOMM Expert Team on Sea Ice (ETSI).

The latest version 5.2 adopted in March 2014 includes 3 polygon, 9 linear and 16 point Ice Objects Classes and 57 Ice features attributes for sea and fresh-water ice. The acting and previous versions of the Catalogue are available from JCOMM web-site, publication section (https://jcomm.info/index.php?option=com_oe&task=viewDocumentRecord&docID=14167).

2   "S-411 Ice Information Product Specification" summary

The Specification is formally managed by the WMO-IOC JCOMM Expert Team on Sea Ice (ETSI). Development of the specifications was led by the BSH (Bundesamt für Seeschifffahrt und Hydrographie) as a part of JCOMM/ETSI. The latest version 1.1.0 was introduced in June 2014. The S411 is fully based on the IHO S-100 framework specification, Geography Markup Language (GML), Encoding Standard and the ISO 19100 series of standards. The application schema of ice information product contains 28 feature types with their attributes, enumerations, is based on the Ice Objects Catalogue (Version 5.2) and can be found in the ICE domain of the IHO Registry. The full schema as XML Schema File is also included in Annex B – Data Product format (encoding) of specification. Ice information datasets use S-100 Level 3a geometry which supports 0-, 1-, and 2-dimentional objects (points, line strings, polygons). The portrayal specification is based on the Styled Layer Descriptors (SLD), follows OGC standards and supports 3 polygon portrayals: first one according to the vessels ice capabilities, the second and third one being the WMO ice concentration/stages of development colour codes. Portrayals for the line and point objects follow the WMO symbology (WMO Sea Ice Nomenclature, vol. 3) and are implemented using SVG-graphics.

The acting version of the S411 is available from JCOMM web-site, publication section (https://jcomm.info/index.php?option=com_oe&task=viewDocumentRecord&docID=14168).

Conversion and r/w tools

The S-411 data can be read and presented using ECDIS SDKs (see section 6) as well as open source GIS software (e.g. QGis). Open source Python-based software is available from the national ice services (BSH, AARI etc) to convert ice information in the WMO SIGRID-3 exchange format into the S-411 format. Check the following resource for Python-based software: ftp://ftp.bsh.de/outgoing/Eisbericht/S411_Specification/

3   S411 roadmap

Short term changes

- Actualize the S411 documents so they are in accordance with the S-100 specification Version 3.0. (due date December 2018)
- Include the proposed new portrayal for icebergs (due date next JCOMM ETSI meeting)

- Include further allowed projections with clarifications on how the single points in polygons and lines should be defined, so that transformations between projections do not incur larger errors. (due date next JCOMM ETSI meeting)
- Clarify that S411 does not include a land mask and that as overlay land should be drawn above the sea ice layer. Sea ice features in S411 should extent somewhat into the used land masked used in the production, so that the use of another land mask does not produce ice free areas at the coast (the other possibility, that small shore polynias are closed due to the use of other land-sea borders are deemed acceptable, noting that sea ice information is made with the prerequisite of sure ship navigation).
- Better specify the relation of the IceNavigationalDisplayMode with Polaris and other possible risk analysis schemes. (due date next JCOMM ETSI meeting)
- Add an appendix clarifying the link to the SIGRID-3 format and the available conversion tools (due date February 2019)

Longer term development

- Further explore the needs to specify a special dusk and night portrayal as well as transparency in relation to navigational charts (S-101). (Next step: discussion at IICWG 2018)
- Explore the possibility to specify generalization principles to adjust portrayal to the map scale. Examples would be to join several iceberg symbols into one single symbol for many icebergs or even into an iceberg area or the inclusion of smaller ice polygons into larger ones. (Next step: discussion at IICWG 2018)
- Explore the interaction with other possible portrayals, starting with S-412 (weather).
- Rewrite the S411 to SIGRID-3 conversion tools (in Python, Fortran etc) so that they fully utilize open source programs (due date May 2019).

5 S-411 test data

Floating ice (sea ice, icebergs) information in S-411 may be found at:
- ftp://ftp.bsh.de/outgoing/Eisbericht/S411/ (Arctic Ocean, Greenland waters, Baltic Sea, Southern Ocean), 2014 – onward in time
- http://ice.aari.aq/S411/, (Southern Ocean, Greenland waters, Baltic Sea), 2015 – onward in time

6 dKart Ice Navigator – an ECS to support sea ice in S57 and S411 formats

NavDK Ltd and Arctic and Antarctic Research Institute (AARI) in close cooperation, both based in Saint Petersburg, Russia, in December 2017 announced the release of the latest version of dKart Ice Navigator – a top-class ECS for navigation in permanent (Arctic Ocean, Southern Ocean) and seasonal ice areas (Baltic Sea, Sea of Okhotsk, Tartar Strait etc), which features:
- balanced support for ice charts both in S57 and S411 formats
- a set of macros to display ice data of various types (concentration, drift, pressure, wind) and satellite imagery in several georeferenced formats (JPEG, JPEG2000, GeoTIFF)
- scheduled ice chart updates
- customizable presentation of ice charts on the screen with national and international symbology, numerical values expressed in user-defined units, animation of forecasts, etc.
- support for Mercator and Polar North/South stereographic projections
- shore-based routing service supplying recommended routes on board, and much more

- system expansion onto the Web allowing remote monitoring of ice situation within port authority responsibility areas, safeguarded zones, etc on mobile devices and desktops.

Implemented sea ice standards

dKart Ice Navigator ECS is based on "Electronic Chart Systems Ice Object Catalogue" (JCOMM-TR-080), version 5.2 (May 2014) and "S-411" Ice information product specifications (JCOMM-TR-081), version 1.1.0 (June 2014).

Ice Now-, Forecasting and Routing Services supported

Ice nowcasts and forecasts are supplied in vector S-411 and S-57 formats and the satellite imagery in optical (EOS Terra/Aqua, Suomi NPP, NOAA, FY3, Sentinel-2,3 etc) and microwave (Radarsat-2, Sentinel-1) ranges is supplied JPEG, JPEG2000, GeoTIFF. Nowcasts charts are based on expert sea ice analysis in a GIS system while forecasts charts are based on vectorization of the output from the numerical model. The ice vector output is initially in the WMO SIGRID-3 (Sea Ice GeoReferenced Information and Data, WMO/TD-NO.1214) which is further converted into S411 or a vector *dcf format chart, which is a transfer format for S57. Such charts and/or imagery are prepared to be displayed laid over official S-57 and CM-93/3 ENCs on the ECS screen.

Ice charts go with recommended routes through ice cover. Such routes come from ship model based calculations of engine modes, hull response, time and costs along each route alternative, and selection of the optimal one according to user-defined criteria. However, route import and route planning functionalities of dKart Ice Navigator allow the final decision about which route to take be left to the ship master on board, and to update it whenever a need for it arises.

Metocean information

As there is currently no support for S412 format, the metocean information (temperature, pressure, wind, sea level, etc) is supplied in vector *dcf format.
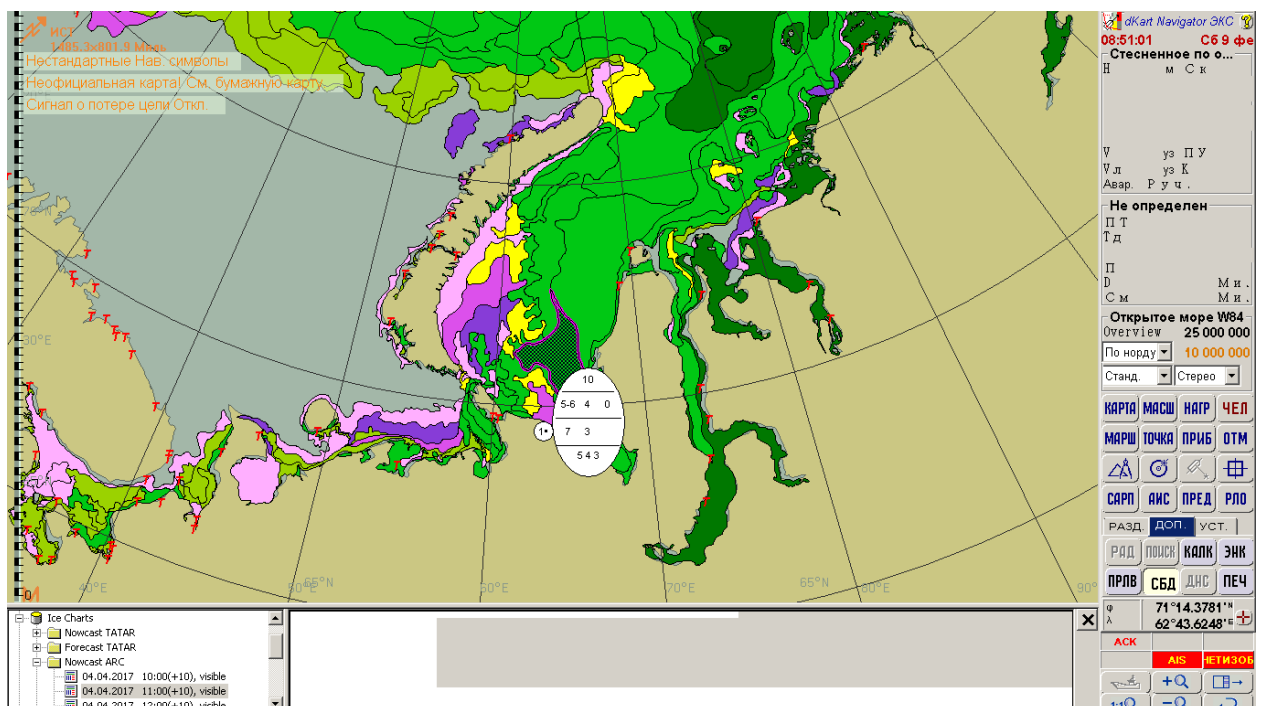
Snapshot of dKart Ice Navigator screen showing AARI ice charts in S411 for Kara, Barents and White Seas for 2017-04-07; colour presentation is based on the oldest stage of development

Navigation through Ice

dKart Ice Navigator uses macros to input ice data in the form of S411 and S57 (*dcf) charts and display those laid over official S57 and CM-93/3 ENCs on the screen. The adjustable transparent display is implemented now, as well as animated visualization of ice charts.

One-click function opens access to numerical ice data values, such as pressure, thickness, ice drift, temperature, wind and others expressed in international or non-system units (e.g. knots per hour for drift or wind). Dual screen display allows observation of ice situation in two remote areas at a time. Ice chart legends are always on display on a dedicated pod in the main window.

Expanding Ice Charts onto the Web

dKart Ice Navigator may have a web representative which allows dissemination of vessel ice and sea traffic information via Internet. Whatever the end-user's software platform (Windows, Android, iOS, Linux, etc), hardware type, be it a smartphone, a laptop or any other gadget, they can monitor navigational situation in an ice area exactly in the same view as on the ECS screen.

Interoperability of the dKart Ice Navigator ECS

Though the dKart Ice Navigator ECS is tuned for the AARI products any external supplier of the vector charts in S411 format and/or satellite imagery may be used pending naming conventions are followed. Naming conventions are based on SIGRID-3 specifications, e.g naming of raster information should follow template senvar_platform_level_region_source_datetime[_Fhhh].ext while vector information should follow template metvar_region_source_datetime[_Fhhh].ext, both with well-known fields. Proposed external suppliers for ice charts in S-411 format may be the JCOMM "Ice Logistics Portal" (http://www.bsis-ice.de/IcePortal/ILP_S411.shtml), AARI-NIC-NMI pilot project on integrated sea ice analysis for Antarctic waters (http://ice.aari.aq/S411/) or the "Polar View" portal for satellite imagery (https://www.polarview.aq/).

7   Contacts

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