

**JCOMM EXPERT TEAM ON SEA ICE (ETSI)  
Second Session  
STEERING GROUP FOR THE GLOBAL DIGITAL  
SEA ICE DATA BANK (GDSIDB)  
Tenth Session**

Hamburg, Germany, 15-17 April 2004

***FINAL REPORT***

JCOMM Meeting Report No. 28

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SECOND SESSION  
STEERING GROUP FOR THE GLOBAL DIGITAL  
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## NOTE

The designations employed and the presentation of material in this publication do not imply the expression of any opinion whatsoever on the part of the Secretariats of the Intergovernmental Oceanographic Commission (of UNESCO), and the World Meteorological Organization concerning the legal status of any country, territory, city or area, or of its authorities, or concerning the delimitation of its frontiers or boundaries.

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## GENERAL SUMMARY OF THE WORK OF THE MEETING

### 1. Opening of the session

#### 1.1 Opening

1.1.1 The second session of the Joint WMO/IOC Technical Commission for Oceanography and Marine Meteorology (JCOMM) Expert Team on Sea Ice (ETSI) and the tenth session of the Steering Group for the Global Digital Sea Ice Data Bank (GDSIDB) were opened at 09:30 hours on Thursday, 15 April 2004, in the German Federal Maritime and Hydrographic Agency (BSH) by Dr Vasily Smolyanitsky, chairman of the ETSI. Dr Smolyanitsky welcomed participants and called on Dr Klaus Strübing to address the meeting on behalf of the Director of the German Federal Maritime and Hydrographic Agency. Dr K. Strübing wished the participants a pleasant stay in Hamburg along with fruitful working days.

1.1.2 On behalf of the Secretary-General of WMO, Mr Michel Jarraud, and the Executive Secretary IOC, Dr P. Bernal, the Secretariat representative also welcomed participants to the meeting. He expressed the very sincere appreciation of WMO and IOC to the German Federal Maritime and Hydrographic Agency and especially to the local organizer of the meeting, Mr K.Strübing, for hosting this meeting and for providing friendly and stimulating working conditions for the participants. The Secretariat representative then outlined the objectives and importance of the meeting. He assured participants of the full support of the Secretariat, both during the meeting and in the future, and he concluded by wishing all participants very fruitful deliberations in this important meeting.

1.1.3 The list of participants in the meeting is given in *Annex I*.

#### 1.2 Adoption of the agenda

1.2.1 The meeting adopted the agenda for the sessions on the basis of the corrected provisional agenda prepared by the Secretariat. This agenda is given in *Annex II*.

#### 1.3 Working arrangements

1.3.1 The meeting agreed its hours of work and other practical session arrangements. The documentation for the meeting was introduced by the Secretariat.

### 2. FIRST SESSION OF THE JCOMM ETSI

#### 2.1 Report by the Chairman of the ETSI

2.1.1 The meeting noted with interest and appreciation a report (*Annex III*) by the chairman of the Expert Team on Sea Ice (ETSI), regarding the present status and effectiveness of its activities during the intersessional period since the last meeting (Buenos Aires, October 2002), and plans for the future. This report outlined the main activities so far within the overall team as well as the main results of the ETSI first session.

2.1.2 The meeting noted that substantial progress had been made in the implementation of the previous work plan, which includes revision of the current version of the WMO Sea Ice Nomenclature with a Glossary on Sea Ice Cover (WMO-No. 259, TP.145, 1970) in English, French, Russian and Spanish to be used in an electronic form, development of an updated version of that document, new standards for sea ice charts, including colour coding, new formats for operational and historical sea ice mapped data exchange, revision of the WMO publication Sea Ice Information Services in the World (WMO-No.574, 2000) and productive collaboration with the International Ice Charting Working Group (IICWG) and the Baltic Sea Ice Meeting (BSIM).

2.1.3 The meeting was informed that the International Meeting "Cooperation for the International Polar Year 2007–2008 (IPY 2007/2008) was held at the Arctic and Antarctic Research Institute in St Petersburg, 22-23 January 2004. Forty experts including representatives of the international organizations and programmes and scientists from national polar institutes participated in the meeting.

2.1.4 The Meeting noted with appreciation that ETSI, in collaboration with IICWG, provided draft requirements for sea ice observations as a part of a White Paper on "An International Collaborative Effort Towards Automated Sea Ice Chart Production", attached in Annex III of the Chairman's report.

## **2.2 Reports by the members of ETSI**

2.2.1 The session reviewed ETSI member's reports from Argentina, Canada, China, Denmark, Germany, Iceland, Japan, Russia, Sweden, UK and USA.

### *Report from the USA National Ice Center*

2.2.2 Mr M. Seymour provided information on sea ice activities in the USA carried out by the National Ice Center (NIC). In that context, the session was informed that the NIC has routinely produced maps of sea ice conditions since 1952. Using visible and infrared (NOAA AVHRR and DMSP OLS), SAR (Radarsat), scatterometer (QuikScat) and passive microwave (DMSP SSM/I) imagery, bi-weekly charts are produced of all ice covered regions of the Arctic and Antarctic, and at least weekly for all ice covered seas continuous to the United States and twice weekly charts of the Alaskan and Great Lakes regions. These charts are made available free on the web (<http://www.natice.noaa.gov>). Tailored support is also available to qualified users, to include annotated imagery support, upon request.

2.2.3 The session noted with appreciation that in the intersessional period, NIC provided tailored support to a number of national and international users. Progress was made on the development of a computer based training system for ice analysis, working with the Canadian Ice Service and Noetix Corp. Modules currently in production include Remote Sensing (SSM/I), Geography and Climatology. Proposed future modules include WMO Ice Code, Interactive Ice Analysis and Ice Forecasting.

2.2.4 The meeting was informed that NIC continued to refine efforts into developing a more robust plan for continuity of operations to specifically address homeland security threats and catastrophic facilities and communications failures. The NIC has made several provisions for creation of ice products and delivery of services from an off-site location, and Radarsat emergency ordering procedures were solidified.

2.2.5 During the intersessional period, the NIC implemented the SSM/I NASA Team 2 algorithm for operational use and has fully integrated QuikScat scatterometer imagery into the ice analysis process. The NIC is now investigating the use of SEAWINDS passive microwave data and is awaiting data from Cryosat and ALOS data in 2004.

2.2.6 The meeting noted that much progress was related to development of a new Sea Ice Mapping System (SIMS). The NIC has fully integrated the SIPAS ice analysis system into the operations environment. A new dissemination system and World Wide Web page featuring the ability for users to define their own shape-file based analysis charts is being rolled out during the spring of 2004.

2.2.7 The meeting noted with interest and appreciation the information on the Polar Ice Prediction System (PIPS 3.0), which will be based on a global ocean model and a sea ice model (C-ICE) developed at Los Alamos National Laboratory. PIPS 3.0 will use data assimilation routines developed at the Naval Postgraduate School. Output products will include ice drift, concentration, stage of development and a prediction of convergence and divergence areas within the pack ice.

*Report of the Canadian Ice Service*

2.2.8 Mr J.Falkingham presented information on the Canadian Ice Service (CIS) activities. The meeting noted with interest that CIS provides information about floating ice in the major navigable waters of the Canadian economic zone for the present, the future and the past. This information is intended to meet two main objectives: to ensure the safety of Canadians, their property and their environment by warning them of hazardous ice conditions; and to provide present and future generations of Canadians with a knowledge of their ice environment sufficient to support environmental science and the development of informed policies. The CIS works with the international community to foster a global awareness of floating ice for operational and scientific purposes.

2.2.9 Throughout the intersessional period, the CIS provided operational ice information on a 7-day-a-week basis throughout the year. In 2003, the CIS began issuing ice charts in the new colour codes being proposed to JCOMM for adoption as the international standard.

2.2.10 The meeting noted that the CIS continued to deliver a service to provide Arctic communities with information regarding the position and condition of local "floe edges" which are important hunting and social gathering places. The CIS also monitors the ice cover on 134 inland lakes using satellite data for numerical weather prediction. The Canadian Meteorological Center reports that this information has made a noticeable improvement in weather forecasts over Canada.

2.2.11 The meeting was informed that the CIS relies on a mix of satellite, aircraft and surface observations. It was noted that Canada is one the last countries to operate air reconnaissance routinely. The most important single data source is the Radarsat satellite from which about 4000 images are acquired annually; AVHRR optical imagery from US satellites is of almost equal importance despite their vulnerability to cloud cover; MODIS and OLS provide additional optical information; SSM-I and QuikSCAT data provide useful background information but have limited resolution.

2.2.12 Mr Falkingham then informed that the CIS ice reconnaissance aircraft is an important source of tactical data in direct support of navigation as well as "ground truth" for satellite data. However, the future of the programme is in some doubt because of its high cost. The Side-Looking Airborne Radar (real aperture) that the aircraft has regularly used was not operated during the winter of 2003-04 because it was too expensive to maintain. A decision on the future of the aircraft is to be made in the very near future along with a decision to replace the SLAR with a modern radar.

2.2.13 The meeting noted that substantial progress had been made in training in the science of ice analysis and forecasting. CIS has continued to develop its "Ice University" concept in which experts in various topics deliver ½ day modules on various science topics for delivery to all analysis and forecasting staff. CIS is in the process of hiring two new ice forecasters and six new Ice Service Specialists to fill vacancies and in anticipation of impending retirements

2.2.14 Over the intersessional period, CIS has continued assessing the capabilities and limitations of space-borne SAR for detecting icebergs as part of a national iceberg monitoring programme. In preparation for the availability of data from advanced SAR satellites the CIS has been involved in a number of projects focused on assessing the potential and application of multiple polarization and polarimetric SAR data for operational sea ice monitoring. In March of 2003 and February of 2004, supported by funding from the CSA, the CIS carried out field programmes focused on field validation airborne polarimetric data (2003) and Alternating Polarization ENVISAT ASAR data (2004).

2.2.15 In September 2003, the first Canadian icebreaker dedicated to scientific activities embarked on its first mission. The CCGS Amundsen departed Quebec City and transited the Northwest Passage to conduct oceanographic studies in the Southern Beaufort Sea as part of the Canadian

Arctic Shelf Exchange Study (CASES). The ship froze into the ice in Amundsen Gulf and is currently overwintering. Science teams conducting a wide variety of experiments are cycled through the ship about every six weeks. CCGS Amundsen plans to break out the ice in May 2004 and conduct more oceanographic work during the summer before returning to Quebec.

2.2.15 The meeting noted with considerable interest CIS international activities in the field of sea ice development, including the close long-standing collaboration between the CIS and the US NIC. The ice information programme for the Great Lakes is now operated jointly by the two services. It is planned to create a North American Ice Service that will eventually encompass integrated databases, joint product preparation and a single window of access to North American ice information products. Starting in 2004, the NIC charts for the Canadian Arctic will be "cut and paste" directly from the CIS charts for the same area. This will allow NIC analysis to spend more time on other parts of the world.

*Report of the Japan Meteorological Agency*

2.2.16 the meeting considered a report presented by V. Smolyanitsky, on behalf of Mr T. Matsumoto, on sea ice activities provided by the Japan Meteorological Agency (JMA). JMA provides a close analysis and monitoring of sea ice in the Sea of Okhotsk twice per week from November to July. The global sea ice analysis is performed automatically using DMSP/SSM/I data; results of analysis from 2003/2004 are planned to feed JMA's Numerical Weather Prediction and Climate Prediction Models. Other satellite data include GMS, NOAA (AVHRR, AMSU-B), QuikSCAT, RADARSAT (1-2 times per week since March 2003) and Aqua/AMSR-E (daily since November 2003). In addition, JMA continues to acquire observations data and charts from Japan Coast Guard and Japan Self-Defence Forces and coastal RADAR data from Hokkaido University. Main operational products include ice conditions charts in the Sea of Okhotsk issued daily from December to May and one-week numerical prediction ice forecast charts for the Southern part of the Sea of Okhotsk and neighbouring sea. The operational products have been available at NEAR-GOOS Regional Real Time Data Base since December 2003.

*Report from the Argentinean Naval Hydrographic Service*

2.2.17 The representative of Argentina with the ETSI, Mr M. Picasso, from the Naval Hydrographic Service introduced a report on sea ice activities in Antarctic areas. It was considered that the Glaciological Division of the Argentine Navy Meteorological Service (SMARA), at the Naval Hydrographic Service (SHN), is the head office responsible for operational sea ice support in the Southern Atlantic and Pacific oceans, including Antarctic seas from 00 to 130 W. All activities are focused mainly to operational support and planning information on icebergs and sea ice conditions in these areas.

2.2.18 The session considered that sea ice and iceberg observations from Argentinian coastal stations and ships are made through code messages as a permanent cooperative effort between SMARA's Glaciological Division and the Argentinian National Meteorological Service. The observational frequency under normal conditions is twice a week for coastal stations during freezing months and twice a week during melting season. The observations from ships are made every six hours. Messages are transmitted in real time to the National Ice Center (NIC) and afterwards sent to the National Snow and Ice Data Center (NSIDC) and Arctic and Antarctic Research Institute (AARI) after being validated through sanity (characters and physical parameters) checks. Archives of historic observations are available through SMARA and through the SHN Argentine Centre of Oceanographic Data (CEADO, acronym for the Spanish letters).

2.2.19 M. Picasso informed the session that the SMARA continued the Antarctic Navigation Course to instruct the Argentinian Antarctic personnel and professional sailors on sea ice and icebergs recognition. By now 559 observers from different Argentinian institutions attended the course.



2.2.20 Participants were informed that the Spanish version of the WMO Sea Ice Nomenclature was revised and submitted to the session for adoption to be published by WMO Secretariat as an official document.

*Report from the Swedish Meteorological and Hydrological Institute*

2.2.21 The meeting noted with interest Mr Grafström's report, which was presented on his behalf by K. Strübing, regarding the present and future status of Swedish Meteorological and Hydrological Institute (SMHI) development of sea ice activities in the Baltic Sea area. He stressed that SMHI is responsible for mapping and forecasting of sea ice and surface temperature in the Baltic region. Daily ice charts have been produced since 1957 during wintertime, the approximate period being 20 November – 20 May. Sea surface temperature charts are produced twice a week also during the mentioned part of the year. The main user of operational ice information is the Swedish Maritime Administration, Icebreaking Department. Daily ice charts and ice forecasts up to 10 days ahead are transmitted to icebreakers. Other users of ice charts are merchant vessels, shipping agencies, shipbrokers and pilot stations.

2.2.22 The main data source is remote sensing from DSMP/NOAA satellites and RADARSAT. Additional information on ice concentration/thickness and floe size are received in real time from icebreakers, vessels, and pilot stations and ice observers along the coast. The meeting noted with appreciation that according to the WMO request, SMHI developed broadcasting sea ice reports for the Baltic area via the NAVTEX system transmission stations and can be received onboard all suitably equipped vessels.

2.2.23 The SMHI is involved in several projects and groups, with focus on improving services and products by means of international cooperation, i.e. participating in groups such as the International Sea Ice Working Group and the Baltic Sea Ice Meeting. The institute currently participates in sea ice-related programmes financed by the European Union (IRIS), by EUMESAT (OSI-SAF, Ocean and Sea Ice Satellite Application Facility) and by ESA (ICEMON). Furthermore, SMHI is involved in the HIROMB cooperation, offering expertise and hosting computer facilities for an operational, high-resolution ocean model for the Baltic Sea and surrounding waters.

*Report from the Icelandic Meteorological Office*

2.2.24 The expert from the Icelandic Meteorological Office (IMO) Dr Jakobsson presented information on IMO sea ice activities in areas of the Icelandic waters. The meeting noted with interest that main sea ice activities at IMO concentrate on providing service to users operating in waters around Iceland.

2.2.25 The session was informed that sea ice information was received from trawlers, weather observers and from the Icelandic Coast Guard which provided detailed ice charts resulting from sea ice reconnaissance flights along the ice edge area in the Denmark Strait and the Iceland Sea and flights closer to the land during times of extensive sea ice with some ice reaching into bays and fjords. In the future, some limited use can be made of satellite imagery received by APT antenna at IMO.

2.2.26 The meeting noted further that all information output is provided to users at sea by the radio, NAVTEX, and IMO Web site. Available information on sea ice is published in annual reports. Gaps in the publication series have been filled thus making the series continuous from 1968 to 1996.

2.2.27 The meeting was informed that the IMO participated in the European science project Integrated Weather, Sea Ice and Ocean Service System (IWICOS), which was completed in the beginning of 2003. Useful experiments of information exchange between ships in Icelandic waters and IMO were performed. The IMO also participated in the EUMETSAT project, directed by the Norwegian Meteorological Institute. The project had started the development of Satellite Application Facilities (SAF) as being distributed as part of its Application Ground Segment, to process the data from its future satellites, namely MSG and EPS-METOP. The Icelandic Ministry

for Foreign Affairs together with Dr Thor Eduard Jakobsson established a working group to study various aspects of traffic increase in the Arctic and in particular along the Northern Sea Route. It has been pointed out that possibilities as well as environmental concerns following a future opening of Arctic Sea Routes in the coming decades should be considered by Icelandic authorities, due to the geographical location of the country in the middle of the North Atlantic Ocean.

*Report from the Danish Meteorological Institute*

2.2.28 The representative of Denmark with the ETSI, Dr H. Andersen, submitted a report to the meeting and informed that the purpose of the Danish Meteorological Institute (DMI) and Greenland Ice Service (GIS) is to aid navigation and provide tactical and strategic support to the shipping community. The service provided by DMI and GIS has been subject to substantial changes over the past two years. Images supplied by the two SAR satellite platforms, e.g. RADARSAT and ENVISAT, now constitute the most important source of information for the ice service production of navigational ice charts. A robust and fully automatic ingest and processing system has been implemented to make available SAR images from RADARSAT and ENVISAT in near real time for the ice analysts.

2.2.29 The meeting noted with appreciation information on research programmes developed by DMI. Research and quality assurance projects have been conducted to optimize the use of SAR data and to increase customer satisfaction. Combined use of satellite observations and oceanographic models would certainly support this goal. To investigate this possibility the DMI has been running and testing an experimental sea ice drift model for the Cape Farewell area for the last three years.

2.2.30 The DMI is deeply involved in the international cooperation with the aim of improving cooperation, services and products. It is actively involved in the IICWG, JCOMM ETSI, several sea ice related research programmes, financed by the European 5<sup>th</sup> framework programme and in Satellite Application Facilities, financed through EUMETSAT.

2.2.31 The session noted that since the introduction of SAR satellite based ice charting in 1999 training of ice analysts has been improved and adjusted to the specific needs of the Greenland Ice Service. A significant amount of training material has been compiled and valuable material has been made available by other ice services through international cooperation. This has helped to make the training more effective and to decrease the amount of time needed to perform the training. As a consequence, the Greenland Ice Service has been able to support and train personnel from the Norwegian Meteorological Institute to enable them to use SAR imagery for ice charting around Svalbard.

*Report from Bundesamt für Seeschifffahrt und Hydrographie*

2.2.32 The session reviewed the report submitted by Mr Klaus Strübing on sea ice activities in Germany and noted with interest that the sea ice service at the Bundesamt für Seeschifffahrt und Hydrographie (BSH) is mainly responsible for ice observations in German waters and regular reporting on and mapping the ice conditions in the area of the Baltic Sea and the coastal areas of the eastern North Sea. Daily ice reports and ice charts have been produced during the winter ice season, i.e. approximately from the end of November to the end of May. Weekly sea surface temperature charts for the North and Baltic Seas are provided by another BSH unit during the whole year. The ice observations from the German coast are stored in a special ice data bank, and allow statistical evaluation of the development of ice conditions with a time series of more than 100 years long. An ice chart data bank covers the ice conditions of the sea area in the region of the western Baltic Sea.

2.2.33 The BSH routinely uses an in-house developed operational model system to support maritime shipping, and to monitor and study the marine environment. The model system, which has been operated for quite a number of years now, comprises several computer programmes producing data in a daily operational programme routine without any manual intervention.

2.2.34 The session noted with appreciation that the Baltic Sea Ice Services have a long-standing collaboration. Its improvement is a continuous process within the activities of the Baltic Sea ice Meeting (BSIM), which has a more than 75 years tradition. With respect to modern communication links the intention is to more and more harmonize products in order to save manpower and reduce the duplication of effort (details are presented in the BSIM Report). GIS has been active in the International Ice Charting Working Group that has now held four annual meetings, actively contributing to several scientific and operational action items.

*Report from the Chinese National Marine Environment Forecast Centre*

2.2.35 The meeting was informed on sea ice major development, including the Chinese Arctic expeditions in 2002-2004 operated by the National Marine Environment Forecast Center (NMEFC). Information was presented by V.Smolyanitsky, on behalf of representative from China. It was considered with interest that operational sea ice forecasts were developed with using of the PIC model for option ice service, MCC method for the Bohai Sea and monitoring sea ice conditions with help of MODIS images and data from the First Oceanic Satellite HY-1A.

2.2.36 The meeting noted with interest that the first oceanic satellite HY-1 was launched successfully in May 2002, which is an experimental operational one with a design life of 2 years. The sea ice images retrieved from HY-1A were applied on monitoring and numerical forecasting at the Bohai Sea during the winters of 2002 and 2003. The sea ice retrieve system for the HY-1A has been constructed in NMEFC. It receives the 1B data from the satellite and outputs sea ice images and various kinds of numeric products including ice concentration, ice thickness and ice edge.

*Report from the Russian Ice Service*

2.2.37 The information on the developments of operational sea ice activities of the Arctic and Antarctic Research Institute (Russia) was presented by V. Smolyanitsky. The meeting noted that sea-ice information services in Russia are provided with ice information by the centre at the Arctic and Antarctic Research Institute in St Petersburg (AARI), as well as by the Hydro-Meteorological Centre in Moscow (Hydrometcentre) and regional hydrometeorological offices in the Arctic, Far East and Baltic countries. AARI provides services mainly for shipping, coastal and harbour activities within the Northern Sea Route, for the Central Arctic Basin and Arctic seas as well as for the seas with the seasonal ice cover and for Antarctic areas.

2.2.38 The meeting considered that Russian operational centres continue extensive use of all available real-time and delayed mode visual and IR imagery from NOAA, METEOR and Terra/Aqua satellites thus minimizing gaps in coverage of frequently obscured by clouds polar regions. Daily ice observations on basic sea ice parameters from the coastal weather polar stations of Roshydromet along with routine icebreakers' reports and WMO GTS GRID and GRIB data complement satellite imagery and serve as ground real information. In cases of support for commercial activities in shelf zones of the Arctic and Far East seas and extreme cases operational SAR data from Radarsat is commercially acquired and included into data flow. Ground-truth and remotely sensed data are directly interpreted into various scale ice charts and feed ice blocks of coupled numerical models. Ice products are issued in various formats including plain language, WMO SIGRID code, colour code and ESRI vector shape file format. Starting from 2003 a variety of marine meteorological products is also available within the Russian Unified System Information on the World Ocean Conditions (ECIMO).

2.2.39 Participants of the meeting noted with interest that in 2003-2004 AARI provided logistics for a renewed break activity "North Pole 32" drifting station (active during 16.04.2003-6.03.2004). A special web page (<http://www.aari.nw.ru/clgmi/np32>) provided online access to daily meteorological and ice drift data from the station. Logistics for the next drifting station "North Pole – 33" is currently under development.

### *Report from the British Antarctic Survey*

2.2.40 The meeting noted with interest and appreciation the report presented by a new ETSI member, Dr J. Shanklin, on sea ice activities operated in the United Kingdom. Dr Shanklin informed that the UK operates three ice-strengthened vessels in Antarctic waters, mostly in the Southern Ocean, Bellingshausen Sea and Weddell Sea. From time to time these may also work in the Arctic.

2.2.41 The two Royal Research Ships make simple observations of sea-ice and icebergs during their voyages. Charts of pack ice encountered on the voyage are prepared and these are stored in the British Antarctic Survey (BAS) archives in Cambridge. Reports of icebergs are made for the Norwegian iceberg-monitoring programme. Rothera station makes a daily sea ice observation and elements of this are reported as an ICE group in synoptic format at 18:00 UT. Rothera and Halley stations make occasional reports in ICEAN code to the US NIC. There is an automatic digital camera at Signy station to record the development of sea ice in the local area for biological studies.

2.2.42 In the light of operational support, it was mentioned that several sea-ice products are supplied to the BAS ships by email from Cambridge. These include ice charts from the US NIC, ice charts from the US FNMOC and ice charts from the German BSH. Real time imagery is provided by HRPT receivers on board the ships and at Rothera station in Antarctica. MODIS images may also be accessed over the Internet. The BAS Twin Otter aircraft are used when required as spotter planes to assess routes through sea-ice and to locate possible areas for working cargo. From 2005 the ships should be able to access products directly on the Internet.

2.2.43 BAS is working on improved representation of sea-ice in the Hadley Centre climate model. Other groups in BAS are interested in both current and archival sea ice observations in connection with studies of atmospheric chemistry and paleo ice extent. In the former context knowledge about the presence of frost flowers is important. This term appears to be absent in the WMO nomenclature. In future research groups will be involved in studies using the Cryosat satellite. One of the BAS aircraft will be instrumented for airborne study of sea-ice.

2.2.44 The meeting noted all information presented by the ETSI members with considerable interest, and agreed that they provided an excellent framework and overall objectives for its own work during the intersessional period.

### **2.3 Report of the BSIS**

2.3.1 The meeting further reviewed the activities of the Baltic Sea Ice System (BSIS) submitted by its chairman, Mr K. Strübing. It was noted that eleven Baltic countries (Denmark, Estonia, Finland, Germany, Latvia, Lithuania, Netherlands, Norway, Poland, Russia and Sweden) within the BSIS successfully cooperate in compilation and relay to end-users of sea ice information, in maintaining common ice terminology and joint ice model to develop an integrated sea ice information and navigation support system.

2.3.2 K. Strübing informed the meeting that the last BSIM-21 session was hosted by the Finish Institute of Marine Research, from 9 to 13 June 2003 in Helsinki. Experts representing national sea-ice and icebreaking services of all countries bordering the Baltic Sea, together with the Netherlands, and WMO representative, attended. National Ice Services of these countries have been providing ice information for many years, with the first such meeting taking place in 1925.

2.3.3 The main topics for discussion during the ETSI session included problems related to the development of colour standards for regional ice charts, formats and codes for operational ice-data exchange, digital sea-ice data banks, remote-sensing methods, and international operational activities coordinated by a number of different WMO bodies, such as the JCOMM ETSI, The Steering Group for the GDSIDB, and International Arctic and Antarctic Buoy Programmes, which are Action Groups of the DBCP Panel.

2.3.4 The meeting reviewed seasonal ice cover, which can extend over the whole region of the Baltic Sea and the South-Eastern North Sea, intensive shipping activities of up to 30,000 vessels during an ice season, and economic requirements requiring professional ice information and icebreaker services for the whole region.

2.3.5 The meeting was informed that ice observations were performed and exchanged daily via the GTS among all services, according to the standards of the Baltic Sea Ice Code (from 1980). Products are available on the Internet. Up to now, close bilateral cooperation between Finland and Sweden, Finland and Russia, Denmark and Germany, Germany and the Netherlands has been improving services for the public. A joint Web-page for the BSIS was developed and established as an independent domain ([www.bsis-ice.de](http://www.bsis-ice.de)).

## **2.4 Report of the IICWG**

2.4.1 The representative of the International Ice Charting Working Group (IICWG) Mr P.Seymour submitted a report on its activities, which includes development of: data and product exchange, terminology, data and mapping standards, operations and customer support, training, applied science, research and development. It was recognized that there is value in "cooperative activities in operational ice services supporting maritime navigation." The session noted some results of the IICWG activities developed during the intersessional period, since the 4th meeting of the group, which was held at the Arctic and Antarctic Research Institute (AARI) in St Petersburg, Russia from 7-11 April 2003. The major themes and discussion areas from the working group were:

Session on Global Monitoring for Environment and Security (GMES) Project Introduction;

Session on ECDIS - Practical results in sea ice and meteorological layers integration with navigation charts and restrictions in current version of S-57 format;

Demonstrations from ECDIS vendors;

Icebreaker Captains Session: Informational report from NW ROSHYDROMET on Administration on ice practices in Baltic waters during winter 2002/2003;

- (i) Greetings from the Northern Sea Route Administration (Moscow) and St Petersburg port authority.

2.4.2 The next meeting will be held in April 2004 in Hamburg, Germany, the week after this meeting.

2.4.3 The session appreciated the important work being undertaken by regional and international bodies, such as the BSIM and the IICWG. It agreed that future collaboration should be continued between the ETSI and these groups, and requested the chairperson of the ETSI and the Secretariats to arrange for such collaboration, as appropriate. **(Action: Chairmen ETSI, BSIM, IICWG; Secretariat)**

## **2.5 WMO Sea ice documents and publications**

### *Sea ice nomenclature*

2.5.1 The session reviewed and commented on a draft of a new French (**Annex IV**) and Spanish (**Annex V**) versions of the WMO Sea Ice Nomenclature prepared by experts from Canada and Argentina. It was recommended to implement appropriate changes in the nomenclature in order to use it as official French and Spanish versions of the WMO document on sea ice symbols and glossary. **(Action: Secretariat, Chairman)**

2.5.2 The meeting agreed that a new term "median ice edge" is to be included in the WMO Sea Ice Nomenclature as Term 4.4.8.5 "Median ice edge: Median (50% occurrence) position of the ice

edge in any period based on a sufficient number of observations", so that Term 4.4.8.4 be extended by the word "median" and the WMO number of term "Fast-ice edge" be changed to 4.4.8.6. **(Action: Chairman, Secretariat)**

2.5.3 The session discussed the proposal from Mr J. Shanklin to include a new definition on "frost flowers", which coincides with the term of the Russian national Nomenclature, and proposed at CMM in 1980. It was agreed that this term be included in the updated version of the Nomenclature. **(Action: Chairman)**

2.5.4 Dr V. Smolyanitsky presented a draft English/French/Russian/Spanish electronic version of the WMO Sea Ice Nomenclature, which is located on Internet at GDSIDB AARI web-site (<http://www.aari.nw.ru/gdsidb/XML/nomenclature.asp>). Developed software makes it possible for a user to browse ice terms in various ways, including alphabetical order, subject etc. The meeting recommended to submit the database and software to the Secretariat to be approved. **(Action: Chairman, Secretariat)**

2.5.5 The session noted with appreciation a draft of a new updated version of the WMO Sea Ice Nomenclature (**Annex VI**) with a new extended version of the WMO glossary on sea ice cover (**Annex VII**), prepared by experts from the AARI. The proposed versions will be used as a source to revise and update the WMO publication No. 259. The following actions were proposed for implementing the revision of the document:

- (i) to prepare an electronic version of the documents to facilitate comparison of the old and new documents **(Action: AARI, May 2004)**;
- (ii) to conduct a review of the nomenclature section by section by correspondence **(Action: Members, Chairman)**;
- (iii) to submit a report on the progress of the review to JCOMM-II **(Action: Chairman, Secretariat, JCOMM-II)**;
- (iv) to continue development for discussion in a final form at ETSI-III **(Action: Chairman, Members, and ETSI-III)**.

2.5.6 It is intended that the final version of the Nomenclature be an ETSI contribution to the IPY.

2.5.7 It was agreed that ETSI would also start to work on a new version of the Illustrated Glossary of Sea Ice Terms as part of the updated Nomenclature. **(Action: Chairman, Members, ASAP)**

2.5.8 The Meeting also proposed to revise (once per year) WMO publication No. 547 "Sea-Ice Information in the World" to be published in electronic form in the JCOMM Technical Report Series. **(Action: Chairman, Members, Secretariat)**

#### *Colour standard for ice charts*

2.5.9 The meeting was presented with the information on a final version of the Ice Chart Colour Code Standard to be used as an international code. **(Annex VIII)**

2.5.10 The meeting noted that proposals for colour coding of ice charts have been discussed since the 1950s but these proposals were used only by a few national sea ice services. However, the recent widespread use of electronic products and navigational information systems requires ice services to change their approach. The IICWG experts in collaboration with ETSI succeeded in preparation of a colour standard which includes, according to the decisions of the third IICWG meeting, two mutually exclusive separate colour codes, one based on a total concentration and another based on a stage of development. Proposed codes are complementary to the existing WMO black and white ice symbols and are flexible in use. Experts from ice services participating

in IICWG since 2002 started to produce ice charts according to the proposed standard. In 2003 IICWG and ETSI experts finalized this standard and submitted it to the WMO Secretariat for publication before the session.

#### *Ice decay/stages of melting*

2.5.11 The session reviewed the comprehensive report prepared by experts from Canada on the results of research, undertaken by the Canadian Ice Service experts, under the Arctic Sea Ice Shipping System (AIRSS), to identify ice decay and the associated strength of the ice with the help of radar backscatter (**Annexes IX, X**). Over the past intersessional period, it was determined that radar alone cannot provide unambiguous indications of the strength of the ice. However, field experiments have shown that there is a consistent relationship between the temperature of the ice and the state of surface melting and the internal strength of the ice.

2.5.12 The meeting noted with appreciation that the following papers were prepared by the experts from Canada in response to the mentioned problems:

- (i) M. Johnston, R. Frederking and G. Timco; *Property Changes of First Year Ice and Old Ice during Summer Melt*; National Research Council of Canada Technical Report HYD-TR-010; March 2003.
- (ii) G.W. Timco et al.; *Data Collection Program on Ice Regimes*; National Research Council of Canada; March 2003.

2.5.13 On the basis of this and ongoing research, amendments to the nomenclature for coding sea ice are being developed. It was noted that initial review of the draft new WMO Sea Ice Nomenclature proposed by A. Bushuev indicates (Agenda item 2.5.5) that there is sufficient scope within the proposed nomenclature to incorporate the Canadian work.

2.5.14 The CIS proposed that this work on Ice Decay/Stages of Melting be dropped as a separate work topic for future ETSI meetings, and be incorporated into the work on the new Sea Ice Nomenclature (**Action: Chairman, J. Falkingham**).

#### *Status of formats for operational and historical sea ice data exchange*

2.5.15 The meeting noted with appreciation that a new format for operational and historical sea ice data exchange was finalized by IICWG experts in close cooperation with ETSI. During 2003, the new format was successfully tested and applied for archival purposes by the GDSIDB centre at NSIDC. The document was submitted to the WMO Secretariat the end of 2003 and is now in the process of printed.

## **2.6 ETSI future activities and working plan for the next intersessional period**

2.6.1 The session was introduced to a document containing a detailed work plan for the Expert Team on Sea Ice for the next intersessional period. The meeting reviewed, corrected and adopted this plan. The meeting noted that ETSI future tasks will include review and advice on scientific, technical and operational aspects of sea ice observations and forecasting, coordination of service development, training and cooperation with international programmes. The final version of the agreed strategy and work plan are reproduced in **Annex XI**.

2.6.2 Recognizing the likelihood of increased economic activities in the Arctic in the future, the ETSI underlines the importance of sea ice services, standards, observations and data. In this respect, the scope of ETSI activities may expand in the future. Some of aspects of future ETSI activities were also discussed and adopted under item 4.

## **3. TENTH SESSION OF THE STEERING GROUP FOR THE GDSIDB**

*Reports of the GDSIDB centres*

3.1 The meeting noted the progress achieved by the Steering Group (SG) for the GDSIDB. It was informed that the fourteenth WMO Congress recognized the ongoing importance of sea ice and it noted with appreciation that the JCOMM ETSI and Steering Group of the GDSIDB were fully operational. The Congress expressed its appreciation to all countries, agencies and institutions involved in the operation of these programmes.

3.2 The meeting was presented with reports by experts from two GDSIDB centres at the Arctic and Antarctic Research Institute (AARI, St Petersburg; Russian Federation, and the USA National Snow and Ice Data Centre (NSIDC, Boulder, CO, USA) on the status of these centres' activities during the intersessional period, since the previous meeting in Buenos Aires, Argentina in October 2002, including contributions of sea ice data sets to the bank from Member States, development of formats, archiving processes, and project visibility. Experts of the steering group for the GDSIDB, co-chaired by Professor Roger Barry from the WDC for Glaciology, Boulder, and Dr Ivan Frolov from AARI, continue to provide QC and software support for archived data for the support of climate oriented programmes.

3.3 Professor Barry informed the session on activities of NSIDC. The session noted that advances in national services included the advent of sea ice products from NASA Earth Observing System instruments, which included the Moderate Resolution Imaging Spectroradiometer (MODIS) providing global ice extent and ice surface temperature and the Advanced Microwave Scanning Radiometer – Earth Observing System (AMSR-E), which provides sea ice concentration (as daily averages) and snow depth over sea ice (as a five-day running average). The meeting was informed that a new Internet resource is the Sea Ice Index ([http://nsidc.org/data/seaiice\\_index/](http://nsidc.org/data/seaiice_index/)), a web site that was useful in monitoring and diagnosing the record setting 2002 summer arctic sea ice extent minimum, and similarly low 2003 summer minimum. The site makes images of ice extent, concentration, anomalies, and trends readily available.

3.4 Following a nationwide trend, NSIDC is moving to make more products GIS compatible. One example is assisting in the implementation of SIGRID-3, a GIS compatible archive and exchange format for GDSIDB chart data.

3.5 Concerning the international activities Professor Barry informed the Meeting that he attended a workshop in Boulder in August 2002 on the Adequacy of the Global Observing Systems for Climate. He assisted Dr Alan Clarke with the preparation of an entry on "Sea Ice" in the GCOS-82 Technical Supplement (see: <http://www.wmo.ch/web/gcos/gcoshome.html>). To ensure those future assessments of the accuracy of sea ice observations for GCOS are complete and accurate, the ETSI requests WMO to ensure close coordination between ETSI and GOOS with respect to sea ice observations. It was agreed that ETSI should be designated the responsible body for information and assessment of sea ice as an Essential Climate Variable (ECV). (Action: R. Barry, Chairman, Secretariat)

3.6 In addition, the session noted that moored upward looking sonar data provided important information on ice thickness distributions. In cooperation with the Alfred Wegener Institute for Polar and Marine Research, Bremerhaven, Germany, NSIDC has published Upward Looking Sonar (ULS) data from 14 stations in the Weddell Sea, 1990-1998, and will publish additional AWI data from the Fram Strait in 2004.

3.7 The session noted the report submitted by the AARI expert, V. Smolyanitsky. AARI, as one of the GDSIDB centres, continued to support the project during the intersessional period. Experts of the Steering Group for the project, provided resources to maintain and extend archived data and enhance processing technique for the benefit of climate oriented programmes. GDSIDB pages at AARI (<http://www.aari.nw.ru/gdsidb>) provide access to project information and data.



3.8 The session noted that historical ice charts in SIGRID format (WMO, 1989) continue to predominate in the project archives. AARI ice charts for the Eurasian Arctic, presently starting in 1950, comprise the longest temporal series, CIS ice charts for Canadian Arctic being the second longest one, while NIC ice charts provide the unique global view. JMA continues to provide information in SIGRID-2 format (WMO, 1994), which is translated into SIGRID at AARI. JMA charts are stored in both formats. Other formats include NSIDC Ease-Grid (mainly for derived climatic products), ESRI shapefile (for operative data) and new SIGRID-3 (sample ice charts). During 2002-2004 AARI weekly ice charts for the Eurasian Arctic extended the project database in SIGRID format. Prime source for AARI weekly ice charts covering Atlantic and Eurasian Arctic from the Greenland to Chukchi seas are regional 3-7 day ice charts for separate seas which in turn are compiled on a basis of extensive use of all available factual information, commonly Meteor and NOAA visible and IR imagery fused in GIS.

3.9 Presently the GDSIDB at AARI holds 7 or 10-day period mapped ice data for the Arctic starting from March 1950 and for the Antarctic from January 1973 and to near the present for both regions. There are a number of gaps in factual data: temporal (mostly in winter time) and spatial (mostly outside navigable areas like Eastern passage/Northern Sea Route or Western passage). From the 1970s GDSIDB ice charts may serve as a ground-truth to SSM/I products (as it is based on comprehensive usage of all available sources of ice information and expert knowledge) or be the unique source of ice conditions and climate for the earlier than 1978 period. Ice charts from the separate ice services have different temporal attributes (starting moment, validity period) and in a number of cases overlap each other, so blending of individual data sets enhances usage of the data. During 2002-2003 the first blending technique for Northern hemisphere GDSIDB charts was developed and implemented at AARI.

3.10 The meeting noted that the output contains total concentration values with 1% steps and corresponding flags of origin for each value. The resulting blended data set (<http://www.aari.nw.ru/gdsidb/blended/>) presently contains the greatest amount of ice data for 1950-1998. ETSI considers that this blended data set represents the best assessment of ice conditions in the Arctic during the corresponding period, based on the data available, and recommends its adoption in reanalysis and assessment activities. The product will be extended, as new data becomes available (**Action: GDSIDB co-chairs, AARI centre, continuously**).

#### *Development of sea ice historical data processing*

3.11 The meeting was provided with separate overview reports of GDSIDB members on sea ice historical data processing maintained in their services, including preparation of historical archives on the basis of operational sea ice products, QC, climate data applied in operational practice, requests from the users for historical ice products, etc.

3.12 The session noted with interest that the National Ice Center is completing work on the project to provide the GDSIDB a complete set of sea ice data for the years of 1972 through the present with the addition of the data sets from 1995 - 2003. The re-analysis and quality control work is now complete on all Arctic data sets with the exception of the year 1997 and very few charts from 2001. Arctic and Antarctic Hemispheric Analyses and Great Lakes Analyses are now being delivered to NSIDC in the proposed SIGRID-3 format for evaluation and testing. The work started by the NIC and the University of Delaware to complete digitization of the 1995-2001 Antarctic charts is near completion. Quality control work has been completed on 1998 and 2001.

3.13 It was noted with appreciation that CIS prepared the following data for archive at GDSIDB: digital regional charts in .e00 vector format for Canadian Arctic and has been working on implementing operational production of charts in Sigrid-3 format. In the future CIS will use the new Sigrid-3 shapefile format for submission of its regional charts collection to GDSIDB. CIS will also work on converting all of its older charts to Sigrid-3 for resubmission to GDSIDB. In addition to the main CIS collection, CIS proposes to provide scanned copies of its historical charts, including weekly regional charts, daily analysis and observational charts starting from 1956 in GIF format (**Action: CIS**).

#### *Submission of new sea ice data to the GDSIDB*

3.14 The session recognized the contributions, which DMI prepared to the GDSIDB as weekly ice charts covering the Greenland area for 2002 and 2003. These charts are available in the new SIGRID-3 format.

3.15 The meeting was informed that the project on digitizing the sea ice data from Swedish ice charts (1980 to present) is almost finalized. Sea ice data have to be quality checked and transformed into the new SIGRID-3 format. This is planned to be done during the second part of 2004 and data then will be transferred to the GDSIDB (**Action: SMHI**).

3.16 The session noted that the Glaciological Division of SMARA provided sea ice observations (under code messages IILL and IISS) for 2002, 2003 and available 2004 sea ice data to GDSIDB's centres in NSIDC and AARI. As before, messages from five Argentinian coastal stations and the icebreaker A.A.A. "ALMIRANTE IRIZAR" were sent to these centres.

#### *New contribution to the GDSIDB from the Member States*

3.17 The session received detailed information from the US National Ice Center and the Canadian Ice Service on new sea ice data sets to be submitted to the GDSIDB during the next intersessional period.

#### *Working plan for the next intersessional period*

3.18 The session discussed and adopted a comprehensive work plan for the SG of the GDSIDB for the next intersessional period, which are included in the overall JCOMM work. It was noted that this work plan (**Annex XII**) would be implemented through the steering group, in close cooperation with the ETSI.

## **4. RELATIONS TO OTHER WMO/IOC AND INTERNATIONAL PROGRAMMES**

4.1 Under this item, the session was presented with the information that the Fourteenth World Meteorological Congress (May, 2003) had approved by Resolution 34 (Cg-XIV) on an International Polar Year 2007-2008 (IPY) and had requested EC-LVI to examine the preparation and implementation of the IPY in collaboration with other relevant international organizations. As follow up actions the Secretary-General established at the Secretariat an internal Steering Committee on the IPY, with a Task Team that developed a WMO proposal to an outline of science plan to be implemented as contributions of WMO Programmes to the IPY.

4.2 The recent session of the JCOMM Management Committee (Geneva, March 2004) stressed that JCOMM by its nature should play a substantial role in the planning and implementation of the IPY, in particular as a mechanism for the establishment of long-term measurement systems for observing in both Polar Regions. It was noted that sea ice products and services provided by JCOMM bring socio-economic benefits to communities in Polar Regions.

4.3 In view of this consideration and in the light of the presented information the meeting agreed the following:

- (i) Given the historical record of sea ice data in the GDSIDB centres, these centres will provide tailored information for the IPY. This may include dedicated IPY web pages linked to GDSIDB normals and ice records updated monthly such as the NSIDC Sea Ice Index, and national ice data that are available on a timely basis (**Action: GDSIDB co-chairs, GDSIDB centres, before IPY**);
- (ii) National Ice Services are encouraged to supply updates and historical documents to the GDSIDB centres. It is noted with appreciation that the NIC and CIS plan to

complete data processing up to 2004 by late 2005. BSIM, DMI and IMO intend to provide historical records. Time series of ice data from coastal stations will be valuable additions to the GDSIDB, where available (**Action: GDSIDB centres, CIS, DMI, IMO, NIC, before IPY**);

- (iii) As a new activity, ETSI requests its members to enhance sea ice observations and data archiving at the designated centres through: (a) filling gaps in the current Arctic and Antarctic buoy networks, beginning in 2006, (b) additional ULS deployment in both polar oceans and transfer of data already collected to the GDSIDB centre in NSIDC (**Action: GDSIDB centres, GDSIDB members, before IPY**).

4.4 The session welcomed the proposed installation by the Russian Federation of a drifting station in the Arctic Ocean within the IPY time frame and encouraged sea ice programmes be added where opportunities arise during ship or shore experiments during the IPY time frame.

4.5 The meeting then discussed the information provided by Mr P. Seymour from the NIC on problems concerning the future implementation of the US Interagency Arctic Buoy Programme (USIABP), which is the national contribution to the International Arctic Buoy Programme (IABP) of the DBCP. The funding for this interagency programme comes from several US agencies. However, due to tight fiscal constraints, the continuation of this programme is in jeopardy. It is critical that this programme be continued, as it currently is the only operational observing system for the Arctic Ocean.

4.6 Noting that weather and climate forecasts are sensitive to Arctic environmental change, the session recommended that the US focal point for the DBCP (Mr Eric A.Meindl, Chief, Project Planning and Integration National Data Buoy Center (NDBC/NWS/NOAA) address this problem at the forthcoming DBCP session in October 2004. (**Action: P. Seymour, Chairman**)

4.7 The meeting was informed that Electronic Navigation Charts (ENCs) are a subset of Electronic Chart Display and Information Systems (ECDIS). ENC standards are controlled by the International Hydrographic Organization (IHO). IHO has many committees and working groups to control the standards for navigation information. Since sea ice and icebergs are navigation hazards that are charted by national ice services, it is proposed that ice information be incorporated into ENCs under Register Structure and Registration Process for an IHO Object Register (**Annex XIII**).

4.8 The meeting recognized that the JCOMM ETSI, as the international body responsible for ice information standards, should established itself as the owner for the Ice Objects register and advise the TSMAD of an intention to adopt and control this register. In the light of these consideration Mr J. Falkingham and Mr M. Picasso agreed to contact IHO to inform of this intent and to get additional information for the future ETSI activities on the mentioned subject. (**Action: Chairman, J. Falkingham and M. Picasso**)

## **5. DATE AND PLACE OF THE NEXT MEETING**

5.1 The meeting agreed that it would need to meet again after the second session of the JCOMM-II (Halifax, Canada, October 2005). It suggested that ETSI and GDSIDB might be timed to take place in WMO Secretariat (Geneva) in late 2006. The chairman and Secretariat were requested to finalize arrangements for the timing and venue for the meeting in due course, and notify group members accordingly. (**Action: Secretariat, Chairman**)

## **6. CLOSURE OF THE MEETING**

6.1 The meeting reviewed and approved the final report of the meeting, including action items and recommendations.

6.2 In closing the meeting, the chairman thanked all participants for their valuable input to what had been a very productive meeting, and looked forward to working with ETSI and GDSIDB

members on the many ongoing action items during the remainder of the intersessional period. He also thanked the Secretariat for its continuing support and local organizer of the sessions, Mr Klaus Strübing, for providing stimulating working and weather conditions for the participants of the meeting.

6.3 The second session of the JCOMM Expert Team on Sea Ice and the tenth session of the Steering Group for the Global Digital Sea Ice Data Bank closed at 1500 hours on Saturday, 17 April 2004.

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## **AGENDA**

### **1. OPENING OF THE MEETING**

- 1.1 Opening
- 1.2 Adoption of the agenda
- 1.3 Working arrangements

### **2. SECOND SESSION OF THE JCOMM ETSI**

- 2.1 Report by the Chairman of the ETSI
- 2.2 Reports by the members of ETSI
- 2.3 BSIM report
- 2.4 IICWG report
- 2.5 WMO sea ice documents and publications
  - 2.5.1 Sea ice nomenclature
  - 2.5.2 Colour standard for ice charts
  - 2.5.3 Ice decay/stages of melting
- 2.6 Status of formats for operational and historical sea ice data exchange
- 2.7 ETSI future activities and working plan for the next intersessional period

### **3. TENTH SESSION OF THE STEERING GROUP FOR THE GDSIDB**

- 3.1 Reports of the GDSIDB centers
- 3.2 Development of sea ice historical data processing
- 3.3 Submission of new sea ice data to the GDSIDB
- 3.4 New Contributions to the GDSIDB from Member States
- 3.5 Working plan for the next intersessional period

### **4. RELATIONS TO OTHER WMO/IOC AND INTERNATIONAL PROGRAMMES**

### **5. DATE AND PLACE OF THE NEXT SESSION**

### **6. CLOSURE OF THE SESSION**

## EXPERT TEAM ON SEA ICE CHAIRMAN REPORT

### Introduction

1. The Expert Team on Sea Ice (ETSI) was formally constituted at JCOMM-I as a part of the JCOMM Services Programme Area (SPA). The initial work plan for the ETSI was developed at JCOMM-I and included in the JCOMM intersessional work programme. Mr Vasily Smolyanitsky was elected the chairman of the ETSI. The members of the ETSI presently comprise the chairman (and ex-officio member of the Team), ten experts representing the national services related to sea ice and the ice-covered regions from Argentina, Canada, China, Denmark, Germany, Iceland, Japan, Sweden, United Kingdom (appointed to ETSI in 2003) and USA, and invited representatives of regional and international sea ice bodies in particular the Global Digital Sea Ice Data Bank (GDSIDB) project, the Baltic Sea Ice Meeting (BSIM) and the International Ice Charting Working Group (IICWG). Personal presentations for Canada, Japan and the USA underwent changes during 2002-2004. In March 2004 Norway proposed an expert from the Norwegian Meteorological Institute to join ETSI.

### Strategy and workplan for the ETSI

2. The strategy and work plan firstly developed at JCOMM-I were revised and updated at the ad-hoc ETSI meeting during the 3rd meeting of the IICWG in November 2001 (Tromsø, Norway), during 2001 – 2002 by correspondence between ETSI members. In 2002 at the first meeting of SPA Coordination Group, they were reviewed and extended. Based upon the documents from the ad hoc ETSI meeting in 2001, a complete workplan and action items list for ETSI/GDSIDB intersessional period 2002-2004 were discussed and agreed at ETSI-I in 2002 and published in the final report of the session. The ETSI action list is given in Appendix A.

### Strategy

3. Similar to other bodies, ETSI should answer both general and specific strategic tasks:
- Provide advice to the Services CG and other Groups of JCOMM, as required on issues related to sea ice and the ice-covered regions;
  - Review and advise on scientific, technical and operational aspects of sea ice observations and forecasting, oversee operations of the GDSIDB, coordinate services development and training and linkages with major international programmes.

### Implementation of the work plan

4. ETSI activities on the topic comprised the work on:
- a) Further amendments to currently effective WMO Sea Ice Nomenclature (WMO publication No. 259);
  - b) Corrections to national English/French/Russian/Spanish equivalents in order to eliminate discrepancies in translations and make sure that equivalents factually used in operational practice;
  - c) Electronic XML version of Nomenclature aiming to facilitate further tetra-lingual comparisons and possible inclusion into the WMO Marine Glossary;
  - d) New draft(s) for WMO Sea Ice Nomenclature. It should be noted that further progress on the topic in 2004-2005 depends on what paradigm(s) will be chosen by ETSI – either continue to support older version of the document or switch to a modern one.
5. The ETSI-I session in 2002 approved several amendments to sea ice terms and symbol definitions published in the ETSI-I report. It is expected that there will be some more amendments



by 2004. In total it will comprise nearly 2 pages of amendments for Supplements 4 and 5 for WMO publication 259. Revision of Spanish/French versions provided in 2002-2004 by ice experts from Argentina and Canada showed the need of significantly more linguistic corrections. It is planned that ETSI-II will summarize these revisions for further formal approval by JCOMM. To facilitate the process of linguistic comparison and correction by the experts by February 2004, a tetra-lingual English/French/Russian/Spanish ad-hoc relational XML database of sea ice terms definitions in UTF-8 coding (preserving national characters) was constructed alongside with active web-page, providing linkage to the database: <http://www.aari.nw.ru/gdsidb/XML/nomenclature.asp>. Terms are arranged by subject, in alphabetical order or as linguistic equivalents with a choice for leading language from EN/FR/RU/ES and a search is provided alongside with 12 redefined versions of terms sorting.

#### Background and necessity for a new Nomenclature

6. The currently effective WMO Sea-Ice Nomenclature was developed by a WMO CMM WG in 1968 and published in 1970 (without scales and symbols). In 1989, it was republished in the form of Supplement No. 4, where volume 3 "International system of sea-ice symbols" is presented, and Supplement No. 5, presenting several supplements and edited main sections of the Nomenclature (ice terms arranged in the subject and alphabetical orders). No international format (code) for operational provision of users and data exchange had been developed before the publication of SIGRID-3 in 2004. During the period of the development of the Nomenclature, the visual air- and shipborne observations were the main method of ice information collection, which influenced inevitably the composition and formulation of terms.

7. Along with an excessively detailed description of some ice features that are not depicted on the ice charts (separate ice ridges, standing floes, rams, etc.), the Nomenclature does not contain a number of notions and terms that are already applied in practice of the ice services (ice cover, zone, ice drift, drift divide, etc.). An absence of these terms and notions, extremely important for investigators and navigators, leads to a possibility of different understandings of information plotted on the chart. Sometimes the physical essence of a phenomenon and bounds of possible quantitative values are not taken into account. Some recommendations for compiling the ice charts also cause objections. In particular, that is for depiction of ice forms of each age stage.

8. The aforementioned facts determine the need and the importance of developing a new version of the WMO Nomenclature on Sea Ice. AARI experts were appointed by ETSI to develop the draft of a new Nomenclature. After scientific discussions within the internal expert group, it was agreed to split the new draft into two documents with the following preliminary titles: a) shorter "Sea Ice Nomenclature for Ice Charting" (author – Dr Sc. Andrey Bushuev) and b) a wider, more scientific one "WMO Glossary on Sea Ice Cover" (authors: Drs Stanislav Losev and Vladimir Spichkin). Both drafts were presented at the International Ice Charting Working Group, 4th Meeting in April 2003 and it was agreed that it should be further developed. It is expected that the ETSI-II session will discuss English versions of both documents and provide further recommendations for JCOMM-II.

#### Summary for "Sea Ice Nomenclature for Ice Charting"

9. The developed preliminary Draft Nomenclature consists of 11 sections including 120 terms. The successive order of the sections is given in accordance with the succession of compiling the ice charts and their coding. Whenever possible, the terms of the existing Nomenclature were preserved. Their number in the Nomenclature in brackets follows these terms. If the term notion was edited, "ed" follows the number. Some terms that are not used for compilation of the ice charts but can be used in the text messages are included in a description of the main term. For example, a description of landfast ice includes a description of the notions "ice foot" and "young coastal ice". After such terms several Nomenclature numbers are given. The Draft Nomenclature includes 22 new terms with part of them being already used during ice observations without preliminary permission ("residual first-year ice", "rough ice", etc.). The definitions of the main zones and their

types (landfast ice, drifting ice, individual field, iceberg waters, clear) are given. Several terms and 3 sections, which were obsolete, belonged to visual observations or duplicated in other places, were excluded. Annex I to the Draft Nomenclature presents code tables, symbols and conventional designations. Annex 2 considers an order of using ice symbols presented in Annex 1 and the technology for preparing and drawing up the graphical ice charts. The proposed drafts of the main section and annexes probably appear to be a first approximation of the final variant of the new version of the WMO Nomenclature on Sea-Ice and require further specifying, additions and editing.

#### Summary for the "Glossary on sea-ice cover"

10. The "Glossary on sea-ice cover" improves, specifies and expands the previous terminology editions. The "Glossary" gives a clear formulation of the notions that define sufficiently fully the essence of diverse characteristics of the ice cover state and ice conditions at sea. The structural principle of the Glossary is a classified list of terms that are used in sea ice research. It includes the main ice notions, types of ice and ice features encountered at sea, their characteristics and components, terms of the processes occurring in the ice cover due to the action of thermal and dynamic factors, terms used for presentation of ice distribution in the water area and terms related to production activity in the areas with a perennial or seasonal ice cover. In total, the glossary contains 17 rubrics and 315 terms. The Glossary is intended for scientists of different branches of geographical science and specialists involved in production development of the ice areas and the offshore zone.

#### Development of new standards for sea ice charts, including colour coding and ice decay

11. In collaboration with the IICWG, the ETSI developed proposals for a) colour standards of ice charts, b) sea ice decay from remotely sensed data and c) a new format for operational and historical sea ice mapped data exchange. It may be noted that standardization of colour coding for ice charts, ice decay from the remotely sensed data and a new format for data exchange are a part of a long-term strategy to extend the scope of information supporting ice navigation and to facilitate its relay to and interpretation by the end-users.

#### Colour coding

12. During the 2000-2003 period, IICWG ice experts succeeded in preparation of the draft colour standard which, according to the decisions of the 3<sup>rd</sup> IICWG meeting (November, 2001) included two mutually exclusive separate colour codes: one mainly based on total concentration and another based on stage of development. Proposed codes are complementary to the existent WMO black and white ice symbols and are flexible in use (for ice services). ETSI-I discussed and adopted the draft and that recommended the Chairman, after final corrections, submit the draft to the WMO Secretariat before JCOMM-II. Simultaneously, ETSI-I recommended national ice services to start implementing colour-coding which is now actually true for most ice services for the second winter season 2003/2004. During 2003 some minor harmonization corrections were proposed by e-mail communication. By March 2004, MS Word version of the document is ready to be submitted and published, preferably as a successive supplement to WMO Sea Ice Nomenclature.

#### Ice decay

13. Extension of summer season ice description by introducing ice decay parameter measured from radar back scatter is a result of research undertaken by Canadian Ice Service experts, under the Arctic Sea Ice Regime Shipping System (AIRSS). The JCOMM-I agreed that as a result of this work, appropriate amendments to the nomenclature for coding sea ice decay should be developed during the next intersessional period. During the last 3<sup>rd</sup> and 4<sup>th</sup> IICWG meetings it was agreed for IICWG experts from Canada and Russian Federation to investigate the inter-relationship between traditional stages of melt and the new ice strength index with respect to the physical process in the seasonal cycle and movement of ships in ice, to improve the exchange of ice melt / strength

science (past, present, future) within IICWG. This action item was recommended by ETSI-I for prolongation to the next intersessional period with a progressive report to be discussed at ETSI-II.

#### New format for operational and historical sea ice mapped data exchange

14. Currently used formats for ice chart coding SIGRID (Sea Ice Grid) and SIGRID-2 were introduced by WMO in 1981 and in 1994 respectively and allow storing primarily climatological data. Presently within the GDSIDB project practically all-historical sea ice data for 1950-2003 are kept in this format. In comparison to a number of commercial standards, the SIGRID format has an advantageous in its capability of comprehensive depiction of sea ice parameters. However, it has a number of restrictions and inconveniences to be kept as a practical operative format. So far most ice services are no longer submitting data to GDSIDB in SIGRID. Based on the current international practices utilizing GIS for chart production and using SIGRID code tables for quantity description of sea ice parameters, IICWG ice experts succeeded in the preparation of the so-called "SIGRID-3" draft format for sea ice data operational and climatological exchange. Harmonization of the draft was made by electronic correspondence and phone conference during 2002. ETSI-I discussed and approved the draft and recommended the Chairman after final minor corrections to submit the format to the WMO Secretariat for publication. In December 2003, a 21 pages final version of the document was submitted to the WMO Secretariat. Simultaneously, ETSI-I and IICWG-IV provided a number of recommendations to facilitate implementation of the format at a national level, including development of freeware software archives and samples.

WMO Publication "Sea-Ice Information Services in the World" and electronic versions of WMO publications related to sea ice

15. Reports from national operational ice services and centres delivered at IICWG-III, IICWG-IV and ETSI-I showed the need and possibilities of tracking annual corrections to descriptions of national sea ice informational services, i.e. maintaining electronic version of WMO publication No. 574. In a broader way, there is a need for publishing on the Internet electronic versions of all existing sea ice publications, as official WMO publications. Many of the documents are already published unofficially on GDSIDB sites at AARI and NSIDC. It is planned that ETSI-II will discuss this item and propose further steps for its implementation in close cooperation between the WMO Secretariat and ETSI members.

#### Requirements for sea ice observations

16. In October 2002, the WMO Secretariat provided drafts for requirements for sea ice observations to be finalized by ETSI experts. However, discussions held during ETSI-I showed it impossible, at the level of ETSI experts, without direct contact with operational and numerical modeling specialists. ETSI-I agreed to solve the question during the intersessional period. IICWG-IV meeting provided such requirements for 9 sea ice variables as a part of a White Paper on "An International Collaborative Effort Towards Automated Sea Ice Chart Production", attached as Appendix B. It is planned that ETSI-II will discuss given requirements and develop further recommendations.

#### International Ice Charting Working Group (IICWG)

17. ETSI/GDSIDB continued to provide strong and quite beneficial interrelation with IICWG. IICWG now joins practically all Northern Hemisphere operational ice bodies, provides vital expertise in developing ice related documents and maintains linkages with a variety of governmental and commercial bodies like icebreaker services and satellite data suppliers. IICWG meetings provide space for ad hoc ETSI expert meetings. The last 4<sup>th</sup> Meeting Ice Charting Working Group (IICWG) was held in St Petersburg, Russian Federation, 7-11 April 2003. The meeting was hosted by the Arctic and Antarctic Research Institute (AARI) and sponsored by NOAA, the US National Ice Center, Canadian Ice Service and the Arctic and Antarctic Research Institute. A full list of meeting documents is available from IICWG-IV site:

[http://www.aari.nw.ru/projects/iicwg\\_iv/](http://www.aari.nw.ru/projects/iicwg_iv/) or from IICWG central page at NSIDC: <http://nsidc.org/noaa/iicwg/>.

18. The meeting was traditionally preceded by a Science Workshop (Monday, 7 April) dedicated to Sea Ice Modeling and Data Assimilation. The agenda of IICWG-IV Meeting included reports from the IICWG Chairs, IICWG Standing Committees - on Data, Information and Customer Support and on Applied Science and Research, other international sea ice working groups, including WMO/IOC JCOMM ETSI, the Baltic Sea Ice Meeting (BSIM), US/Canada Joint Ice Working Group, International Ice Patrol and various technical sessions. Thematic sessions during the Meeting were dedicated to Sea Ice Modeling and Data Assimilation, Ice Centre Relationships including GMES (Global Monitoring for Environment and Security), ECDIS, Satellite Data Access, and Development of Sea Ice Mapping Systems. The meeting agreed the action items, which serve as the workplan for the WG intersessional period. IICWG-IV discussed the status and the steps to be undertaken for finalization/development of the following WMO sea ice documents: SIGRID-3 format for sea ice charts exchange, colour coding standards, and WMO sea ice nomenclature documents. The next 5th IICWG Meeting will be held 19-24 April 2004, i.e. next week immediately after ETSI-II/GDSIDB-X sessions, in Hamburg, Germany. It should be noted that a special item on interrelations with IICWG is planned on the ETSI-II agenda.

19. Extended information on IICWG activities is expected to be given in the report of the IICWG representative at ETSI.

#### Baltic Sea Ice Meeting (BSIM)

20. Similar to IICWG, ETSI/GDSIDB continued to provide traditional and also quite a successful interrelation with BSIM. BSIM joins all 11 Baltic Sea ice services thus presenting a fine example of the progress in harmonization of ice services production and relay. BSIM members have some of the oldest sea ice expertise and ice data records in the world. BSIM like IICWG maintains linkages with a variety of governmental and non-governmental bodies like icebreaker captains/services, satellite data suppliers, etc. As of from 2003 there is a common web site of Baltic Sea ice services hosted by the German ice service: <http://www.bsis-ice.de>.

21. The last 21<sup>st</sup> Baltic Sea Ice Meeting was hosted by the Finnish Institute of Marine Research in Helsinki, Finland, 9-13 June 2003. The agenda of the Meeting included the Chairman's report (present chair – K.Strübing, Germany) and national ice services reports describing ice related data acquisition, processing, presentations and products relay to the users. Most of the reporters touched the special features of ice services/support during extreme ice season 2002/2003 as well as implementation of GIS techniques in ice practices. Reports of the icebreaking services presently acting within the Nordic level agreement between Denmark, Finland and Sweden followed ice services reports. The representative of WMO Secretariat and ETSI chair reported relations with WMO/IOC JCOMM bodies. Part of the agenda was dedicated to Baltic Sea climatology. Observations on ice concentration, and thickness, occurrence of ridges, rafting and rotten ice are coded in a concise Baltic Sea Ice Code (BSIC) and stored in Baltic Sea Ice Data Bank for climatological calculations. Partly they are published by SMHI in annual summaries. BSIC is still of good use. The last revised version of the code was published in 2001 as some discrepancies and some changes in fairway section had to be corrected.

22. Other items on the BSIM-21 agenda included reports on BOOS, PAPA, scientific session on KSAT and SAR data possibilities in ice monitoring, reports on ice informational systems like IceMap, IBNet and IceView, EU projects like GMES, ICEMON and IWICOS. Meeting also discussed possible deficiencies in ice services' and icebreaking systems, future requirements for data and candidate for new products/services. Strategy for future cooperation was discussed and formulated in the 1<sup>st</sup> draft of the *Memorandum of Understanding to formalize the cooperation of the Baltic Sea ice services* (MoU). This MoU is the first step to build up a single entry Baltic Sea ice information service, and it should lead to an agreement between BSIM countries. After BSIM-21, it should be discussed further at the directors level of national institutes with the next final draft

planned to be ready within months. The next 22<sup>nd</sup> Baltic Sea Ice Meeting will be hosted by the EMHI and held in Tallinn, Estonia at the end of September 2005.

23. Extended information on BSIM activities is expected to be given in the report of BSIM chairman / BSIM representative in ETSI.

#### International Polar Year 2007 – 2008

24. The International Meeting “Cooperation for the International Polar Year 2007 – 2008 (IPY 2007/2008) was held at the Arctic and Antarctic Research Institute of Roshydromet in St Petersburg on 22-23 January 2004. The Meeting was initiated at the “Russia – EU Workshop on Polar Research” in Brussels (June 2003) and organized by Roshydromet and the Russian Academy of Science with support from the European Commission, by the International Science and Technology Centre, and the Russian Polar Foundation. Forty experts including representatives of international organizations and programmes and scientists from national polar institutes participated in the Meeting.

25. The main aim of the Meeting was to determine the potential national participation in the IPY 2007/2008 and the interested international organizations, and to define the areas of common interest and possibilities for future cooperation in holding the IPY. The participants agreed the statement on IPY scientific priorities and goals and formulated recommendations to governmental bodies and interested organizations, including ICSU and WMO. Full text of the agreement is available in the Meeting documents. It is planned that ICY aspects will be discussed during the forthcoming ETSI 2<sup>nd</sup> session following possible recommendations from the current JCOMM MAN-III.

#### National activities

26. National activities in a form of progressive reports covering several items of ETSI-I Action Sheet, including data provision and training, are presented as separate documents from national ice services.



Appendices: 2

APPENDIX A

**ETSI ACTION SHEET for intersessional period**

*(Submitted from ETSI-I report, Buenos Aires, Argentina, 21 - 25 October 2002)*

Ref.	Subject	Action proposed	With whom	Target
Para 2.1.5	Sea ice data management	To address to WMO Secretariat the ETSI concerns on the decreased availability of data necessary to support safety of navigation in ice covered waters that has resulted from the space agencies` data policies	Secretariat, Members	ASAP
Para 2.1.6	Sea ice training	To prepare a document on training in the field of sea ice activities to be submitted for information to JCOMM Capacity Building PA Coordinator	Chairman, Members	Intersessional period
Para 2.2.48	Sea-Ice Information Services in the World	To revise the WMO publication No. 574, 2000	WMO consultant	JCOMM-II
Para 2.5.9	Electronic versions of WMO publications	To publish on Internet electronic versions of all existing sea ice publications, as official WMO publications	Secretariat, Chairman	Intersessional period
Para 2.5.10	Requirements for sea ice observations	To prepare requirements for sea ice observations to be revised by JCOMM-II	Members, Secretariat	15 November 2002
Para 2.5.11	WMO Sea Ice Nomenclature	(i) To submit to WMO Secretariat agreed corrections for WMO publication No. 259 for formal approval by JCOMM;	Secretariat	Before JCOMM-II
Para 2.5.12, 2.5.13, 2.5.14		(ii) To revise prepared by AARI amendments, to WMO. Sea Ice Nomenclature to be submitted for formal approval by JCOMM;	Members, BSIM, IICWG, Secretariat	Before JCOMM-II
		(iii) To appoint an expert to prepare a consolidated set of requirements and proposals for a revision of WMO publication No. 259	Members	Intersessional period
2.2.21		(iv) To submit a draft of the revised Spanish version of WMO Sea Ice Nomenclature to WMO Secretariat to be edited and published	Argentina, Secretariat	
Para 2.5.16	International colour code for sea ice charts	To submit agreed international standard for colour code for sea ice to the JCOMM copresidents for formal approval on behalf of JCOMM to be published by WMO Secretariat	IICWG, Secretariat	Before JCOMM-II
Para 2.6.6	Archive format for sea ice data	To revise and comment the proposed archive format for sea ice data to be submitted for approval by appropriate WMO bodies	Members, Secretariat, National services	Intersessional period

<b>Ref.</b>	<b>Subject</b>	<b>Action proposed</b>	<b>With whom</b>	<b>Target</b>
Para 2.5.17	Ice decay/stages of melting	(i) To develop of appropriate amendments to the WMO Sea Ice Nomenclature for coding sea ice decay;	CIS, AARI	ETSI-II
Para 2.5.21		(ii) To compile the analysis of evaluation reports on presentation of ice strength information received from ships	CIS	Spring 2003
Para 4.1	Relations to WMO/IOC and other international programmes	To develop blended sea ice variables for global climate analysis and to prepare historical sea ice data information for the Southern Ocean	Members, SG GDSIDB	Intersessional period
Para 2.3.6	ETSI and BSIM collaboration	To continue development of ETSI and BSIM collaboration	ETSI, BSIM	Continuous
Para 2.2.15	Sea ice monitoring in the Sea of Okhotsk	To feed the result of JMA operational analysis of sea ice in the Sea of Okhotsk to JMA's Numerical Weather Prediction Model and Climate Prediction Model	JMA	Continuous
Para 3.11	Sea ice charts for the Southern hemisphere	To digitize and compile results of QC of sea ice charts for the Antarctic areas: - From 1995 to 2000; - From 2001 to 2002 - From 1973 to 1994	NIC	October 2005 August 2003 End 2007
Para 3.13, 3.15	Contributions to GDSIDB	(i) To transfer weekly sea ice charts for the Baltic Sea to the GDSIDB to be digitized during the next intersessional period.	DMI	Continuous
		(ii) To make digital database of sea ice charts for the Canadian Arctic available to users from CIS website	CIS	ASAP
Para 5.1	Date and place of the next meeting	To finalize arrangements for the timing and venue for the next ETSI-II and GDSIDB-X sessions in due course, and notify group members accordingly.	Secretariat, China, Germany	2003

APPENDIX B

**National Operational Ice Information Requirements**

(White Paper on “An International Collaborative Effort Towards Automated Sea Ice Chart Production”, Appendix B. Prepared for the International Ice Chart Working Group, April, 2003)

Ice information requirement	Spatial resolution*		Temporal resolution*		Description
	Strategic	Tactical	Strategic	Tactical	
Ice/water boundary or Ice edge	5 km	<1 km	Daily	6 hours	In case of a diffuse ice edge, the CIS defines the ice/water boundary as 10% ice concentration
Ice concentration	+/- 10% Requires resolution <100m	+/- 5% requires Resolution <25m	Daily	6 hours	Percentage of ice covered area. Ice concentration is a key parameter in the WMO egg code (reference).
Stage of development (e.g. new, thin, first-year, and multi-year ice)	50-100 m	<20 m	Daily	6 hours	Ice classes are defined by WMO (reference).
Iceberg detection	<50m	<5 m	Daily	Hourly	Detection and tracking, possibly classification of type (reference).
Presence and location of leads (open water)	50-100 m Similar to ice conc.	<20 m	Daily	6 hours	Leads and polynyas
Ice thickness	5 km for average thickness over an area to +/- 20% of total thickness	<100m to determine average and maximum thickness (including rafting) over an area to +/- 10% of total thickness	2x/week	Daily	Important for navigation and/or loads on structures
Ice topography and roughness	<50m to determine extent of ridging; need average ridge heights to within +/- 20%	<10m to determine mean and maximum ridge heights to within +/- 10%	Daily	6 hours	Presence, location and height of ridges.  Roughness indicated by concentration of ridges (in % or in number per unit area) plus average height (or total thickness) of ridges
Ice decay state (or, more specifically, ice strength)	20 km for average strength over an area to +/- 20% of total strength	5 km for average strength over an area to +/- 10% of total strength	Weekly	Daily	Identification of melt onset and ponding
Snow properties (e.g. thickness, wetness/density)	5 km for average snow depth to +/- 20% and density to ??? %	1 km for average snow depth to +/- 10% and density to ??? %	Weekly	Daily	To determine hull friction for ship resistance – also important for ice strength



## NOMENCLATURE OMM DES GLACES EN MER

### WMO/OMM/BMO - No.259 Suppl.No.5 Nomenclature des glaces par sujets

1. **Glace flottante** (Floating ice): Toute glace flottant dans l'eau. Les principales sortes de glace flottante sont la glace de lac, la glace de rivière, la glace de mer qui se forme par congélation de l'eau de mer en surface, et la glace de glacier (glace d'origine terrestre) formée sur la terre ferme ou provenant d'un plateau de glace. Ce concept comprend aussi la glace jetée en côte ou échouée.
- 1.1 **Glace de mer** (Sea ice): Toute forme de glace trouvée en mer qui résulte du gel de l'eau de mer.
- 1.1.1 **Banquise côtière** (Fast ice): Voir 3.1 - Glace de mer qui se forme et reste fixe le long de la côte, où elle est attachée soit au rivage, soit à un mur de glace, soit encore à une falaise de glacier, entre des hauts-fonds ou des icebergs échoués. Des fluctuations verticales peuvent être observées quand le niveau de la mer varie. La banquise côtière peut être formée sur place à partir de l'eau de mer ou de glace flottante de n'importe quel âge retenue au rivage par le gel; elle peut s'étendre à plusieurs mètres comme à plusieurs centaines de kilomètres de la côte. La banquise côtière peut être de la glace de plus d'un an et on peut alors la désigner en employant l'expression correspondant à son âge (vieille, de deuxième année ou de plusieurs années). Si elle s'élève à plus de 2 m environ au-dessus du niveau de la mer, on l'appelle alors plateau de glace.
- 1.1.2 **Glace dérivante/banquise** (Drift ice / pack ice): Terme utilisé au sens large pour désigner toute zone de glace de mer autre que la banquise côtière, quelle que soit sa forme ou sa disposition. Lorsque les concentrations sont élevées, par exemple 7/10 ou plus, l'expression "glace dérivante" peut être remplacée par le terme "banquise".  
\*Antérieurement: Le terme "banquise" était utilisé pour toutes les gammes de concentration.
- 1.2 **Glace d'origine terrestre** (Ice of land origin): Glace formée sur la terre ferme ou sur un plateau de glace, et flottant dans l'eau. Le concept inclut aussi la glace qui est jetée en côte ou échouée.
- 1.3 **Glace de lac** (Lake ice): Glace formée sur un lac, quel que soit l'endroit où on l'observe.
- 1.4 **Glace de rivière** (River ice): Glace formée sur un cours d'eau, quel que soit l'endroit où on l'observe.
2. **Formation de la glace** (Développement)
- 2.1 **Nouvelle glace** (New ice): Terme général s'appliquant à toute glace formée récemment. Ce terme recouvre ceux de frasil, sorbet, gadoue et shuga qui correspondent à différents aspects de la glace formée par des cristaux qui sont encore faiblement soudés entre eux par le gel (s'ils le sont) et n'ont un aspect défini que lorsqu'ils flottent en surface.
- 2.1.1 **Frasil** (Frazil ice): Fines aiguilles ou plaquettes de glace en suspension dans l'eau.
- 2.1.2 **Sorbet** (Grease ice): Stade de la congélation postérieur au frasil; les cristaux commencent à s'agglutiner pour former en surface une couche épaisse comme de la soupe. A ce stade, la mer réfléchit peu la lumière et prend une apparence mate.
- 2.1.3 **Gadoue** (Slush): Neige saturée et mélangée d'eau reposant sur la terre ou la glace, ou masse

visqueuse flottant sur l'eau après une forte chute de neige.

- 2.1.4 Shuga** (Shuga): Accumulation de morceaux de glace blanche et spongieuse ayant quelques centimètres de longueur; ils sont formés à partir de sorbet ou de gadoue et, quelquefois, de glace de fond remontant à la surface.
- 2.2 Nilas** (Nilas): Couche de glace mince et élastique, ondulant facilement sous les vagues et la houle ou sous la pression, et formant sous la pression des avancées en forme de "doigts" entrecroisés (chevauchement avec imbrication). Cette couche a une surface mate et peut atteindre 10 cm d'épaisseur. On peut distinguer le nilas sombre et le nilas clair.
  - 2.2.1 Nilas sombre** (Dark nilas): Nilas ayant moins de 5 cm d'épaisseur et une couleur très sombre.
  - 2.2.2 Nilas clair** (Light nilas): Nilas ayant plus de 5 cm d'épaisseur et qui est de couleur plus claire que le nilas sombre.
  - 2.2.3 Glace vitrée** (Ice rind): Croûte de glace brillante et cassante formée sur la surface calme d'une eau habituellement peu saline, par congélation directe ou à partir de sorbet. Son épaisseur peut atteindre environ 5 cm. Elle se casse facilement sous l'action du vent ou de la houle, le plus souvent en morceaux rectangulaires.
- 2.3 Glace en crêpes** (Pancake ice): Morceaux de glace de forme circulaire, ayant de 30 cm à 3 m de diamètre et jusqu'à 10 cm d'épaisseur, avec des bords relevés du fait du frottement des morceaux les uns contre les autres. Ils peuvent se former par houle faible à partir de sorbet, de gadoue ou de shuga ou du fait de la fragmentation de glace vitrée ou de nilas, ou encore à partir de glace grise s'il y a une forte houle ou de grosses vagues. La glace en crêpes se forme aussi parfois en profondeur, à l'interface entre deux masses d'eau ayant des caractéristiques physiques différentes, d'où elle remonte en surface. Elle peut rapidement couvrir de grandes étendues d'eau.
- 2.4 Jeune glace** (Young ice): Glace au stade de transition entre le nilas et la glace de première année, d'une épaisseur de 10 à 30 cm. Peut être divisée en glace grise et en glace blanchâtre.
  - 2.4.1 Glace grise** (Grey ice): Jeune glace de 10 à 15 cm d'épaisseur, moins souple que le nilas et se brisant sous l'effet de la houle. En général, les fragments se chevauchent et s'empilent sous l'effet de la pression.
  - 2.4.2 Glace blanchâtre** (Grey-white ice): Jeune glace de 15 à 30 cm d'épaisseur. Sous l'effet de la pression, aura plus tendance à faire des crêtes qu'à s'empiler.
- 2.5 Glace de première année** (First-year ice): Glace de mer ayant au plus un hiver de croissance et provenant de jeune glace; son épaisseur varie entre 30 cm et 2 m. Peut-être subdivisée en glace mince de première année/glace blanche, glace moyenne de première année et glace épaisse de première année.
  - 2.5.1 Glace mince de première année/glace blanche** (Thin first-year ice / white ice): Glace mince de première année de 30 à 70 cm d'épaisseur.
    - 2.5.1.1 Glace mince de première année/glace blanche, premier stade** (Thin first-year ice / white ice first stage): De 30 à 50 cm d'épaisseur.
    - 2.5.1.2 Glace mince de première année/glace blanche, deuxième stade** (Thin first-year ice / white ice second stage): De 50 à 70 cm d'épaisseur.
  - 2.5.2 Glace moyenne de première année** (Medium first-year ice): Glace de première année de 70 à 120 cm d'épaisseur.

**2.5.3** **Glacé épaisse de première année** (Thick first-year ice): Glacé de première année de plus de 120 cm d'épaisseur.

**2.6** **Vieille glacé** (Old ice): Glacé de mer ayant survécu à au moins une fonte d'été et dont l'épaisseur caractéristique peut atteindre 3 m et plus. La plupart des accidents topographiques sont plus arrondis que sur la glacé de première année. Peut être divisée en glacé de deuxième année et en glacé de plusieurs années.

**2.6.1** **Glacé de deuxième année** (Second-year ice): Vieille glacé n'ayant subi qu'un été de fonte et dont l'épaisseur caractéristique peut atteindre 2,5 m et plus dans certains cas. Comme elle est plus épaisse que la glacé de première année, elle flotte plus haut sur l'eau. Contrairement à ce qui se passe avec la glacé vieille de plusieurs années, la fonte d'été produit un dessin régulier de nombreuses petites mares d'eau. Les endroits mis à nu et les mares sont généralement bleu-vert.

**2.6.2** **Glacé de plusieurs années** (Multi-year ice): Vieille glacé, ayant 3 m et plus d'épaisseur, qui a survécu à au moins deux fontes d'été. Les hummocks sont encore plus arrondis que dans le cas d'une glacé de deuxième année et la glacé est presque exempte de sel. Là où la glacé est vive, sa couleur est généralement bleue. La fusion entraîne une configuration caractérisée par de grandes mares irrégulières interconnectées et par un système de drainage bien développé.

### **3. Différents aspects de la banquise côtière** (Forms of fast ice)

**3.1** **Banquise côtière** (Fast ice): Glacé de mer qui se forme et reste fixe le long de la côte, où elle est attachée soit au rivage, soit à un mur de glacé, soit encore à une falaise de glacier, entre des hauts-fonds ou des icebergs échoués. Des fluctuations verticales peuvent être observées quand le niveau de la mer varie. La banquise côtière peut être formée sur place à partir de l'eau de mer ou de glacé flottante de n'importe quel âge retenue au rivage par le gel; elle peut s'étendre à plusieurs mètres comme à plusieurs centaines de kilomètres de la côte. La banquise côtière peut être de la glacé de plus d'un an et on peut alors la désigner en employant l'expression correspondant à son âge (vieille, de deuxième année ou de plusieurs années). Si elle s'élève à plus de 2 m environ au-dessus du niveau de la mer, on l'appelle alors plateau de glacé.

**3.1.1** **Jeune glacé côtière** (Young coastal ice): Stade initial de la formation d'une banquise côtière représenté par le nilas ou la jeune glacé; sa largeur varie de quelques mètres jusqu'à 100 ou 200 mètres à partir de la côte.

**3.2** **Banquette côtière** (Icefoot): Etroite bande de glacé attachée à la côte, qui ne bouge pas avec la marée et qui reste en place quand la banquise côtière est partie à la dérive.

**3.3** **Glacé de fond** (Anchor ice): Glacé immergée, attachée ou ancrée au fond, quel que soit son mode de formation.

**3.4** **Glacé échouée** (Grounded ice): Glacé flottante qui est échouée dans des eaux peu profondes (voir glacé jetée en côte).

**3.4.1** **Glacé jetée en côte** (Stranded ice): Glacé qui était flottante mais qui a été déposée à sec sur le rivage par le retrait de la mer (voir glacé échouée).

**3.4.2** **Hummock échoué** (Grounded hummock): Ensemble de glaces hummockées échouées. Les hummocks peuvent être échoués isolément ou en alignement (ou chaîne).

### **4. Occurrence de glacé flottante** (Occurrence of floating ice)

**4.1** **Couverture de glacé** (Ice cover): Rapport entre une surface de glacé de concentration

quelconque et la surface totale de la mer dans une grande région géographique, qui peut être le globe tout entier, un hémisphère ou une entité océanographique déterminée comme la baie de Baffin ou la mer de Barents.

- 4.2 Concentration** (Concentration): Rapport, exprimé en dixièmes\*, indiquant la proportion de la surface de la mer qui, par rapport à celle de l'ensemble de la zone considérée, est couverte de glace. La concentration totale englobe toutes les phases de développement existantes. La concentration partielle peut ne concerner que la glace correspondant à une phase particulière ou à une forme bien précise et ne représenter seulement qu'une partie de la concentration totale. \*Antérieurement: Dans les données anciennes relatives aux glaces en mer, certains pays ont utilisé des "octas".
- 4.2.1 Glace compacte** (Compact ice): Glace flottante dont la concentration est de 10/10 et où il n'y a pas d'eau visible.
- 4.2.1.1 Glace consolidée** (Consolidated ice): Glace flottante dont la concentration est de 10/10 et où les floes ont été soudés par le gel.
- 4.2.2 Glace très serrée** (Very close ice): Glace flottante dont la concentration est de 9/10 à moins de 10/10.
- 4.2.3 Glace serrée** (Close ice): Glace flottante dont la concentration est de 7/10 à 8/10 et qui est composée de floes dont la plupart sont en contact.
- 4.2.4 Glace lâche** (Open ice): Glace flottante dont la concentration est de 4/10 à 6/10 avec de nombreux chenaux et polynies; les floes ne sont généralement pas en contact les uns avec les autres.
- 4.2.5 Glace très lâche** (Very open ice): Glace flottante dont la concentration est de 1/10 à 3/10 et où il y a plus d'eau que de glace.
- 4.2.6 Eau libre** (Open water): Grande étendue d'eau librement navigable dans laquelle la glace de mer est présente à des concentrations inférieures à 1/10. Il n'y a pas de glace d'origine terrestre.
- 4.2.7 Bergy water** (Bergy water): Zone d'eau librement navigable dans laquelle des glaces d'origine terrestre sont présentes en concentrations inférieures à 1/10. Il se peut que de la glace de mer soit présente, mais la concentration totale de toute la glace ne doit pas excéder 1/10.
- 4.2.8 Libre de glace** (Ice-free): Aucune glace n'est présente. S'il y a de la glace de quelque espèce que ce soit, ce terme ne doit pas être employé.
- 4.3 Formes des glaces flottantes** (Forms of floating ice)
- 4.3.1 Glace en crêpes** (Pancake ice): Morceaux de glace de forme circulaire, ayant de 30 cm à 3 m de diamètre et jusqu'à 10 cm d'épaisseur, avec des bords relevés du fait du frottement des morceaux les uns contre les autres. Ils peuvent se former par houle faible à partir de sorbet, de gadoue ou de shuga ou du fait de la fragmentation de glace vitrée ou de nilas, ou encore à partir de glace grise s'il y a une forte houle ou de grosses vagues. La glace en crêpes se forme aussi parfois en profondeur, à l'interface entre deux masses d'eau ayant des caractéristiques physiques différentes, d'où elle remonte en surface. Elle peut rapidement couvrir de grandes étendues d'eau.
- 4.3.2 Floe** (Floe): Tout fragment de glace de mer relativement plat ayant 20 m ou plus d'extension horizontale. Selon leur extension horizontale, les floes sont subdivisés comme suit :
- 4.3.2.1 Géant** (Floe giant): Plus de 10 km d'extension.

- 4.3.2.2 **Immense** (Floe vast): De 2 à 10 km d'extension.
- 4.3.2.3 **Grand** (Floe big): De 500 à 2000 m d'extension.
- 4.3.2.4 **Moyen** (Floe medium): De 100 à 500 m d'extension.
- 4.3.2.5 **Petit** (Floe small): De 20 à 100 m d'extension.
- 4.3.3 **Glaçon** (Ice cake): Tout fragment relativement plat de glace de mer ayant moins de 20 m d'extension linéaire.
  - 4.3.3.1 **Petit glaçon** (Small ice cake): Glaçon de moins de 2 m d'extension.
- 4.3.4 **Floeberg** (Floeberg): Grosse pièce de glace de mer composée d'un hummock, ou d'un groupe de hummocks, séparée de toute glace environnante. Peut typiquement émerger jusqu'à 5 m au-dessus du niveau de la mer.
  - 4.3.4.1 **Fragment de floe** (Floe bit): Un morceau de glace en mer relativement petit, n'ayant normalement pas plus de 10 m d'un bord à l'autre, composé d'un ou de plusieurs hummocks ou d'une partie de crête(s), soudé par le gel et isolé des environs. Il émerge typiquement jusqu'à 2 m au-dessus du niveau de la mer.
- 4.3.5 **Mosaïque de glace** (Ice breccia): Morceaux de glace à différents stades de développement, soudés par le gel.
- 4.3.6 **Brash** (Brash ice): Accumulation de glaces flottantes composées de fragments qui n'ont pas plus de 2 m d'extension et qui proviennent de la destruction d'autres formes de glace.
- 4.3.7 **Iceberg** (Iceberg): Voir 10.4.2 - Importante masse détachée d'un glacier, de forme très variable, émergeant de plus de 5 m au-dessus du niveau de la mer, et qui peut être flottante ou échouée. Les icebergs peuvent être tabulaires, en dôme, en pente, pointus, érodés ou des icebergs de glacier.
- 4.3.8 **Iceberg de glacier** (Glacier berg): Voir 10.4.2.1. - Iceberg de forme irrégulière.
- 4.3.9 **Iceberg tabulaire** (Tabular berg): Voir 10.4.2.2 - Iceberg à sommet plat. La plupart des icebergs tabulaires proviennent du vèlage d'un plateau de glace et présentent des bandes horizontales (voir île de glace).
- 4.3.10 **Île de glace** (Ice island): Voir 10.4.3. - Très grand fragment de glace flottante qui émerge d'environ 5 m au-dessus du niveau de la mer, provenant d'un plateau de glace arctique. L'épaisseur totale est de 30 à 50 m, et la surface de quelques milliers de mètres carrés à 500 km<sup>2</sup> ou plus. La surface est ordinairement caractérisée par une ondulation régulière qui lui donne, vue d'avion, une apparence côtelée.
- 4.3.11 **Fragment d'iceberg** (Bergy bit): Voir 10.4.4 - Vaste bloc flottant de glace de glacier qui émerge généralement de 1 à 5 m et qui a habituellement une superficie de 100 à 300 m<sup>2</sup>.
- 4.3.12 **Bourguignon** (Growler): Voir 10.4.5 - Bloc de glace plus petit qu'un fragment d'iceberg, émergeant à moins d'un mètre au-dessus de la surface de la mer et s'étendant habituellement sur une superficie d'environ 20m<sup>2</sup>. De couleur blanche, mais parfois transparent ou bleu-vert, le bourguignon est difficile à reconnaître lorsqu'il est entouré de glace de mer ou flotte dans une mer agitée.
- 4.4 **Disposition des glaces** (Arrangement)

- 4.4.1 Champ de glace** (Ice field): Etendue de glace flottante formée de floes de n'importe quelle taille et dont l'étendue est de plus de 10 km (voir banc de glace).
- 4.4.1.1 Grand champ de glace** (Large ice field): Champ de glace ayant plus de 20 km d'étendue.
- 4.4.1.2 Champ de glace moyen** (Medium ice field): Champ de glace ayant de 15 à 20 km d'étendue.
- 4.4.1.3 Petit champ de glace** (Small ice field): Champ de glace ayant de 10 à 15 km d'étendue.
- 4.4.1.4 Banc de glace** (Ice patch): Etendue de glace flottante ayant moins de 10 km.
- 4.4.2 Mer de glace** (Ice massif): Accumulation variable de glace serrée ou très serrée, couvrant des centaines de kilomètres carrés, que l'on trouve dans le même région tous les étés.
- 4.4.3 Ceinture (de glace)** (Belt): Vaste zone de glace dérivante plus longue que large; la largeur peut aller de 1 à plus de 100 km.
- 4.4.4 Langue (de glace)** (Tongue): Avancée de la lisière des glaces qui peut avoir plusieurs kilomètres de longueur et est causée par le vent ou le courant.
- 4.4.5 Cordon (de glace)** (Strip): Longue et étroite bande de glace flottante ayant 1 km ou moins de longueur, ordinairement composée de petits fragments détachés de la masse de glace principale et réunis sous l'effet du vent, de la houle ou du courant.
- 4.4.5.1 Isthme de glace** (Ice isthmus): Passage étroit entre deux zones de glace très serrée ou compacte. Il peut être difficile à traverser; néanmoins, on peut parfois en rencontrer sur une route recommandée.
- 4.4.6 Baie** (Bight): Grande échancrure, en forme de croissant, de la lisière des glaces, formée soit par le vent, soit par le courant.
- 4.4.7 Embâcle** (Ice jam): Accumulation de glaces de rivière ou de mer, brisées et immobiles en raison de restrictions physiques. Cette accumulation résiste à la pression.
- 4.4.8 Lisière des glaces** (Ice edge): Démarcation, à un moment quelconque, entre la mer libre et n'importe quelle espèce de glace de mer, qu'elle soit fixe ou dérivante. Cette lisière peut être serrée ou lâche (voir ligne de démarcation des glaces).
- 4.4.8.1 Lisière serrée** (Compacted ice edge): Lisière des glaces nettement définie, rendue compacte par le vent ou le courant, ordinairement du côté au vent d'une zone de glace dérivante.
- 4.4.8.1.1 Barrière due à un embâcle de sarrasins** (Jammed brash barrier): Cordon ou bande étroite de nouvelle glace, de jeune glace ou de sarrasins (en général de 100 à 5000 m de large), qui s'est formé à la limite de la glace dérivante, de la banquise côtière ou près de la côte. La glace a été rendue très compacte, surtout par l'action du vent, et peut être immergée de 2 à 20 m sans avoir normalement une importante topographie. Les barrières dues à un embâcle de sarrasins peuvent être dispersées lors d'un changement des vents, mais elles peuvent aussi se consolider et former un cordon de glace particulièrement épais comparativement à la glace dérivante environnante.
- 4.4.8.2 Lisière lâche** (Diffuse ice edge): Lisière des glaces mal définie, délimitant une région de glaces flottantes dispersées, ordinairement du côté sous le vent d'une zone de glace dérivante.
- 4.4.8.3 Limite des glaces** (Ice limit): Terme de climatologie désignant la position extrême moyenne, médiane, minimale ou maximale de la lisière des glaces pour un mois ou toute autre période donnée déterminée sur la base d'observations portant sur de nombreuses années. Cette

expression doit toujours être complétée par moyenne, médiane, minimale ou maximale (voir limite moyenne des glaces).

- 4.4.8.4 Limite moyenne des glaces** (Mean ice edge): Position moyenne de la lisière des glaces pour un mois ou une période donnée déterminée sur la base d'observations portant sur de nombreuses années. Les autres termes qui peuvent être employés sont : lisière maximale moyenne ou lisière minimale moyenne (voir limite des glaces).
- 4.4.8.5 Limite de la banquise côtière** (Fast-ice edge): Démarcation, à un moment quelconque, entre la banquise côtière et l'eau libre.
- 4.4.9 Ligne de démarcation des glaces** (Ice boundary): Démarcation, à un moment quelconque, entre la banquise côtière et la glace dérivante ou entre des zones de glace dérivante de concentrations différentes (voir lisière des glaces).
- 4.4.9.1 Ligne de démarcation de la banquise côtière** (Fast ice boundary): Démarcation, à un moment quelconque, entre la banquise côtière et la glace dérivante.
- 4.4.9.2 Ligne de démarcation de concentrations** (Concentration boundary): Ligne marquant approximativement la transition entre deux zones de glace dérivante de concentrations nettement différentes.
- 4.4.10 Champ d'icebergs échoués** (Iceberg tongue): Voir 10.4.2.3 - Importante accumulation d'icebergs s'étendant à partir de la côte, tenus en place par échouage et pouvant être réunis par une banquise côtière.

## **5. Mouvement de la glace flottante** (Floating-ice motion processes)

- 5.1 Divergence** (Diverging): Champ de glace ou floes qui, à l'intérieur d'une zone donnée, sont soumis à des mouvements de divergence ou de dispersion qui réduisent la concentration des glaces et/ou diminuent les contraintes dans les glaces.
- 5.2 Tassement** (Compacting): On dit que des morceaux de glace flottante sont soumis au tassement quand ils sont entraînés par un mouvement de convergence qui a pour effet d'augmenter la concentration de la glace et/ou de produire des contraintes pouvant amener des déformations de la glace.
- 5.3 Cisaillement** (Shearing): Une zone de glace dérivante est soumise au cisaillement quand le mouvement des glaces varie substantiellement dans la direction perpendiculaire au mouvement, ce qui soumet la glace à des forces de rotation. Ces forces peuvent provoquer un phénomène comparable à une brèche de séparation.

## **6. Processus de déformation** (Deformation processes)

- 6.1 Formation de fractures** (Fracturing): Phénomène de pression par lequel la glace est soumise à une déformation permanente qui amène sa rupture. Cette expression est généralement utilisée pour décrire des cassures à travers une glace très serrée, une glace compacte et une glace consolidée.
- 6.2 Formation de hummocks** (Hummocking): Phénomène de pression par lequel la glace de mer est amenée à s'empiler et à former des hummocks. Lorsque ce phénomène s'accompagne d'une rotation des floes, on dit qu'il y a torsion.
- 6.3 Formation de crêtes** (Ridging): Phénomène de pression par lequel la glace de mer est amenée à

former des crêtes.

**6.4 Chevauchement des glaces** (Rafting): Phénomène de pression par lequel un fragment de glace monte sur un autre. Se produit surtout dans la nouvelle glace et la jeune glace (voir chevauchement avec imbrication).

**6.4.1 Chevauchement avec imbrication** (Finger rafting): Type de glace empilée dans lequel les floes en se chevauchant, forment sur leurs bords des avancées en forme de "doigts" qui s'imbriquent alternativement au-dessus ou au-dessous d'autres floes. Ce phénomène se retrouve fréquemment dans le nilas et la glace grise. (Il a été remarqué que le chevauchement avec imbrication de la glace grise est commun en Antarctique).

**6.5 Chevauchement de glace sur les berges** (Shore ice ride-up): Processus au cours duquel une nappe de glace est poussée sur les berges.

**6.6 Erosion** (Weathering): Phénomène d'ablation et d'accumulation qui fait peu à peu disparaître les irrégularités de la surface de la glace.

## **7. Ouvertures dans les glaces** (Openings in the ice)

**7.1 Fracture** (Fracture): Toute cassure ou rupture dans une glace très serrée, une glace compacte, une glace consolidée, une banquise côtière ou un simple floe, qui est provoquée par des phénomènes de déformation. Les fractures peuvent contenir du "brash" et/ou être recouvertes de nilas et/ou de jeune glace. Leur longueur peut varier de quelques mètres à plusieurs kilomètres.

**7.1.1 Fissure** (Crack): Toute fracture dans une banquise côtière, une glace consolidée ou un simple floe qui s'est traduite par une séparation comprise entre quelques centimètres et un mètre.

**7.1.1.1 Fissure de marée** (Tide crack): Fissure à la ligne de jonction entre la banquette de glace ou un mur de glace et une banquise côtière, cette dernière étant soumise aux mouvements de la marée.

**7.1.1.2 Brèche de séparation** (Flaw): Etroite zone de séparation entre la glace dérivante et une banquise côtière où les morceaux de glace sont dans un état chaotique; elle se forme quand la glace dérivante, sous l'effet d'un vent ou d'un courant fort, se déplace le long de la ligne de démarcation de la banquise côtière en produisant un effet de cisaillement (voir cisaillement).

**7.1.2 Fracture très étroite** (Very small fracture): De 1 à 50 m de largeur.

**7.1.3 Fracture étroite** (Small fracture): De 50 à 200 m de largeur.

**7.1.4 Fracture moyenne** (Medium fracture): De 200 à 500 m de largeur.

**7.1.5 Large fracture** (Large fracture): De plus de 500 m de largeur.

**7.2 Zone de fractures** (Fracture zone): Région où il y a un grand nombre de fractures.

**7.3 Chenal** (Lead): Toute fracture ou passage à travers la glace de mer accessible à un navire de surface.

**7.3.1 Chenal côtier** (Shore lead): Chenal entre la glace dérivante et le rivage ou entre la glace dérivante et une falaise.

**7.3.2 Chenal de séparation** (Flaw lead): Passage entre la glace dérivante et une banquise côtière accessible aux navires de surface.



**7.4 Polynie (Polynya):** Toute ouverture de forme non linéaire entourée de glace. Les polynies peuvent contenir du "brash" (sarrasins) et/ou être couvertes de nouvelle glace, de nilas ou de jeune glace.

**7.4.1 Polynie côtière (Shore polynya):** Polynie entre la glace dérivante et la côte ou entre la glace dérivante et une falaise de glace.

**7.4.2 Polynie de séparation (Flaw polynya):** Polynie entre la glace dérivante et une banquise côtière.

**7.4.3 Polynie récurrente (Recurring polynya):** Polynie réapparaissant à la même position tous les ans.

## **8. Aspects de la surface de la glace (Ice-surface features)**

**8.1 Glace plane (Level ice):** Glace de mer qui n'a subi aucune déformation.

**8.2 Glace déformée (Deformed ice):** Terme général désignant des glaces qui ont été serrées les unes contre les autres et, de ce fait, soulevées ou enfoncées par endroits. Les subdivisions de ce terme général sont : glace entassée, glace tourmentée et glace hummockée.

**8.2.1 Glace empilée ou entassée (Rafted ice):** Type de déformation de la glace dans laquelle les plaques de glace se chevauchent les unes les autres (voir chevauchement avec imbrication).

**8.2.1.1 Glace imbriquée (Finger rafted ice):** Type de glace empilée dans lequel les floes, en se chevauchant, forment sur leurs bords des avancées en forme de "doigts" qui s'imbriquent alternativement au-dessus ou au-dessous d'autres floes.

**8.2.2 Crête (Ridge):** Ligne ou mur de glace brisée qui est soulevée par la pression. Peut-être récente ou érodée. Le volume correspondant de glace brisée poussée vers le bas par la pression au-dessous d'une crête est appelé quille de glace.

**8.2.2.1 Nouvelle crête (New ridge):** Crête récente à sommets aigus et dont les flancs ont ordinairement une pente de 40°. Les fragments de glace sont discernables d'avion à base altitude.

**8.2.2.2 Crête érodée (Weathered ridge):** Crête dont les sommets sont légèrement arrondis et dont les flancs ont généralement entre 30° et 40° de pente. Les fragments de glace qui la composent ne sont pas discernables les uns des autres.

**8.2.2.3 Crête très érodée (Very weathered ridge):** Crête à sommets très arrondis et dont les flancs ont généralement de 20° à 30° de pente.

**8.2.2.4 Vieille crête (Aged ridge):** Crête qui a subi une forte érosion. Ces crêtes apparaissent plutôt comme des ondulations.

**8.2.2.5 Crête consolidée (Consolidated ridge):** Crête dont la base est soudée par le gel.

**8.2.2.6 Glace tourmentée (Ridged ice):** Glace empilée au hasard, un fragment sur un autre, et formant des crêtes ou des murs. Se trouve habituellement dans la glace de première année (voir formation de crêtes).

**8.2.2.6.1 Zone de glace tourmentée (Ridged ice zone):** Région où les glaces présentent de nombreuses crêtes ayant des caractéristiques semblables.

**8.2.2.7 Crête de cisaillement (Shear ridge):** Formation de crêtes de glace qui se produit lorsqu'un

élément de glace est érodé par frottement contre un autre. Les crêtes de ce type sont plus linéaires que celles qui sont causées par la pression.

- 8.2.2.7.1 Champ de cisaillement** (Shear ridge field): de nombreuses crêtes de cisaillement côte à côte.
- 8.2.3 Hummock** (Hummock): Monticule de glace brisée qui a été soulevée par la pression. Peut être récent ou érodé. Le volume de glace brisée qui s'est enfoncé sous l'effet de la pression et se trouve submergé sous le hummock est appelé un bummock.
- 8.2.3.1 Glace hummockée** (Hummocked ice): Glace de mer empilée au hasard, un fragment sur un autre, et formant une surface irrégulière. Quand elle est érodée, cette glace semble faite de monticules arrondis.
- 8.2.3.2 Champ de blocaille** (Rubble field): Zone de glace de mer extrêmement déformée, d'une épaisseur inhabituelle, formée pendant l'hiver par le mouvement de la glace dérivante contre un rocher, un îlot émergeant ou toutes autres obstructions, ou autour de ces obstacles.
- 8.3 Floe dressé** (Standing floe): Floe isolé, dressé verticalement ou incliné, et entouré de glace plutôt lisse.
- 8.4 Eperon** (Ram): Avancée sous-marine d'un mur de glace, d'une falaise de glace, d'un iceberg ou d'un floe. Sa formation est due en général à une fonte et à une érosion plus intenses de la partie émergée.
- 8.5 Glace vive** (Bare ice): Glace non recouverte de neige.
- 8.6 Glace recouverte de neige** (Snow-covered ice): Glace recouverte de neige.
- 8.6.1 Sastrugi** (Sastrugi): Crêtes irrégulières et anguleuses formées sur une surface couverte de neige par l'action du vent (érosion et dépôt de neige). Sur la glace dérivante, les crêtes sont parallèles à la direction du vent dominant qui souffle au moment de leur formation.
- 8.6.2 Congère** (Snowdrift): Accumulation de neige déposée sous le vent d'un obstacle ou amoncelée par des tourbillons de vent. Une congère en forme de croissant, dont les deux extrémités sont orientées sous le vent, est appelée une "barkhane" de neige.
- 9. Phases de la fonte** (Stages of melting)
  - 9.1 Mare** (Puddle): Accumulation sur la glace d'eau de fonte provenant principalement de la fonte de la neige mais, aux stades les plus avancés, aussi de la fonte de la glace. Au début, ces mares sont de simples flaques de neige fondue.
  - 9.2 Trous de fonte** (Thaw holes): Trous verticaux dans la glace de mer qui se forment quand, du fait de la fusion, les mares de surface rejoignent l'eau de mer sous-jacente.
  - 9.3 Glace asséchée** (Dried ice): Glace de mer de la surface de laquelle l'eau de fonte a disparu par suite de la formation de fissures et de trous de fonte. Pendant la période d'assèchement, la glace blanchit.
  - 9.4 Glace pourrie** (Rotten ice): Glace de mer qui est criblée de trous de fonte et qui se trouve à un stade avancé de désintégration.
  - 9.5 Glace inondée** (Flooded ice): Glace de mer qui a été inondée par de l'eau de fonte ou de l'eau de rivière et qui est lourdement chargée d'eau et de neige mouillée.

**9.6 Cordon d'eau littoral** (Shore melt): Eau libre entre la côte et la banquise côtière, résultant de la fonte de la glace et/ou de l'apport d'un cours d'eau.

## **10. Glace d'origine terrestre** (Ice of land origin)

**10.1 Névé** (Firn): Veille neige qui s'est recristallisée en un matériau dense. A l'encontre de la neige ordinaire, les particules en sont, dans une certaine mesure, soudées les unes aux autres mais, contrairement à ce qui se passe dans la glace, les espaces contenant de l'air y sont encore reliés les uns aux autres.

**10.2 Glace de glacier** (Glacier ice): Glace faisant partie ou provenant d'un glacier, qu'elle soit sur terre ou flottant dans la mer sous la forme d'iceberg, de fragment d'iceberg ou de bourguignon.

**10.2.1 Glacier** (Glacier): Masse de neige et de glace se déplaçant continuellement d'un niveau continental supérieur à un niveau inférieur ou s'étalant continuellement si elle flotte. Les principales formes de glacier sont : inlandsis, les plateaux de glace, les coulées de glace, les calottes glaciaires, les glaciers de piémont, les cirques glaciaires et les divers types de glaciers de montagne (ou de vallée).

**10.2.2 Mur de glace** (Ice wall): Paroi de glace formant la bordure aval d'un glacier qui ne flotte pas. Un mur de glace repose sur la terre, le soubassement rocheux pouvant se trouver au niveau ou sous le niveau de la mer (voir falaise de glace).

**10.2.3 Coulée de glace** (Ice stream): Partie d'un inlandsis dans laquelle la glace s'écoule plus rapidement et pas nécessairement dans la même direction que la glace environnante. Les limites en sont parfois nettement marquées par un changement dans la direction de la pente de la surface, mais elles peuvent aussi en être indistinctes.

**10.2.4 Langue de glacier** (Glacier tongue): Extension d'un glacier en mer, le plus souvent flottante. Dans l'antarctique, les langues de glacier peuvent s'étendre sur plusieurs dizaines de kilomètres.

**10.3 Plateau de glace** (Ice shelf): Glacier plat flottant, d'une épaisseur considérable, qui émerge de 2 à 50 m ou plus et est fixé à la côte. Généralement très étendu; sa surface est plane ou légèrement ondulée. Il est alimenté par l'accumulation annuelle de neige et souvent aussi par l'avancée vers la mer de glaciers. Quelques parties peuvent être échouées. Le bord qui fait face à la mer est appelé falaise de glace.

**10.3.1 Falaise de glace** (Ice front): Paroi verticale qui constitue la face tournée vers la mer d'un plateau de glace ou de tout autre glacier flottant et dont la hauteur est comprise entre 2 et 50 m, ou plus, au-dessus du niveau de la mer (voir mur de glace).

## **10.4 Glace vêlée d'origine terrestre** (Calved ice of land origin)

**10.4.1 Vêlage** (Calving): Séparation, par fracture, d'une masse de glace à partir d'un mur de glace, d'une falaise de glace ou d'un iceberg.

**10.4.2 Iceberg** (Iceberg): Importante masse détachée d'un glacier, de forme très variable, émergeant de plus de 5 m au-dessus du niveau de la mer, et qui peut être flottante ou échouée. Les icebergs peuvent être tabulaires, en dôme, en pente, pointus, érodés ou des icebergs de glacier.

**10.4.2.1 Iceberg de glacier** (Glacier berg): Iceberg de forme irrégulière.

**10.4.2.2 Iceberg tabulaire** (Tabular berg): Iceberg à sommet plat. La plupart des icebergs tabulaires proviennent du vêlage d'un plateau de glace et présentent des bandes horizontales (voir île de

glace).

- 10.4.2.3 Champ d'icebergs échoués** (Iceberg tongue): Importante accumulation d'icebergs s'étendant à partir de la côte, tenus en place par échouage et pouvant être réunis par une banquise côtière.
- 10.4.3 Ile de glace** (Ice island): Très grand fragment de glace flottante qui émerge d'environ 5 m au-dessus du niveau de la mer, provenant d'un plateau de glace arctique. L'épaisseur totale est de 30 à 50 m, et la surface de quelques milliers de mètres carrés à 500 km<sup>2</sup> ou plus. La surface est ordinairement caractérisée par une ondulation régulière qui lui donne, vue d'avion, une apparence côtelée.
- 10.4.4 Fragment d'iceberg** (Bergy bit): Vaste bloc flottant de glace de glacier qui émerge généralement de 1 à 5 m et qui a habituellement une superficie de 100 à 300 m<sup>2</sup>.
- 10.4.5 Bourguignon** (Growler): Bloc de glace plus petit qu'un fragment d'iceberg, émergeant à moins d'un mètre au-dessus de la surface de la mer et s'étendant habituellement sur une superficie d'environ 20 m<sup>2</sup>. De couleur blanche, mais parfois transparent ou bleu-vert, le bourguignon est difficile à reconnaître lorsqu'il est entouré de glace de mer ou flotte dans une mer agitée.

## **11. Indices de glace dans le ciel et dans l'atmosphère** (Sky and air indications)

- 11.1 Ciel d'eau** (Water sky): Bandes sombres sur le dessous de nuages bas indiquant la présence d'eau dans le voisinage de la glace de mer.
- 11.2 Halo glaciaire** (Ice blink): Reflet blanchâtre sur des nuages bas au-dessus d'une accumulation de glaces lointaines.
- 11.3 Brume d'évaporation** (Frost smoke): Bancs de brume qui sont provoqués par le contact d'air froid avec une eau relativement chaude et qui peuvent apparaître au-dessus d'ouvertures dans la glace ou sous le vent de la lisière des glaces et peuvent persister pendant que la glace se forme.

## **12. Termes relatifs à la navigation de surface** (Terms relating to surface shipping)

- 12.1 Coincé** (Beset): Situation d'un navire entouré par les glaces et incapable de se mouvoir.
- 12.2 Bloqué par les glaces** (Ice-bound): On dit qu'un port, une crique, etc., est bloqué par les glaces quand la navigation est rendue impossible du fait de la glace sauf, peut-être, avec l'aide d'un brise-glace.
- 12.3 Presser** (Nip): On dit que la glace presse quand elle serre fortement la coque d'un navire. D'un bateau qui a été pris ainsi, même s'il est intact, on dit qu'il a été pressé.
- 12.4 Glace soumise à pression** (Ice under pressure): Glace dans laquelle se produisent des processus de déformation et qui représente, de ce fait, un obstacle ou un danger pour la navigation.
- 12.5 Zone difficile** (Difficulty area): Expression qualitative générale indiquant que, relativement parlant, les conditions de glace régnant dans cette région sont telles que la navigation y est difficile.
- 12.6 Zone facile** (Easy area): Expression qualitative générale indiquant que, relativement parlant, les conditions de glace régnant dans cette région sont telles que la navigation n'y est pas difficile.
- 12.7 Zone de fragilité** (Area of weakness): Zone observée par satellite où soit la concentration, soit

l'épaisseur de la glace est sensiblement moindre que dans les zones environnantes. Etant donné qu'il s'agit d'une observation par satellite, il n'est pas toujours possible d'effectuer une analyse quantitative précise, mais les conditions de navigation sont sensiblement plus faciles que dans les zones environnantes.

- 12.8 Port de glace** (Ice port): Baie dans une falaise de glace, souvent temporaire, où les navires peuvent accoster et décharger directement sur le plateau de glace.
- 13. Termes relatifs à la navigation sous-marine** (Terms relating to submarine navigation)
- 13.1 Voûte de glace** (Ice canopy): La glace dérivante du point de vue d'un sous-marinier.
- 13.2 Glace propice** (Friendly ice): Du point de vue d'un sous-marinier, voûte de glace comportant beaucoup de grandes claires-voies ou autres caractéristiques permettant à un sous-marin de faire surface. Pour qu'il en soit ainsi, il doit y avoir plus de dix de ces ouvertures par 30 milles nautiques (56 km) sur la route du sous-marin.
- 13.3 Glace hostile** (Hostile ice): Du point de vue d'un sous-marinier, voûte de glace présentant peu (moins de 10 par 30 milles nautiques) de grandes claires-voies ou autres caractéristiques permettant à un sous-marin de faire surface.
- 13.4 Bummock** (Bummock): Du point de vue d'un sous-marinier, saillie de la face inférieure de la voûte de glace; c'est l'inverse d'un hummock.
- 13.5 Quille de glace** (Ice keel): Du point de vue d'un sous-marinier, excroissance suspendue à une voûte de glace; c'est l'inverse d'une crête (voir 8.2.2). Les quilles de glace peuvent s'étendre jusqu'à 50 mètres sous la surface.
- 13.6 Claire-voie** (Skylight): Du point de vue d'un sous-marinier, parties minces de la voûte de glace, ordinairement de moins de 1 m d'épaisseur et qui, vues de dessous, apparaissent comme des parties claires, translucides sur le fond sombre. La surface inférieure d'une claire-voie est habituellement plate. Les claires-voies sont dites grandes si elles sont assez étendues pour permettre à un sous-marin d'essayer d'atteindre la surface (120 m), et petites dans le cas contraire.
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## OMM NOMENCLATURA HIELO MARINO

No.259 Suppl.No.5

By Beatriz Lorenzo

### 1. Términos de hielo ordenados por tema

1. **Hielo flotante** (*Floating ice[en]*): Cualquier forma de hielo que se encuentra flotando en el agua. Las principales clases de hielo flotante son hielo lacustre, hielo fluvial y hielo marino, que se forman por la congelación del agua en la superficie; y hielo glaciario (hielo de origen terrestre) formado sobre tierra o en una barrera de hielo. El concepto incluye hielo encallado o varado.

1.1 **Hielo marino** (*Sea ice[en]*): Cualquier forma de hielo encontrado en el mar, originado por la congelación de agua de mar.

1.1.1 **Hielo fijo** (*Fast ice [en]*): Véase 3.1 - Hielo marino que se forma y permanece fijo a lo largo de la costa, en donde es anexado a la orilla, a una pared de hielo, a un frente de barrera, entre bajos fondos o témpanos varados. Fluctuaciones verticales del hielo fijo pueden ser observadas durante cambios del nivel del mar. El hielo fijo puede ser formado in situ de agua de mar o por congelamiento hacia la costa del hielo flotante de cualquier edad, y puede extenderse unos pocos metros o varios cientos de kilómetros desde la costa. El hielo fijo puede ser de más de un año de edad y entonces añadir con sufijo la categoría apropiada de su edad (viejo, del segundo año o de varios años). Cuando tiene más de alrededor de 2 m sobre el nivel del mar se lo denomina barrera de hielo.

1.1.2 **Hielo a la deriva/ pack de hielo** (*Drift ice/Pack ice[en]*): Término utilizado en sentido amplio para incluir cualquier área de hielo marino menos hielo fijo, no importando que forma adopta o como está dispuesto. Cuando las concentraciones son altas, i.e. 7/10 o más, el hielo a la deriva puede ser reemplazado por el término pack de hielo\*.

\* Nota El término pack de hielo fue previamente utilizado para todos los rangos de concentraciones.

1.2 **Hielo de origen terrestre** (*Ice of land origin[en]*): Hielo formado sobre tierra o en una barrera de hielo que se encuentra flotando en el agua. El concepto incluye hielo encallado o varado.

1.3 **Hielo lacustre** (*Lake ice[en]*): Hielo formado sobre un lago sin considerar el lugar en donde se lo observe.

1.4 **Hielo fluvial** (*River ice[en]*): Hielo formado en un río sin considerar el lugar en donde se lo observe.

### 2. Desarrollo (Development [en]):

2.1 **Hielo nuevo** (*New ice [en]*): Término general para el hielo recientemente formado que incluye cristales de hielo, hielo grasoso, pasta y shuga. Estos tipos de hielo están compuestos de cristales de hielo que sólo están débilmente soldados entre sí por congelamiento (si es que todos lo están) y tienen una forma definida únicamente mientras ellos están a flote.

2.1.1 **Cristales de hielo** (*Frazil ice [en]*): Agujas o placas finas de hielo, suspendidas en el agua.

2.1.2 **Hielo grasoso** (Grease ice [en]): Estado posterior de congelamiento donde los cristales de hielo cuando éstos han coagulado para formar una capa espesa sobre la superficie. El hielo grasoso refleja poca luz, dando al mar una apariencia o aspecto mate.

2.1.3 **Pasta o grumo** (Slush [en]): Nieve que está saturada y mezclada con agua sobre superficies terrestres o de hielo, o como una masa flotante viscosa en agua después de una intensa nevada.

2.1.4 **Shuga** (Shuga [en]): Acumulación de terrones de hielo blanco esponjoso, de pocos centímetros de espesor; se forman del hielo grasoso o pastoso y algunas veces de hielo de fondo que ascendiendo a la superficie.

2.2 **Nilas** (Nilas [en]): Costra de hielo delgada y elástica, que se dobla fácilmente por efecto de las olas de viento y mar de leva y bajo presión interponiéndose en un modelo de 'dedos' entrelazados (Sobreescurreamiento de dedos). Tiene una superficie mate y hasta 10 cm de espesor. Puede subdividirse en nilas oscuras y nilas claras.

2.2.1 **Nilas oscuras** (Dark nilas [en]): Nilas que tienen por debajo de 5 cm de espesor y coloración muy oscura.

2.2.2 **Nilas claras** (Light nilas [en]): Nilas que tienen más de 5 cm de espesor y preferentemente de color más claro que las nilas oscuras.

2.2.3 **Costra de hielo** (Ice rind [en]): Costra de hielo quebradiza y brillante formada sobre una superficie quieta por congelamiento directo o de hielo grasoso, usualmente de baja salinidad. Espesor de alrededor de 5 cm. Se rompe fácilmente por la acción del viento o mar de leva, partiéndose comúnmente en pedazos rectangulares.

2.3 **Hielo panqueque** (Pancake ice [en]): Trozos de hielo predominantemente circulares de 30 cm a 3 m de diámetro, y hasta 10 cm de espesor, con bordes levantados por los choques entre uno y otro. Pueden formarse sobre un mar de leva suave, de hielo grasoso, shuga o pasta, o de rupturas de costra de hielo o nilas; o bajo severas condiciones de mar de leva y de viento, de hielo gris. Algunas veces se forman a cierta profundidad, en la interfase entre cuerpos de agua de distintas características físicas, desde donde aflora a la superficie; su aparición puede rápidamente cubrir vastas áreas de agua.

2.4 **Hielo joven** (Young ice [en]): Hielo en la etapa de transición entre nilas y hielo de primer año, con 10-30 cm de espesor. Puede ser subdividido en hielo gris y hielo gris-blanco.

2.4.1 **Hielo gris** (Grey ice [en]): Hielo joven de 10-15 cm de espesor. Es menos elástico que las nilas y se quiebra por efecto del mar de leva. Usualmente se junta bajo presión.

2.4.2 **Hielo gris-blanco** (Grey-white ice [en]): Hielo joven de 15-30 cm de espesor. Bajo presión es más probable que se acordone antes que se apile.

2.5 **Hielo de primer año** (First-year ice [en]): Hielo marino de no más de un invierno de crecimiento, desarrollándose de hielo joven, de espesor entre 30 cm y 2 m. Puede ser subdividido en hielo delgado de primer año / hielo blanco, hielo medio de primer año y hielo grueso de primer año.

2.5.1 **Hielo delgado de primer año / hielo blanco** (Thin first-year ice / white ice [en]): Hielo de primer año de 30 a 70 cm de espesor.

2.5.1.1 **Hielo delgado de primer año/ hielo blanco primera etapa** (*Thin first-year ice / white ice first stage [en]*): 30 a 50 cm de espesor.

2.5.1.2 **Hielo delgado de primer año/ hielo blanco segunda etapa** (*Thin first-year ice / white ice second stage [en]*): 50 a 70 cm de espesor.

2.5.2 **Hielo medio de primer año** (*Medium first-year ice [en]*): Hielo de primer año de 70-120 cm de espesor.

2.5.3 **Hielo grueso de primer año** (*Thick first-year ice [en]*): Hielo de primer año de más de 120 cm de espesor.

2.6 **Hielo viejo** (*Old ice [en]*): Hielo marino que ha sobrevivido al menos un derretimiento de verano; de espesor típico de hasta 3 m o más. La mayoría de los rasgos topográficos son más suaves que sobre el hielo de primer año. Puede ser subdividido en hielo de segundo año y hielo de varios años.

2.6.1 **Hielo del segundo año** (*Second-year ice [en]*): Hielo viejo que ha sobrevivido sólo un derretimiento de verano; de espesor típico de hasta 2,5 m y a veces más. Debido a que tiene más espesor que el hielo de primer año, está más alto sobre la superficie del agua. En contraste con el hielo de varios años, el derretimiento del verano produce un modelo regular de numerosos charcos pequeños. Las manchas y charcos desnudos son usualmente de color azul verdoso.

2.6.2 **Hielo de varios años** (*Multi-year ice [en]*): Hielo viejo de hasta 3 o más m de espesor que ha sobrevivido por lo menos dos derretimientos de verano. Montículos aún más alisados que el hielo de segundo año y el hielo está casi libre de sal. El color, en donde está desnudo, es generalmente azul. Los modelos de fusión consisten en grandes charcos irregulares interconectados y en un sistema de drenaje bien desarrollado.

### 3. Formas de hielo fijo (Forms of fast ice [en]): null

3.1 **Hielo fijo** (*Fast ice [en]*): - Hielo marino que se forma y permanece fijo a lo largo de la costa, en donde es anexado a la orilla, a una pared de hielo, a un frente de barrera, entre bajos fondos o témpanos varados. Fluctuaciones verticales del hielo fijo pueden ser observadas durante cambios del nivel del mar. El hielo fijo puede ser formado in situ de agua de mar o por congelamiento hacia la costa del hielo flotante de cualquier edad, y puede extenderse unos pocos metros o varios cientos de kilómetros desde la costa. El hielo fijo puede ser de más de un año de edad y entonces añadir con su fijo la categoría apropiada de su edad (viejo, del segundo año o de varios años). Cuando tiene más de alrededor de 2 m sobre el nivel del mar se lo denomina barrera de hielo.

3.1.1 **Hielo costero joven** (*Young coastal ice [en]*): La etapa inicial de formación de hielo fijo consistiendo de nilas o hielo joven, su ancho varía desde unos pocos metros hasta 100 - 200 m desde la línea de la costa.

3.2 **Pie de hielo** (*Icefoot [en]*): Una angosta pestaña de hielo anexada a la costa e inmóvil por mareas y permaneciendo después que el hielo fijo se ha apartado.

3.3 **Hielo de fondo** (*Anchor ice [en]*): Hielo sumergido, anexado o fijado al fondo, sin tener en cuenta la naturaleza de su formación.

3.4 **Hielo varado** (*Grounded ice [en]*): Hielo flotante varado en bajos fondos.



3.4.1 **Hielo encallado** (*Stranded ice [en]*): Hielo que ha estado flotando y ha sido depositado sobre la costa al retirarse la marea alta.

3.4.2 **Montículo varado** (*Grounded hummock [en]*): Formación de hielo varado y amonticulado. Hay montículos varados aislados e hileras (o cadenas) de montículos varados.

#### 4. Ocurrencia de hielo flotante (*Occurrence of floating ice [en]*): null

4.1 **Cobertura de hielo** (*Ice cover [en]*): La relación de un área de hielo de cualquier concentración respecto del área total de la superficie del mar dentro de alguna area geográfica local grande; esta área local puede ser global, hemisférica o prescrita por una entidad oceanográfica específica, tal como la bahía Baffin o el mar de Barents .

4.2 **Concentración** (*Concentration [en]*): La relación expresada en décimas\* describiendo la cantidad de superficie del mar cubierta por hielo como una fracción del área total considerada. La concentración total incluye todos los estados de desarrollo presentes, la concentración parcial puede referirse a la cantidad de un estado determinado o a una forma particular de hielo y representa solamente una parte del total.

\*Nota: En datos históricos de hielo marino, los octavos han sido usados por algunos países.

4.2.1 **Hielo compacto** (*Compact ice [en]*): Hielo flotante en 10/10 de concentración y no hay agua visible.

4.2.1.1 **Hielo consolidado** (*Consolidated ice [en]*): Hielo flotante con concentración de 10/10 y los bandejones están soldados unos con otros por congelamiento.

4.2.2 **Hielo muy cerrado** (*Very close ice [en]*): Hielo flotante con concentración de 9/10 a menos de 10/10.

4.2.3 **Hielo cerrado** (*Close ice [en]*): Hielo flotante con concentración es 7/10 a 8/10 compuesto de bandejones mayormente en contacto.

4.2.4 **Hielo abierto** (*Open ice [en]*): Hielo flotante con concentración de 4/10 a 6/10, con muchos canales y polinias y los bandejones no están mayormente en contacto uno con los otros.

4.2.5 **Hielo muy abierto** (*Very open ice [en]*): Hielo flotante con concentración de 1/10 a 3/10 y agua predomina sobre el hielo.

4.2.6 **Aguas libres** (*Open water [en]*): Área grande de agua libremente navegable en la cual el hielo marino está presente en concentraciones menores de 1/10. No está presente el hielo de origen terrestre.

4.2.7 **Aguas con tempanitos** (*Bergy water [en]*): Área de agua libremente navegable en la cual está presente hielo de origen terrestre en concentraciones menores de 1/10. Puede haber hielo marino presente, si bien la concentración total de todo el hielo no excederá 1/10.

4.2.8 **Libre de hielo** (*Ice-free [en]*): No hay hielo presente. Si cualquier tipo de hielo está presente éste término no debe ser usado.

### **4.3 Formas de hielo flotante (Forms of floating ice [en]): null**

4.3.1 **Hielo panqueque** (*Pancake ice [en]*): Trozos de hielo predominantemente circulares de 30 cm a 3 m de diámetro, y hasta 10 cm de espesor, con bordes levantados por los choques entre uno y otro. Pueden formarse sobre un mar de leva suave, de hielo grasoso, shuga o pasta, o de rupturas de costra de hielo o nilas; o bajo severas condiciones de mar de leva y de viento, de hielo gris. Algunas veces se forman a cierta profundidad, en la interfase entre cuerpos de agua de distintas características físicas, desde donde aflora a la superficie; su aparición puede rápidamente cubrir vastas áreas de agua.

4.3.2 **Bandejón** (*Floe [en]*): Cualquier trozo de hielo marino relativamente plano de 20 m o más transversalmente. Los bandejones son subdivididos de acuerdo a su mayor extensión horizontal como sigue:

4.3.2.1 **Bandejón gigante** (*Floe giant [en]*): Más de 10 km a través (cf 4.3.2).

4.3.2.2 **Vasto bandejón** (*Floe vast [en]*): 2-10 km a través (cf 4.3.2).

4.3.2.3 **Bandejón grande** (*Floe big [en]*): 500-2000 m a través (cf 4.3.2).

4.3.2.4 **Bandejón medio** (*Floe medium [en]*): 100-500 m a través (cf 4.3.2).

4.3.2.5 **Bandejón chico** (*Floe small [en]*): 20-100 m a través (cf 4.3.2).

4.3.3 **Torta de hielo** (*Ice cake [en]*): Cualquier trozo de hielo marino relativamente plano de menos de 20 m a través.

4.3.3.1 **Torta chica de hielo** (*Small ice cake [en]*): Una torta de hielo de menos de 2 m a través.

4.3.4 **Tempanito marino** (*Floeberg [en]*): Trozo de hielo marino macizo compuesto de un montículo de hielo o un grupo de soladados entre si por congelamiento, y separado de cualquier hielo circundante. Generalmente puede emerger hasta 5 m sobre el nivel del mar.

4.3.4.1 **Fragmento de bandejón** (*Floe-bit [en]*): Trozo relativamente pequeño de hielo marino; normalmente no más de 10 m a través, compuesto de (un) montículo(s) o parte de (un) cordón(ones), soldados entre si por congelamiento, y separado de cualquier hielo circundante. Sobresale típicamente hasta 2 m sobre el nivel del mar.

4.3.5 **Brecha de hielo** (*Ice breccia [en]*): Hielo de diferentes estados de desarrollo, soladados entre si por congelamiento.

4.3.6 **Escombros de hielo** (*Brash ice [en]*): Acumulaciones de hielo flotante formadas por fragmentos de no más de 2 m a través, despojos de otras formas de hielo.

4.3.7 **Témpano** (*Iceberg [en]*): Véase 10.4.2. – Trozo de hielo macizo de formas muy variadas, sobresaliendo más de 5 m sobre el nivel del mar, que se ha desprendido de un glaciar, y puede estar a flote o varado. Los témpanos pueden ser descriptos como tabulares, abovedados (forma de domo), inclinados, pinaculares, afectados por temperie o témpanos de glaciar.

4.3.8 **Témpano de glaciar** (*Glacier berg [en]*): Véase 10.4.2.1 - Témpano de forma irregular.

4.3.9 **Témpano tabular** (Tabular berg [en]): Véase 10.4.2.2 - *Témpano de tope plano. La mayoría de los témpanos tabulares se forman por el desprendimiento de una barrera de hielo y muestran estratos horizontales (cf isla de hielo).*

4.3.10 **Isla de hielo** (Ice island [en]): Véase 10.4.3. - *Gran trozo de hielo flotante sobresaliendo unos 5 m sobre el nivel del mar, que se ha desprendido de una barrera de hielo ártica, teniendo 30-50 m de espesor y un área de unos pocos miles de metros cuadrados a 500 km<sup>2</sup> o más, y usualmente caracterizado por una superficie regularmente ondulada lo cual le da un aspecto acanalado desde el aire.*

4.3.11 **Fragmento de tempanito** (Bergy bit [en]): Véase 10.4.4 - *Trozo grande de hielo de glaciar flotante, mostrando generalmente menos de 5 m sobre el nivel del mar pero más de 1 m y normalmente de unos 100-300 m<sup>2</sup> de área.*

4.3.12 **Gruñón** (Growler [en]): Véase 10.4.5 – **Enmendado en ETSI-I (2001) para leer:** *Pieza de hielo más pequeña que un fragmento de tempanito y flotando menos de 1 m sobre la superficie del mar, un gruñón generalmente aparece blanco pero algunas veces transparente o de color azul verdoso. Se extiende menos de 1 m sobre la superficie del mar y normalmente ocupando un área de alrededor de 20 m<sup>2</sup>, los gruñones son difíciles de distinguir cuando están rodeados de hielo marino o en fuerte estado de mar.*

#### **4.4 Distribución (Arrangement [en]):**

4.4.1 **Campo de hielo** (Ice field [en]): *Área de hielo flotante consistente en cualquier tamaño de bandejón, superior a 10 km a través.*

4.4.1.1 **Campo de hielo grande** (Large ice field [en]): *Campo de hielo de más de 20 km a través.*

4.4.1.2 **Campo de hielo medio** (Medium ice field [en]): *Campo de hielo de 15-20 km a través.*

4.4.1.3 **Campo de hielo chico** (Small ice field [en]): *Campo de hielo de 10-15 km a través.*

4.4.1.4 **Manchón de hielo** (Ice patch [en]): *Área de hielo flotante de menos de 10 km a través.*

4.4.2 **Macizo de hielo** (Ice massif [en]): *Acumulación variable de hielo cerrado o muy cerrado cubriendo cientos de kilómetros cuadrados que es encontrada en la misma región cada verano.*

4.4.3 **Faja de hielo** (Belt [en]): *Rasgo grande de una distribución de hielo a la deriva; más largo que ancho; desde 1 km a más de 100 km de ancho.*

4.4.4 **Lengua** (Tongue [en]): *Saliente del borde del hielo de varios kilómetros de longitud, causada por viento o corriente.*

4.4.5 **Cinta de hielo** (Strip [en]): *Área larga y angosta de hielo flotante, de alrededor de 1 km o menos de ancho, usualmente compuesta de fragmentos pequeños, separados de la masa principal de hielo y unidos bajo la influencia del viento, el mar de leva o la corriente.*

4.4.5.1 **Istmo de hielo** (Ice isthmus [en]): *Conexión angosta entre dos áreas de hielo muy cerradas o compactas. Puede ser difícil de atravesar, mientras sea parte algunas veces de una ruta recomendada.*

4.4.6 **Caleta** (Bight [en]): Entrada pronunciada en el borde del hielo producida por viento o corriente.

4.4.7 **Hielo apiñado** (Ice jam [en]– Enmendado por ETSI-I (2001) para leer: Acumulación de hielo roto de río o de mar sin movimiento debido a alguna restricción física y resistiendo a presiones.

4.4.8 **Borde de hielo** (Ice edge [en]): Demarcación en cualquier momento dado entre el mar abierto y el hielo marino de cualquier tipo, sea fijo o a la deriva. Puede ser compacto o difuso (cf frontera de hielo).

4.4.8.1 **Borde compacto de hielo** (Compacted ice edge [en]): Borde de hielo claramente definido, cerrado, compactado por viento o corriente; usualmente a barlovento de un área de hielo a la deriva.

4.4.8.1.1 **Barrera de hielo apiñado de escombros** (Jammed brash barrier [en]): Cinta o faja angosta de hielo nuevo, joven o escombros de hielo (generalmente de 100 a 5.000 m de ancho) formada en el borde de ambos hielo a la deriva o fijo o en la costa. Es extremadamente compacta debido a la acción del viento y puede extenderse de 2 a 20 metros bajo de la superficie, pero normalmente no tiene topografía apreciable. Una barrera de hielo apiñado de escombros puede dispersarse con cambios del viento pero puede también consolidarse para formar una inusual cinta de hielo grueso comparada con el hielo a la deriva circundante.

4.4.8.2 **Borde difuso de hielo** (Diffuse ice edge [en]): Borde de hielo pobremente definido limitando un área de hielo disperso; usualmente a sotavento de un área de hielo a la deriva.

4.4.8.3 **Límite de hielo** (Ice limit [en]): Término climatológico referido a la extensión extrema mínima o extrema máxima del borde de hielo correspondiente a un mes o período basado en observaciones sobre un número de años. El término debe ser precedido por mínimo o máximo (cf borde medio de hielo).

4.4.8.4 **Borde medio de hielo** (Mean ice edge [en]): Posición media del borde de hielo en algún mes o período dada basada en observaciones sobre un número de años. Otros términos que pueden utilizarse son borde máximo medio del hielo y borde mínimo medio del hielo (cf límite de hielo).

4.4.8.5 **Borde de hielo fijo** (Fast-ice edge [en]): La demarcación en cualquier momento dado entre hielo fijo y aguas libres.

4.4.9 **Frontera de hielo** (Ice boundary [en]): La demarcación en cualquier momento dado entre el hielo fijo y el hielo a la deriva o entre áreas de hielos a la deriva de diferentes concentraciones (véase borde de hielo).

4.4.9.1 **Frontera de hielo fijo** (Fast ice boundary [en]): La frontera de hielo en algún momento dado entre el hielo fijo y el hielo a la deriva.

4.4.9.2 **Frontera de concentraciones** (Concentration boundary [en]): Línea aproximando la transición entre dos áreas de hielo a la deriva con concentraciones claramente diferentes.

4.4.10 **Lengua de témpano** (Iceberg tongue [en]): Véase 10.4.2.3. – Una mayor acumulación de témpanos proyectada desde la costa, retenida en su lugar por varadura y unidos entre sí por hielo fijo.

## 5. Procesos de movimiento de hielo flotante (Floating-ice motion processes [en]):

5.1 **Divergencia** (*Diverging [en]*): Campos de hielo o bandejones que en un área están sujetos a movimientos divergentes o dispersivos, de esta manera reduciendo la concentración de hielo y/o aliviando tensiones en el hielo.

5.2 **Compactación** (*Compacting [en]*): Se dice que trozos de hielo flotante se están compactando cuando ellos están sujetos a un movimiento de convergente, que incrementa la concentración de hielo y/o produce tensiones que pueden resultar en deformación de hielo.

5.3 **Cortante** (*Shearing [en]*): Área de hielo a la deriva que está sometida a cortante cuando el movimiento de hielo varía significativamente en la dirección normal a la del movimiento, sometiendo al hielo a fuerzas rotacionales. Estas fuerzas pueden resultar en fenómeno similar a la cisura.

## 6. Procesos de deformación (**Deformation processes [en]**): null

6.1 **Fracturamiento** (*Fracturing [en]*): Proceso de presión por medio del cual el hielo es permanentemente deformado, y las rupturas ocurren. Más comúnmente utilizado para describir quebraduras a través del hielo muy cerrado, hielo compacto y hielo consolidado.

6.2 **Amonticulamiento** (*Hummocking [en]*): Proceso de presión por el cual el hielo marino es forzado a formar montículos. Cuando los bandejones giran en el proceso se llaman arremolinados.

6.3 **Acordonamiento** (*Ridging [en]*): Proceso de presión por el cual el hielo marino es forzado a formar cordones.

6.4 **Sobreescurrecimiento** (*Rafting [en]*): Proceso de presión mediante el cual un trozo de hielo pasa por encima de otros. Más común en hielo nuevo y joven (cf sobreescurrecimiento de dedos).

6.4.1 **Sobreescurrecimiento de dedos** (*Finger rafting [en]*): **Enmendado por ETSI-I (2001) para leer:** Tipo de sobreescurrecimiento por el cual los encastrados entrelazados están formados como “dedos” alternadamente sobre y debajo del otro hielo. Esto es comúnmente encontrado en nilas y hielo gris. (Fue observado que el sobreescurrecimiento de dedos en hielo gris es común en la Antártida).

6.5 **Hielo montado sobre la costa** (*Shore ice ride-up [en]*): Proceso por el cual el hielo es empujado a la costa como una placa.

6.6 **Efectos de temperie** (*Weathering [en]*): Procesos de ablación y acumulación los cuales eliminan gradualmente las irregularidades en una superficie de hielo.

## 7. Aberturas en el hielo (**Openings in the ice [en]**): null

7.1 **Fractura** (*Fracture [en]*): Cualquier quebradura o ruptura a través de hielo muy cerrado, hielo compacto, hielo consolidado, hielo fijo o de un bandejón aislado como consecuencia de procesos de deformación. Las fracturas pueden contener escombros de hielo y/o pueden estar cubiertas con nilas y/o hielo joven. La extensión puede variar de unos pocos metros a varios kilómetros.

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7.1.1 **Rajadura** (*Crack [en]*): Cualquier fractura de hielo fijo, hielo consolidado o de un bandejón aislado la cual puede haber sido seguida de una separación de unos pocos centímetros a 1 m.

7.1.1.1 **Rajadura de marea** (*Tide crack [en]*): Rajadura en la línea de unión entre pie de hielo o pared de hielo inmóviles y hielo fijo, este último sujeto a subir y bajar por la marea.

7.1.1.2 **Grieta** (*Flaw [en]*): Zona de separación angosta entre hielo a la deriva y hielo fijo, en donde los trozos de hielo se encuentran en estado caótico; se forma cuando el hielo a la deriva cizalla bajo el efecto de viento fuerte o corriente a lo largo de fornera de hielo fijo (cf cortante).

7.1.2 **Fractura muy chica** (*Very small fracture [en]*): 1 a 50 m de ancho.

7.1.3 **Fractura chica** (*Small fracture [en]*): 50 a 200 m de ancho.

7.1.4 **Fractura media** (*Medium fracture [en]*): 200 a 500 m de ancho.

7.1.5 **Fractura grande** (*Large fracture [en]*): Más de 500 m de ancho.

7.2 **Zona de fractura** (*Fracture zone [en]*): Área que tiene gran número de fracturas

7.3 **Canal** (*Lead [en]*): Cualquier fractura o pasaje a través del hielo marino que es navegable por embarcaciones de superficie.

7.3.1 **Canal costero** (*Shore lead [en]*): Canal entre hielo a la deriva y la costa o entre hielo a la deriva y el frente del hielo.

7.3.2 **Canal grietado** (*Flaw lead [en]*): Pasaje entre hielo a la deriva y hielo fijo que es navegable por embarcaciones de superficie.

7.4 **Polinia** (*Polynya [en]*): Cualquier abertura de forma irregular encerrada en hielo. Las polinias pueden contener escombros de hielo y/o estar cubiertas con hielo nuevo, nilas o hielo joven.

7.4.1 **Polinia costera** (*Shore polynya [en]*): Polinia entre hielo a la deriva y la costa o entre hielo a la deriva y el frente del hielo.

7.4.2 **Polinia grietada** (*Flaw polynya [en]*): Polinia entre hielo a la deriva y hielo fijo.

7.4.3 **Polinia recurrente** (*Recurring polynya [en]*): Polinia, que reaparece en la misma posición cada año.

## 8. Características (o rasgos) de la superficie del hielo (**Ice-surface features [en]**):

8.1 **Hielo plano** (*Level ice [en]*): Hielo marino el cual no ha sido afectado por deformación.

8.2 **Hielo deformado** (*Deformed ice [en]*): Término general para el hielo que ha sido apretado entre sí y en algunos lugares forzado a movimientos verticales hacia arriba (y hacia abajo). Subdivisiones son hielo sobreescurrido, hielo acordonado y hielo amonticulado.

8.2.1 **Hielo sobreescurrido** (*Rafted ice [en]*): Tipo de hielo deformado que se forma por pasaje de un trozo sobre otro (cf sobreescurrimiento de dedos).

8.2.1.1 **Hielo sobreescurrido con forma de dedos** (*Finger rafted ice [en]*): Tipo de hielo sobreescurrido en el cual los bandejones se asemejan a 'dedos' entrelazados alternándose uno arriba y otro abajo.

8.2.2 **Cordón de hielo** (*Ridge [en]*): Línea o pared de hielo quebrado forzado hacia arriba por presión. Puede ser nuevo o erosionado. El volumen sumergido de hielo quebrado bajo un cordón, forzado hacia abajo por presión, se denomina quilla de hielo.

8.2.2.1 **Cordón de hielo nuevo** (*New ridge [en]*): Cordón recientemente formado con picos agudos y la pendiente de sus costados usualmente de 40°. Los fragmentos son visibles desde el aire a baja altura.

8.2.2.2 **Cordón de hielo afectado por temperie** (*Weathered ridge [en]*): Cordón con sus topes suavizados y redondeados, y la pendiente de sus costados usualmente de 30° a 40°. Fragmentos individuales no son visibles.

8.2.2.3 **Cordón de hielo muy afectado por temperie** (*Very weathered ridge [en]*): Cordón con sus topes muy redondeados, la pendiente de sus costados usualmente de 20° - 30°.

8.2.2.4 **Cordón de hielo viejo** (*Aged ridge [en]*): Cordón que ha sido sometido a un considerable desgaste. Estos cordones son mejor descriptos como ondulaciones.

8.2.2.5 **Cordón de hielo consolidado** (*Consolidated ridge [en]*): Cordón en el cual la base se ha soldado entre si por congelación.

8.2.2.6 **Hielo acordonado** (*Ridged ice [en]*): Hielo apilado al azar, un trozo sobre otro formando cordones o paredes de hielo. Normalmente se encuentra en hielo de primer año (cf acordonamiento).

8.2.2.6.1 **Zona de hielo acordonado** (*Ridged ice zone [en]*): Area en la cual se ha formado mucho hielo acordonado con características similares.

8.2.2.7 **Cordón de cortante** (*Shear ridge [en]*): Formación de un cordón de hielo que se desarrolla cuando un tipo de hielo pasa rozando a otro. Este tipo de cordón es más lineal que aquellos causados por presión solamente.

8.2.2.7.1 **Campo de cordón de cortante** (*Shear ridge field [en]*): Muchos cordones de cortante uno al lado de otro.

8.2.3 **Montículo** (*Hummock [en]*): Loma pequeña de hielo quebrado que ha sido forzado hacia arriba por efecto de la presión. Puede ser nuevo o erosionado. El volumen sumergido de hielo quebrado debajo del montículo por efecto de presión se denomina bummock.

8.2.3.1 **Hielo amonticulado** (*Hummocked ice [en]*): Hielo marino apilado al azar un trozo sobre otro para formar una superficie irregular. Cuando han sido afectados por temperie, toma la apariencia de suaves lomas.

8.2.3.2 **Campo de escombros** (*Rubble field [en]*): Área de hielo marino extremadamente deforme de espesor inusual formada durante el invierno por el movimiento del hielo a la deriva en contra, o alrededor de una roca sobresaliente, islote u otra obstrucción.

8.3 **Bandejón levantado** (*Standing floe [en]*): Bandejón de hielo separado, parado verticalmente o inclinado y encerrado por hielo preferentemente más plano.

8.4 **Espolón** (*Ram [en]*): *Proyección sumergida de hielo de una pared de hielo, frente del hielo, témpano o bandejón. Su formación es usualmente debida a derretimiento y erosión muy intensa de la parte sumergida.*

8.5 **Hielo desnudo** (*Bare ice [en]*): *Hielo sin cobertura de nieve.*

8.6 **Hielo nevado** (*Snow-covered ice [en]*): *Hielo cubierto con nieve.*

8.6.1 **Sastrugi** (*Sastrugi [en]*): *Cordones irregulares y agudos formados sobre una superficie nevada por erosión del viento y deposición. En hielo a la deriva los cordones son paralelos a la dirección del viento predominante en el momento en que ellos fueron formados.*

8.6.2 **Nieve a la deriva** (*Snowdrift [en]*): *Acumulación de nieve arrastrada por el viento depositada a sotavento de obstrucciones o protuberancias por los remolinos del viento. Nieve a la deriva con forma de luna creciente, con las puntas apuntando viento abajo, es conocida como barca de nieve.*

## 9. Etapas de fusión (Stages of melting [en]):

9.1 **Charco** (*Puddle [en]*): *Acumulación de agua líquida sobre el hielo, principalmente debido al derretimiento de la nieve, pero en los estados más avanzados también por el derretimiento del hielo. La etapa inicial consiste de parches de nieve derretida.*

9.2 **Alvéolos de fusión** (*Thaw holes [en]*): *Agujeros verticales en el hielo marino formados cuando la fusión de los charcos de superficie lo atraviesan hasta el agua subyacente.*

9.3 **Hielo seco** (*Dried ice [en]*): *Hielo marino de la superficie del cual ha desaparecido el agua líquida luego de la formación de grietas y alvéolos de fusión. Durante el período de secado, la superficie se emblanquece.*

9.4 **Hielo podrido** (*Rotten ice [en]*): *Hielo marino que se ha comenzado a alveolarse y que se encuentra en un estado avanzado de desintegración.*

9.5 **Hielo inundado** (*Flooded ice [en]*): *Hielo marino que ha sido inundado por agua líquida o agua de río y es pesadamente cargado de agua y nieve húmeda.*

9.6 **Fusión costera** (*Shore melt [en]*): *Agua libre entre la costa y el hielo fijo, formada por la fusión y/o como resultado de una descarga de río.*

## 10. Hielo de origen terrestre (Ice of land origin [en]): null

10.1 **Neviza** (*Firn [en]*): *Nieve vieja que ha recristalizado en un material denso. A diferencia de la nieve ordinaria, las partículas son hasta cierto punto juntadas unas con otras, pero, a diferencia del hielo, los espacios de aire en ese material aún se conectan entre sí.*

10.2 **Hielo de glaciar** (*Glacier ice [en]*): *Hielo en, u originándose de, un glaciar, ya sea sobre tierra o flotando en el mar como témpanos, tempanitos o gruñones.*

10.2.1 **Glaciar** (*Glacier [en]*): *Masa de nieve y hielo continuamente en movimiento de la parte superior a la inferior del terreno o, si está a flote, extendiéndose continuamente. Las formas principales de glaciar son: sábanas de hielo tierra adentro, barreras de hielo, corrientes de hielo, casquetes de hielo, hielos de piedmonte, circos glaciares y varios tipos de glaciares de montaña (valle).*



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10.2.2 **Pared de hielo** (*Ice wall [en]*): Acantilado de hielo formando el margen hacia el mar de un glaciar que no está a flote. Una pared de hielo está varada, el basamento rocoso está a nivel o por debajo del nivel ma. (cf frente de hielo).

10.2.3 **Corriente de hielo** (*Ice stream [en]*): Parte de una sabana de hielo de tierra adentro en la que el hielo fluye más rápidamente y no necesariamente en la misma dirección que el hielo circundante. Los márgenes están a veces claramente determinados por un cambio en la dirección de la superficie de la ladera pero puede ser indistinto.

10.2.4 **Lengua de glaciar** (*Glacier tongue [en]*): Extensión de un glaciar proyectada hacia el mar, usualmente a flote. En la Antártida, las lenguas de glaciar pueden extenderse sobre varias decenas de kilómetros.

10.3 **Barrera de hielo** (*Ice shelf [en]*): Sabana de hielo flotante de considerable espesor, 2-50 m o más sobre el nivel del mar, anexada a la costa. Usualmente tiene una gran extensión horizontal y con una superficie plana o suavemente ondulada. Alimentada por acumulaciones anuales de nieve y a menudo también por la extensión hacia el mar de glaciares terrestres. Áreas limitadas pueden estar varadas. El borde hacia el mar de la barrera de hielo se denomina frente de hielo (qv).

10.3.1 **Frente del hielo** (*Ice front [en]*): Acantilado vertical que forma la cara hacia el mar de una barrera de hielo u otro glaciar flotando variando la altura de 2-50 m o más sobre el nivel del mar (cf pared de hielo).

#### **10.4 Hielo desprendido de origen terrestre (Calved ice of land origin [en]):**

10.4.1 **Desprendimiento** (*Calving [en]*): La fractura y separación de una masa de hielo desde una pared de hielo, frente de hielo o témpano.

10.4.2 **Témpano** (*Iceberg [en]*): Véase 10.4.2. – Trozo de hielo macizo de formas muy variadas, sobresaliendo más de 5 m sobre el nivel del mar, que se ha desprendido de un glaciar, y puede estar a flote o varado. Los témpanos pueden ser descriptos como tabulares, abovedados (forma de domo), inclinados, pinaculares, afectados por temperie o témpanos de glaciar.

10.4.2.1 **Témpano de glaciar** (*Glacier berg [en]*): Témpano de forma irregular.

10.4.2.2 **Témpano tabular** (*Tabular berg [en]*): Témpano de tope chato o plano. La mayor parte de los témpanos tabulares se forman por fractura y separación de una barrera de hielo y muestran estratos horizontales. (cf isla de hielo).

10.4.2.3 **Lengua de témpano** (*Iceberg tongue [en]*): Una mayor acumulación de témpanos proyectada desde la costa, retenida en su lugar por varadura y unidos entre sí por hielo fijo.

10.4.3 **Isla de hielo** (*Ice island [en]*): Gran trozo de hielo flotante sobresaliendo unos 5 m sobre el nivel del mar, que se ha desprendido de una barrera de hielo ártica, teniendo 30-50 m de espesor y un área de unos pocos miles de metros cuadrados a 500 km<sup>2</sup> o más, y usualmente caracterizado por una superficie regularmente ondulada lo cual le da un aspecto acanalado desde el aire.

10.4.4 **Fragmento de tempanito** (*Bergy bit [en]*): Trozo grande de hielo de glaciar flotante, mostrando generalmente menos de 5 m sobre el nivel del mar pero más de 1 m y normalmente de unos 100-300 m<sup>2</sup> de área.

10.4.5 **Gruñón** (Growler [en]): **Enmendado en ETSI-I (2001) para leer:** *Pieza de hielo más pequeña que un fragmento de tempanito y flotando menos de 1 m sobre la superficie del mar, un gruñón generalmente aparece blanco pero algunas veces transparente o de color azul verdoso. Se extiende menos de 1 m sobre la superficie del mar y normalmente ocupando un área de alrededor de 20 m<sup>2</sup>, los gruñones son difíciles de distinguir cuando están rodeados de hielo marino o en fuerte estado de mar.*

11. Indicaciones relativas al cielo y al aire (Sky and air indications [en]):

11.1 **Cielo de agua** (Water sky [en]): *Manchones oscuros que se observan en la base de las nubes bajas, indicando presencia de rasgos de agua en la vecindad del hielo marino.*

11.2 **Resplandor del hielo** (Ice blink [en]): *Iluminación blanquecina en las nubes bajas sobre una acumulación distante de hielo.*

11.3 **Humo de mar** (Frost smoke [en]): *Nubes semejante a neblina producidas por el contacto del aire frío con el agua de mar relativamente más cálida, que puede aparecer sobre aberturas de agua en el hielo o a sotavento del borde del hielo, y que puede persistir mientras el hielo se está formando.*

12. Términos relativos a la navegación de superficie (Terms relating to surface shipping [en]): null

12.1 **Atrapado** (Beset [en]): *Situación de un buque rodeado por el hielo e imposibilitado de moverse.*

12.2 **Cercado por el hielo** (Ice-bound [en]): *Un puerto, caleta, etc., se dice que está cercado por el hielo cuando la navegación por buques queda impedida a causa del hielo, excepto posiblemente con asistencia de un rompehielos.*

12.3 **Comprimir** (Nip [en]): *Se dice que el hielo comprime cuando presiona fuertemente contra un buque. Un buque así atrapado, aunque no dañado, se dice que ha sido comprimido.*

12.4 **Hielo bajo presión** (Ice under pressure [en]): *Hielo en el cual los procesos de deformación están ocurriendo activamente y en consecuencia presentan impedimento potencial o peligro para la navegación.*

12.5 **Área dificultosa** (Difficult area [en]): *Expresión cualitativa general que indica, de manera relativa, que la severidad de las condiciones hielo prevaleciendo en un área es tal que la navegación en ella es dificultosa.*

12.6 **Área accesible** (Easy area [en]): *Expresión cualitativa general que indica, de manera relativa, que las condiciones de hielo prevaleciendo en un área son tales que la navegación en ella no es difícil.*

12.7 **Área de debilidad** (Area of weakness [en]): *Área observada por satélite en la que o bien la concentración o el espesor del hielo es significativamente inferior que aquél de las áreas circundantes. Porque la situación es observada por satélite, no siempre es posible un análisis cuantitativo preciso, pero las condiciones de navegación son significativamente más fáciles que en áreas circundantes.*

12.8 **Puerto de hielo** (*Ice port [en]*): Bahiamiento en el frente del hielo, a menudo de naturaleza temporaria, en donde los buques pueden amarrar a lo largo y descargar directamente sobre la barrera de hielo.

### 13. Términos relativos a la navegación submarina (Terms relating to submarine navigation [en]):

13.1 **Techo de hielo** (*Ice canopy [en]*): Hielo a la deriva desde el punto de vista del submarinista.

13.2 **Hielo amigable** (*Friendly ice [en]*): Desde el punto de vista del submarinista, un techo de hielo conteniendo muchas lumbreras grandes u otros rasgos que permiten al submarino emerger a la superficie. Deberá haber más de diez de tales lumbreras por cada 30 millas náuticas (56 km) a lo largo de laderrota del submarino.

13.3 **Hielo hostil** (*Hostile ice [en]*): Desde el punto de vista del submarinista, techo de hielo que no contiene grandes lumbreras u otros rasgos que permitan un submarino emerger a la superficie.

13.4 **Fondo de hielo** (*Bummock [en]*): Desde el punto de vista del submarinista, la proyección hacia abajo desde el lado inferior del hielo del techo de hielo, la contraparte de un montículo.

13.5 **Quilla de hielo** (*Ice keel [en]*): Desde el punto de vista del submarinista, la proyección hacia abajo de un cordón sobre el lado de abajo de un techo de hielo; la contraparte de un cordón. Las quillas de hielo pueden extenderse hasta 50 m por debajo del nivel del mar.

13.6 **Lumbreras** (*Skylight [en]*): Desde el punto de vista del submarinista, capas delgadas en el techo de hielo, usualmente de menos de 1 m de espesor y una apareciendo desde abajo como manchas relativamente claras, translúcidas en la oscuridad circundante. La superficie inferior de estas lumbreras es normalmente chata. Las lumbreras son llamadas grandes si es lo bastante gran para permitir la emersión de un submarino a través de ellas (120 m) o pequeñas si no lo permiten.

## WMO SEA ICE NOMENCLATURE

### Explanatory note

1. The quality of providing information on the ice cover state to the users is determined to a great extent by completeness and consistency of four main documents: Nomenclature (terminology), scales, system of symbols and format (code). The development of these documents should take into account:

- physical essence of a process or a phenomenon,
- limits of possible quantitative values,
- significance of information on the given characteristic for users,
- technical possibility of determining and the accuracy,
- illustrativity of the cartographic depiction of information,
- minimum (without loss of accuracy) volume of coded digital or letter-digital ice chart.

2. The “WMO Sea-Ice Nomenclature”, which is currently effective, was developed by the WMO CMM WG in 1968 and published in 1970 (without scales and symbols). In 1989, it was republished in the form of Supplement No.4, where volume 3 “International system of sea-ice symbols” is presented, and Supplement No.5, presenting several supplemented and edited main sections of the Nomenclature (ice terms arranged in the subject and alphabetical orders). No international format (code) for operational provision of users and data exchange has yet been developed.

3. During the period of the development of the Nomenclature, the visual air - and shipborne observations were the main method of ice information collection, which influenced inevitably the composition and formulation of terms.

4. Along with an excessively detailed description of some ice features that are not even depicted on the ice charts (separate ice ridges, standing floes, rams, etc.), the Nomenclature does not contain a number of notions and terms that are already applied in practice of the ice services (ice cover, zone, ice drift, drift divide, etc.). An absence of these terms and notions, extremely important for investigators and navigators, leads to a possibility of different understanding of information plotted on the chart.

5. Sometimes the physical essence of a phenomenon and bounds of possible quantitative values are not taken into account. Thus, the terms 6.2 Hummocking and 6.3 Ridging are presented as different deformation processes although this is in fact a result of one process – ice pressure.

6. The extent ice surface coverage with ice hummocks and ice ridges according to Nomenclature can be expressed either in partial concentration of the area of ridges in tenths or in the quantity per nautical mile. However, the expression in tenths does not take into account the limit of the maximum possible value of hummock and ridge concentration, which is not greater than 20%.

*Some recommendations for compiling the ice charts also cause objections.*

7. In particular, we consider incorrect in principle the recommendations of the effective nomenclature on depiction of ice forms of each age stage. The ice cover of the seas presents as a rule ice breccia of different age. Only the oldest ice has at this the shape of ice fields, whereas all other ice – frozen in different periods after the onset of ice formation areas of ice-free water, fractures and leads. As a result of this recommendation, the drifting ice forms are not indicated on the ice charts at all at the present time. The aforementioned facts determine the need and the importance of developing a new version of WMO Nomenclature on Sea Ice.

### **Specific features of the Draft Nomenclature**

8. The developed preliminary Draft Nomenclature consists of 11 sections including 120 terms. The successive order of the sections is given in accordance with the succession of compiling the ice charts and their coding. Whenever possible, the terms of the existing Nomenclature were preserved. These terms are followed by their number in the Nomenclature in brackets. If the term notion was edited, "ed" follows the number. Some terms that are not used for compilation of the ice charts but can be used in the text messages are included in a description of the main term. For example, a description of landfast ice includes a description of the notions "Ice foot" and "Young coastal ice". After such terms several Nomenclature numbers are given.

9. The Draft Nomenclature includes 22 new terms with part of them being already used during ice observations without preliminary permission ("*residual first-year ice*", "*rough ice*", etc.). The definitions of the main zones and their types (*landfast ice, drifting ice, individual field, iceberg waters, clear*) are given. These new terms are given by sections:

Section 1:

- 1.2 *Ice cover*;
- 1.7 *No observational data*;
- 1.8 *Zone*;
- 1.8.1 *Basic zones*;
- 1.8.2 *Additional zones*.

Section 2:

- 2.4.3 *Strips, patches*.

Section 3:

- 3.5.1 *Residual first-year ice*;
- 3.6 *Ice age composition*.

Section 5:

- 5.1 *Ice floe*.

Section 6:

- 6.2.2 *Rough ice*;
- *Hillocky multiyear ice*;
- 6.5 *Dirty ice*.

Section 7:

- 7.4 *Barrier of ice ridges*;
- 7.7 *Jammed brash barrier*.

Section 9:

- *Fracture*.

Section 10:

- 10.1 *Ice drift*;
- 10.1.1 *Drift vector*;
- 10.1.2 *Drift divide*;
- 10.5 *Ice pressure*;
- 10.5.1 *Zone of pressure*.

Section 11

- 11.6 *Recommended place*;
- 11.7 *Recommended route*;
- 11.8 *Channel in ice made by a ship (vessel)*.

10. The following terms and sections were excluded (by the numbers of the existing Nomenclature):

- 2.3 *Pancake ice* – the term description is given in the section of Forms;
- 3.1.1 *Young coastal ice* and 3.2 *Landfast ice foot* are included to the description of the main term;
- 3.1 *Landfast ice* and 3.3 *Anchor ice* – as a feature typical only of rivers;
- 4.2.1.1 *Consolidated floating ice* - there is a term "*Ice breccia*";

- 4.3.7.- 4.3.12 *Icebergs* and their types in the section of Forms – a full description of these terms is given in the section “*Ice of land origin*”;
- 4.4.1.1 *Large ice field*, 4.4.1.2 *Medium ice field*, 4.4.1.3 *Small ice field*, 4.4.3 *Ice belt*, 4.4.4 *Ice tongue*, 4.4.6 *Bight* – these features are described by their boundaries, hence separate terms are not needed;
- 7.1.2 *very small fracture*, 7.1.3 *Small fracture*, 7.1.4 *Medium fracture*, 7.1.5 *Large fracture* - are either described by the boundaries or are not depicted on the ice charts;
- 7.4.1 *Shore polynyas*, 7.4.2 *Flaw polynya*, 7.4.3 *Recurring polynya* – are transferred to the description of the term “*Polynya*”;
- 8.2.1.1 *Finger rafter ice* – transferred to the description of the term “*Rafted ice*”, it was not taken into account that the character of rafting is not reflected on the ice charts;
- 8.2.2.1 *New ridge*, 8.2.2.2 *Weathered ridge*, 8.2.2.3 *Very weathered ridge*, 8.2.2.4 *Aged ridge*, 8.2.2.5 *Consolidated ridge*, 8.3 *Standing floe* – the types of ice ridges are not depicted on the ice charts;
- 10.1 *Firn*, 10.2.3 *Ice stream* – a description of inland glaciers, which is not in the objectives of the Nomenclature;
- 12.4 *Ice under pressure* – repetition of the term;
- 12.7 *Ice port* - described by the boundary of the ice front;
- Section 6 “*Deformation processes*” is excluded. The term 6.1 *Fracturing* is transferred to the section “*Floating ice motion processes*”;
- Section 11 “*Sky and air indications*” is excluded. Data obtained as a result of such observations cannot be considered reliable at present and used for operational and research purposes;
- Section 13 “*Terms relating to submarine navigation*” is excluded – the terms in this section cannot be used in compiling the ice charts.

*Annex I to the Draft Nomenclature presents code tables, symbols and conventional designations.*

11. For coding information for attributive description of zones and ice objects, their area used code tables 1 – 8 ensuring unambiguous determination of each variable (characteristic) of ice in the zones or of ice objects and tables 9 – 18 – scales for a quantitative or qualitative assessment of these characteristics.

12. Each variable (characteristic) of ice in a zone or an ice object is coded by a two-letter identifier (code symbol). The first letter defines belonging to some or other information block (code table), and the second – a specific variable value, that is the term of the Nomenclature defining it. Then, the code figures of relative area, points of assessment or true values (size, thickness, azimuth, etc.) follow.

13. Thus, the proposed coding system clearly separates designation of the notions and quantitative characteristics and excludes the need for preserving a constant place for each variable in the attributive description of zones and the use of the term “*Undetermined/unknown*”. That is why the advisability of such coding system is obvious.

14. Code tables 1-8 were made on the basis of multiyear experience and have already been used for a number of years for ice information coding in the SIGRID-2 and in Shapefile formats. A letter rather than a digital designation of variables clearly separates the code symbols of the variables and their quantitative values excluding the need for preserving a constant place for each variable in the attributive description of zones and the use of the term “*Undetermined/unknown*”. That is why the advisability of such coding system is of no doubt.

15. However, the situation with the scales (Tables 9–18) cannot be considered as satisfactory. As indicated in the Introduction to Annex 1, the main scales (of pressure, stage of melting, snow cover thickness, size of icebergs) are presented from Supplement No. 4 of 1989 to the WMO Nomenclature. Similar to the Nomenclature itself, they are mainly intended for coding data obtained as a result of visual observations and completely do not take into account the possibilities of modern satellite remote sensing tools.

16. A scale of one of the most important ice cover characteristics “Stages of melting” can serve as an example. It reflects not the ice cover decay as a result of melting, but the external indications of the process and most of them can be determined only visually and has some other deficiencies. Similar comments can be also made for some other scales.

17. However, now only general comments can be formulated on these scales with indication of their shortcomings. For their specification or to be more exact, for the development of new versions, it is necessary to undertake special studies including joint international research.

18. Some scales, in particular of the snow thickness and sizes of icebergs, are proposed to be excluded and replaced with the indication of snow thickness in decimeters, horizontal sizes of specific glacier bergs in tens of metres and tabular bergs in hundreds of metres. Some columns of the code tables contain symbols and conventional designations.

19. Similar to the existing Nomenclature, two alternative variants of the symbols are proposed – numerical and graphical symbols. The graphical symbols are more illustrative, while the logic of their construction significantly facilitates storage. In addition, the graphical symbols allow a more compact transmission of information. One symbol can describe the age and the prevailing forms of the oldest ice while in the graphical symbol of the largest forms of breccia fields, their partial concentration, which is an important navigation characteristic, can be indicated. However, a system of numerical symbols is constantly used in the practice of the majority of national ice centres, and the users have been already accustomed to it. This determines the need for preserving two options.

20. The international format for exchange and dissemination of data on the ice situation should provide data transmission via the communication lines and storage of spatially distributed information on the ice cover characteristics and include the attributive and spatial components. For using the received coded information for operational purposes, it is converted to a cartographic image, whereas at the ice centres, its statistical processing and calculations are performed and forecasts are developed using geo-information technologies. Annex 2 considers an order of using ice symbols presented in Annex 1 and the technology for preparing and drawing up the graphical ice charts.

21. In compliance with the currently existing International System of Sea-Ice Symbols, the forms of ice features are coded and depicted on the ice charts only by the numerical symbols. A possibility for using two variants is envisaged: indication of the forms of each ice age category or indication of the prevailing and secondary sizes of the ice fields. The principal deficiencies of the first and second variants were repeatedly pointed out. Only the oldest ice has the form of fields, whereas the ice conditions are determined not by the prevailing forms, but by the largest forms and their partial concentration. As a result, this important ice cover characteristic determining to a great extent the ice conditions of practical activity in the ice-infested seas is typically not depicted at all on the ice charts.

22. In the proposed draft, the attributes of the zones include the prevailing forms of the oldest ice and the forms of the largest breccia fields with the indication of their partial concentration. These data can be most fully and clearly depicted by using the graphical symbols. Therefore, the graphical symbols are proposed as the main variant and the numerical symbols as substituting them. The proposed drafts of the main section and annexes probably appear to be a first approximation of the final variant of the new version of the WMO Nomenclature on Sea-Ice and require further specifying, addition and editing.

### **Introduction to revised version**

This version of the new WMO Sea Ice Nomenclature has been edited from that written by Dr Bushuyev to reflect normal English usage. Where possible the original sense has been kept, however in places it was not possible to decide unambiguously what was intended. I have used change tracking to show all the amendments that I have made. Note:

- a) Some entries go beyond simple definitions. We need to decide if such items are best given in the nomenclature or in the glossary.
- b) In places the text is inconsistent. For example pack ice is defined, but drift ice is used in the text. I have changed the text to match the definitions, but I may have missed some entries.
- c) If I have made changes beyond correction of the English this is indicated by [Note: ....]
- d) I have added a few additional notes on current UK Antarctic practice, again indicated by [Note: ....]



## WMO GLOSSARY ON SEA ICE COVER

### 1. Main notions and definitions

#### 1.1 *Floating ice*

Any form of ice floating in water. The principal kinds of floating ice at the sea surface are sea ice which formed by the freezing of sea water at the surface, lake ice and river ice formed on the river or lake and glacier ice (ice of land origin). The concept also includes ice that is grounded. (1. Ed.)

##### 1.1.1 *Sea ice*

Ice, which has originated from the freezing of sea water. It presents the main kind of floating ice encountered at sea. (1.1.Ed.)

##### 1.1.2 *Ice of land origin*

Ice formed on land or in an ice shelf, found floating in water (1.2 Ed.)

##### 1.1.3 *River, lake ice*

Ice formed on a river or on a lake and exported to sea during the autumn or spring ice drifting. The river ice fields are depicted on radar images similar to the old fields. It differs significantly by its mechanical and electrical-magnetic characteristics from sea ice of the same age.

#### 1.2 *Ice cover*

A set of ice floes covering some or other water area regardless of their age, concentration, mobility and other characteristics. Thus, this is the most general notion requiring as a rule further specification. The ice cover boundaries are the ice edge and the coastline.

#### 1.3 *Fast ice*

Consolidated solid fast ice attached to the shore, to an ice wall or to an ice front. It forms by freezing of the ice cover forming in the coastal zone to the shore or as a result of freezing of the drifting ice of any age category to the shore or fast ice. Vertical fluctuations may be observed during changes of sea level. It can be preserved without fracturing for two or more years transforming from first-year ice to multiyear ice and even shelf ice. The fast ice width can vary from several hundreds of meters to several hundreds of kilometers. Part of fast ice presenting a narrow fringe of ice directly attached to the coast and shallow bottom, immobile at sea level oscillations and remaining after the fast ice has moved away is called the Ice foot. Fast ice at the initial stage of formation consisting of nilas and young ice with a width up to 100-200 m is called the Young coastal ice. When coding information and depicting it on the ice charts, indication that this fast ice allows us not to indicate total concentration, which is always equal to 10/10 in accordance with the definition (3.1, 3.1.1, 3.2 Ed.).

#### 1.4 *Pack ice*

Any ice at the sea surface except for fast ice and stamukhas regardless of its age, forms, origin and other characteristics that has a possibility of forward movement (drift) under the action of winds, currents and tides. As a result of the dynamic processes (drift, diverging, converging), the total and partial concentrations of drifting ice constantly change (1.1.2 Ed.).

### 1.5 *Bergy water*

A large area of navigable water in which ice of land origin is present or possible at total concentration less than 1/10. Such zones do not usually have a clearly expressed edge (boundaries with ice-free water). A characterization of ice conditions in some area by this term can be made both on the basis of data of direct observations, and data of previous observations and also from climatic data (4.2.7 Ed.).

### 1.6 *Ice-free*

No ice present. If ice of any kind is present this term should not be used (4.2.8. Ed.)

### 1.7 *No observational data*

Zone where observations were not conducted.

### 1.8 *Zone*

Part of the water area contoured on the ice chart in a form of a closed polygon within which the ice cover characteristics given for this zone are considered similar. By the composition of variables, there is a subdivision into the basic zones and additional zones.

#### 1.8.1. *Basic zones*

They are delineated by mobility, total concentration and age categories. Such additional characteristics as hummock and ridge concentration, rafting of young ice, stages of melting are usually included to a description of characteristics of these basic zones. It is considered at this that the boundaries of the main and additional characteristics coincide. The basic zones are subdivided into the following types: Fast ice, Drifting Ice, Bergy water, Ice-free water. On the large-scale ice charts, giant and sometimes vast ice floes can be contoured and described as the main zones.

#### 1.8.2. *Additional zones*

They present separate layers of an ice chart. They are identified only by one characteristic if it is necessary to show the actual boundaries of zones of discontinuities (leads and fractures), increased hummock and ridge concentration or vice versa, level ice, zones of different stages of melting or other additional characteristics.

### 1.9 *Ice boundary*

The demarcation between fast ice and drift ice or between different zones of drift ice. When used as a climatologic term, for describing the position of the boundary of spreading of ice of any concentration or age in any given month or a period based on the observation data for a number of years, the term should be preceded by a word average, minimum or maximum with indication of the ice cover characteristic after it. For example: "Average boundary of multiyear close ice" (4.4.9 Ed.).

#### 1.9.1 *Ice edge*

The demarcation between the open sea and sea ice of any kind, whether fast (fast ice edge) or drifting. The drift ice edge may be termed compacted or diffuse (4.4.8 Ed.).

##### 1.9.1.1 *Ice limit*

Climatological term referring to the average, extreme minimum or extreme maximum extent of the ice edge in any given month or period based on observations over a number of years. Term should be preceded by the word average, minimum or maximum (4.4.8.3, 4.4.8.4 Ed.).

## 2. Arrangement

### 2.1 Area of ice cover

The ratio in percentage of the ice cover area to the total sea area or some large geographical local at a specific moment of time. This local may be global covering an area of the seas of the entire hemisphere or some part of an ocean or a sea, for example such as Baffin Bay or the Barents Sea (4.1 Ed.).

### 2.2 Concentration

The ratio of the area of ice features to the total area of a sea part (zone) delineated on the chart, expressed in tenths. The total concentration includes all stages of development and partial concentration determines the area of ice of specific age or horizontal sizes comprising only part of total concentration. The concentration within 0-1/10 and 9/10 – 10/10 during instrumental observations can be expressed in hundredths (4.2 Ed.).

#### 2.2.1. Compact pack ice

Floating ice in which the concentration is 10/10 and no water is visible (4.2.1)

##### 2.2.1.1 Consolidated ice

Floating ice in which the concentration is 10/10 and the *floes* are frozen together. (4.2.1.1)

#### 2.2.2. Very close pack ice

Floating ice in which the concentration is 9/10 and more but less than 10/10 (4.2.2.Ed.)

#### 2.2.3 Close pack ice

Floating ice, in which the concentration is 7/10 to 8/10, composed of *floes* mostly in contact (4.2.3).

#### 2.2.4 Open pack ice

Floating ice in which the ice concentration is 4/10 to 6/10, with many fractures, and the *floes* are generally not in contact with one another (4.2.4).

#### 2.2.5 Very open pack ice

Floating ice in which the concentration is 1/10 to 3/10 and water preponderates over ice (4.2.5.).

#### 2.2.6 Open water

A large area of freely navigable water in which sea ice (ice of land origin is absent) is present in concentrations less than 1/10. (4.2.6)

### 2.3 Ice massif

A variable accumulation of *close* or *very close ice* covering hundreds of square kilometers which is found in the same region every summer (4.4.2).

### 2.4 Ice field

Area of floating ice of any size, which is greater than 10 km across. The characteristics, position and sizes of fields are described as separate zones. (4.4.1 Ed.)

#### 2.4.1 *Ice patch*

Accumulation of floating ice less than 10 km across in ice-free water or among ice in smaller concentration.

#### 2.4.2 *Strip*

Long narrow zone of floating ice, about 1 km or less in width, usually composed of small fragments detached from the main mass of ice, and run together under the influence of wind, swell or current (4.4.5)

#### 2.4.3 *Strip, Patch*

The term is applied for characterizing the irregularities of the total and partial concentration in the delineated zone at impossibility of depicting the position of strips and patches on the ice chart as separate zones.

### **3. Development**

#### 3.1 *New ice*

A general term for recently formed ice which includes frazil ice, grease ice, slush and shuga. These types of ice are composed of ice crystals which are only weakly frozen together (if at all) and have a definite form only while they are afloat (2.1)

##### 3.1.1 *Frazil ice*

Fine spicules or plates of ice, suspended in water (2.1)

##### 3.1.2 *Grease ice*

A later stage of freezing than *frazil ice* when the crystals have coagulated to form a soupy layer on the surface. Grease ice reflects little light, giving the sea a matt appearance (2.1.2)

##### 3.1.3 *Slush*

Snow which is saturated and mixed with water on land or ice surfaces, or as a viscous floating mass in water after a heavy snowfall (2.1.3)

##### 3.1.4 *Shuga*

An accumulation of spongy white ice lumps, a few centimeters across; they are formed from grease ice or slush and sometimes from anchor ice rising to the surface (2.1.4)

#### 3.2 *Nilas*

A thin elastic crust of ice, easily bending on waves and swell and under pressure, thrusting in a pattern of interlocking 'fingers' (finger rafting). Has a matt surface and is up to 10 cm in thickness. May be subdivided into dark nilas and light nilas. (2.2)

##### 3.2.1 *Dark nilas*

Nilas which is under 5 cm in thickness and is very dark in color (2.2.1)

### 3.2.2 *Light nilas*

Nilas which is more than 5 cm in thickness and rather lighter in colour than dark nilas (2.2.2)

### 3.2.3 *Ice rind*

A brittle shiny crust of ice formed on a quiet surface by direct freezing or from *grease ice*, usually in water of low salinity. Thickness to about 5 cm. Easily broken by wind or swell, commonly breaking in rectangular pieces. (2.2.3)

### 3.3 *Young ice*

Ice in the transition stage between nilas and first-year ice, 10-30 cm in thickness. May be subdivided into grey ice and grey-white ice (2.4)

#### 3.3.1 *Grey ice*

Young ice 10-15 cm thick. Less elastic than nilas and breaks on swell. Usually rafts under pressure (2.4.1)

#### 3.3.2 *Grey-white ice*

Young ice 15-30 cm thick. Under pressure more likely to ridge than to raft (2.4.2)

### 3.4 *First-year ice*

Sea ice of not more than one winter's growth, developing from young ice; thickness 30 cm - 2 m, and sometimes slightly more. May be subdivided into thin first-year ice/white ice, medium first-year ice and thick first-year ice (2.5 Ed.)

#### 3.4.1 *Thin first year ice/white ice*

First-year ice 30-70 cm thick. May be subdivided into thin first-year ice of the first stage 30 to 50 cm thick and thin first-year ice of the second stage 50 to 70 cm (2.5.1.Ed.)

#### 3.4.2 *Medium first-year ice*

First-year ice 70-120 cm thick (2.5.2)

#### 3.4.3 *Thick first-year ice*

First-year ice over 120 cm thick (2.5.3)

### 3.5 *Old ice*

Sea ice which has survived at least one summer's melt; typical thickness up to 3m or more. It is subdivided into residual first-year ice, second-year ice and multi-year ice (2.6 Ed.)

#### 3.5.1 *Residual first-year ice*

First-year ice that has survived the summer's melt and is now in the new cycle of growth. It is 30 to 160-180 cm thick depending on the region where it was in summer. After 1 January (in the Southern hemisphere after 1 July), this ice is called second-year ice.

### 3.5.2 *Second-year ice*

Old ice which has survived only one summer's melt; typical thickness up to 2.5 m and sometimes more. Because it is thicker than first-year ice, it stands higher out of the water. Ridged features as a result of melting during the preceding summer attain a smoothed rounded shape. In summer, numerous puddles of extended irregular shape form on its surface. Bare ice patches and puddles are usually greenish-blue. (2.6.1 Ed.)

### 3.5.3 *Multi-year ice*

Old ice up to 3 m or more thick which has survived at least two summers' melt. Hummocks even smoother than in second-year ice and attain a look of mounds and hills. The surface of multiyear ice fields in places not subjected to deformations is also hilly due to non-uniform multiple melting. The ice is almost salt-free. Its color, where bare, is usually blue. As a result of melting, round puddles appear at its surface in summer and a well-developed drainage system is formed. (2.6.2.Ed.)

## 3.6 *Age structure of ice*

The observed or calculated by models age categories of ice and their partial concentrations. A sum of partial concentrations of ice of different age should be equal to the total ice concentration in the given zone.

## 4. **Ice of land origin**

### 4.1 *Glacier ice*

Ice in, or originating from, a glacier, whether on land or floating on the sea as icebergs, bergy bits or growlers (10.2)

### 4.2 *Glacier*

A mass of ice predominantly of atmospheric origin continuously moving from higher to lower ground. A seaward margin of a glacier, which is aground, the rock basement being at or below sea-level, is termed an Ice wall. The projecting seaward extension of a glacier, usually afloat is termed a Glacier tongue). In the Antarctic, glacier tongues may extend over many tens of kilometers. (10.2.1, 10.2.2, 10.2.4 Ed.)

### 4.3 *Ice shelf*

A floating ice sheet of considerable thickness showing 2-50 m or more above sea-level, attached to the coast or a glacier. Usually of great horizontal extent and with a level or gently undulating surface. Nourished by annual snow accumulation at the surface and often also by the seaward extension of land glaciers. Limited areas may be aground. The seaward edge is termed an Ice front. (10.3, 10.3.1 Ed.)

### 4.4 *Iceberg*

A massive piece of ice of varying shape, protruding more than 5 m above sea-level, which has broken away from a glacier or an ice shelf, and which may be afloat or aground. Icebergs by their external look may be subdivided into tabular, dome-shaped, sloping and rounded bergs. (10.4.2 Ed.)

#### 4.4.1 *Glacier berg*

An irregularly shaped iceberg (10.4.2.1)

#### 4.4.2 *A flat-topped iceberg*

Most *tabular bergs* form by *calving* from an *ice shelf* and show horizontal banding (cf. ice island). (10.4.2.2)

#### 4.4.3 *Bergy bit*

A large piece of floating ice of land origin, showing less than 5 m above sea-level and about 100-300 m<sup>2</sup> in area (10.4.4 Ed.)

#### 4.4.4 *Growler*

Smaller piece of ice of land origin than a bergy bit. The color is usually white, but sometimes transparent or blue-green, normally occupying an area of about 20 m<sup>2</sup>. The growlers are distinguished with difficulty when they are surrounded by ice and also at strong swell (10.4.5 Ed.)

#### 4.5 *Iceberg tongue*

A major accumulation of icebergs, bergy bits and growlers projecting from the coast, held in place by grounding or joined together by fast ice (10.4.2.3 Ed.)

#### 4.6 *Ice island*

A large piece of floating ice protruding about 5 m above sea-level, which has broken away from an Arctic ice shelf, having a thickness of 15-30 m and an area of from a few thousand square meters to 500 km<sup>2</sup> or more, and usually characterized by a regularly undulating surface which gives it a ribbed appearance from the air. (10.4.3)

### 5. **Forms of floating ice**

#### 5.1 *Ice fragment*

A general name of any relatively flat piece of sea or river ice with a size from fractions of meter up to several kilometers across.

#### 5.2 *Floe*

Any relatively flat piece of sea ice 20 m or more across. Floes are subdivided according to horizontal extent as follows: (4.3.2)

##### 5.2.1 *Giant*

Over 10 km across. (4.3.2.1)

##### 5.2.2 *Vast*

2 to 10 km across (4.3.2.2)

##### 5.2.3 *Big*

500 – 2000 m across (4.3.2.3)

##### 5.2.4 *Medium*

100 – 500 m across (4.3.2.4)

#### 5.2.5 *Small*

20 – 100 m across (4.3.2.5)

#### 5.3 *Ice cake*

Any relatively flat piece of sea ice less than 20 m across (4.3.3)

##### 5.3.1 *Small ice cake*

An ice cake less than 2 m across (4.3.3.1)

##### 5.3.2 *Brash ice*

Accumulations of floating ice made up of fragments not more than 2 m across, the wreckage of other forms of ice as a result of melting (4.3.6 Ed.)

#### 5.4 *Pancake ice*

Predominantly circular plates of ice from 30 cm to 3 m in diameter, and up to about 10 cm in thickness, with raised rims due to the pieces striking against one another. It may be formed on a slight swell from grease ice, shuga or slush or as a result of the breaking of ice rind, nilas or, under severe conditions of swell, of grey ice. (4.3.1 Ed.)

#### 5.5 *Ice breccia*

Ice of different stages of development frozen together (4.3.5)

### **6. Ice surface features**

#### 6.1 *Level ice*

Sea ice which has not been affected by deformation (8.1)

#### 6.2 *Deformed ice*

A general term for ice which has been squeezed together and broken up with formation of surface and underwater conglomerations. Subdivisions are rafted ice, rough ice, ridged ice, jammed brash barrier and hillocky multiyear ice (8.2 Ed.)

##### 6.2.1 *Rafted ice*

Type of deformed ice formed by one piece of ice overriding another. If ice floes override each other alternately over and under the other like thrusting fingers, the ice is termed Finger rafted ice (8.2.1, 8.2.1.1 Ed)

##### 6.2.2 *Rough ice*

First-year ice subjected to fracturing and hummocking at the stage of young ice, formed as a result of freezing together of pancake ice or of fragments of fresh ridges collapsed to the fractures after the end of compacting and the onset of ice diverging. The irregularities of such type cover significant areas where snow accumulation increases and the heat conductivity and the tangential stress coefficient significantly change. During the radar sounding, segments of rough ice are depicted by increased brightness with ice ridges being indiscernible at their background. As a result of further growth, the irregularities at the bottom surface of rough ice are usually completely smoothed by the end of winter and the ice thickness becomes approximately equal to that of ice of



the same age of quiet growth. During the period of summer melting, all small irregularities at the surface of ice fields are smoothed; hence this type of relief is typical only of first-year ice.

### 6.2.3 *Hummocked ice*

Sea ice piled haphazardly one piece over another predominantly in the form of ice ridges and separate hummocks. (8.2.3.1 Ed.)

### 6.2.4 *Hillocky multiyear ice*

A qualitative assessment of the relief of multiyear ice formed as a result of non-uniform melting of initially level ice and smoothing of ice ridges and hummocks. It can be assessed as smoothed multiyear ice, moderately hillocky multiyear ice and strongly hillocky multiyear ice.

### 6.3 *Bare ice*

Ice without snow cover (8.5)

### 6.4 *Snow-covered ice*

Ice covered with snow (8.6)

### 6.5 *Dirty ice*

Ice that has different mineral or organic admixtures of natural or anthropogenic origin on the surface or in its strata. The composition and concentration of admixtures can be determined by the analysis of snow and ice samples.

## 7. **Separate Ice features**

### 7.1 *Hummock*

A hillocky conglomeration of broken ice formed by pressure at the place of contact of the angle of one ice floe with another ice floe. The underwater portion of a hummock is termed a bummock (8.2.3 Ed.)

### 7.2 *Ridge*

A comparatively rectilinear conglomeration of ice fragments formed by pressure at the contact line of ice floes usually along the earlier existing cracks and leads or at the boundary between the ice floes of different age. In this case, isostatically unbalanced hummocks usually form on the older ice surface. Ice ridges can also form as a result of direct fracturing of ice fields of even thick first-year and multiyear ice at very strong pressures. The underwater portion of a ridge is termed an ice keel (8.2.2, 13.5 Ed.)

### 7.3 *Ridged ice belt*

Fractured ice piled in the form of several parallel ridges formed at the external boundary of fast ice or on drift divides as a result of repeated pressures (8.2.2.6 Ed.)

### 7.4 *Line of ridges*

A thick ice ridge on landfast ice including stamukhas in places, which attach it to ground.

### 7.5 *Floeberg*

A massive piece of sea ice composed of a hummock, or a group of hummocks frozen together, presenting a separate floating ice fragment in ice-free water or among separate ice fragments. It may protrude up to 5 m above sea-level (4.3.4 Ed.)

### 7.6 *Stamukha (Grounded hummock)*

A thick hummocked grounded ice formation. Stamukhas form of floebergs and hummocked grounded ice fragments at subsequent hummocking. They are distinguished by a large height (up to 10 m and more above sea level) and steep slopes. There are single grounded hummocks and lines (or chains) of grounded hummocks. Stamukhas forming at one and the same place are termed recurring stamukhas (3.4.2 Ed.).

### 7.7 *Windrow*

A compact layer of ice cake and small ice cake formed as a result of repeated hummocking and rafting. In the coastal zone and near the fast ice boundary, the windrow thickness can achieve 10-20 m. In some cases it extends down to the bottom. Windrow presents a serious obstacle for shipping.

### 7.8 *Ram*

An underwater ice projection from an ice wall, ice front, iceberg or floe. Its formation is usually due to a more intensive melting and erosion of the unsubmerged part (8.4)

## 8. **Stages of melting**

### 8.1 *Puddle*

An accumulation on ice of melt-water, mainly due to melting snow, but in the more advanced stages also to the melting of ice. Initial stage consists of patches of melted snow. (9.1)

### 8.2 *Flooded ice*

Sea ice, usually first-year ice flooded by a melt or river water layer (9.5 Ed.).

### 8.3 *Thaw holes*

Vertical holes in sea ice formed when surface puddles melt through to the underlying water (9.2)

### 8.4 *Dried ice*

Sea ice that was earlier at the flooded ice stage from the surface of which melt-water has disappeared after the formation of cracks and thaw holes. During the period of drying, the surface whitens (9.3)

### 8.5 *Rotten ice*

Sea ice which has become honeycombed (lace) and which is in an advanced state of disintegration (9.4)

## 9. **Opening in the ice**

## 9.1 *Fracturing*

Any break or rupture through close ice, compact ice, consolidated ice, fast ice, or a single floe resulting from shears and deformation processes. It may contain brash ice and be covered with nilas or young ice. Length may vary from a few meters to several tens of kilometers (7.1 Ed.)

### 9.1.1 *Crack*

Any fracture of fast ice, consolidated ice or a single floe with a width ranging from a few centimeters to 50 m and a length from several tens or hundreds of meters to several hundreds of kilometers. (7.1.1 Ed.)

#### 9.1.1.1 *Tide crack*

Crack between fast ice subject to sea level tidal rise and fall and fast ice foot or ice wall. (7.1.1.1 Ed.)

## 9.2 *Flaw*

A narrow separation zone between drift ice and fast ice filled with continuous small ice cake with some small floes, where the pieces of ice are in chaotic state; it forms when drift ice moves under the effect of a strong wind or current along the fast ice boundary. Flaws also form at drift divides. (7.1.1.2 Ed.)

## 9.3 *Lead*

An expanded by more than 50 m rectilinear or wedge-shaped crack from several kilometers to several hundreds of kilometers in length. At below zero air temperatures, new, nilas and young ice forms at the surface of leads (7.3 Ed.)

### 9.3.1 *Shore lead*

A lead between drift ice and the shore or between drift ice and an ice front. (7.3.1)

### 9.3.2 *Flaw lead*

A passage-way between drift ice and fast ice which is navigable by surface vessels (7.3.2)

## 9.4 *Fracture*

A restricted space the length of which is comparable with the width of ice-free water or very open broken ice among solid very close and close ice. Diamond- or lens-shaped fractures form as a result of shear of ice floes along the line of the earlier existent crack or lead. Due to cracks and leads being not rectilinear, they expand in some places converging in the other places with a typically insignificant pressure and even hummocking forming thus a chain of fractures. This is the most stable types of fractures that can exist up to several months. In the autumn-winter period, nilas and young ice and then first-year ice forms at their surface. Less stable fractures the shape and dimensions of which constantly change are formed as a result of shears between the giant and vast ice floes and by local diverging of close ice of smaller formations.

## 9.5 *Polynya*

A stable ice-free water space among or at the boundary of fast ice. Polynyas may contain very open broken and brash ice or be covered with new ice, nilas or young ice. A polynya is sometimes restricted by the shore from one side and is termed a shore polynya. If it is restricted by fast ice, then it is termed a flaw polynya. If it recurs in the same position every year, it is termed a recurring polynya (7.4, 7.4.1, 7.4.2, 7.4.3 Ed.)

## **10. Pack ice motion processes**

### *10.1 Ice drift*

Forward displacement of ice floes and other ice features resulting from the impact of wind and currents including tidal currents and of forces transferred through the ice cover from other regions. The drift direction and velocity of a specific ice feature or ice cover area depend at each specific moment of time on the parameters of the indicated external forces and also on their own morphometric characteristics (size, concentration and upper and lower surface roughness), position relative to the coastline of the continent and the islands and the seabed relief. A complex of these causes determines a spatial non-uniformity of the ice drift.

#### *10.1.1 Drift vector*

A segment on the graphical or digital ice chart connecting the location of one and the same ice cover point at the successive moments of time. For a subsequent analysis and calculations, the observed drift vector field is usually interpolated to the regular grid points with a step chosen on the basis of the objectives and the ice drift variability in the given area during this period. The vectors at the regular grid points can be also obtained by means of model calculations.

#### *10.1.2 Drift divide*

A boundary between the ice massifs or zones drifting in different directions or with a different speed. The drift divide indications include the increased fracturing of the ice cover, flaws, ridging belts, leads and diverging zones. One frequently observes ice floe rotation at the drift divide.

### *10.2 Shearing*

Mutual displacement of the ice floe resulting in their turn and deformation and formation of fractures. (5.3 Ed.)

### *10.3 Fracturing*

Pressure process whereby ice is permanently deformed, and rupture occurs. Most commonly used to describe breaking across landfast ice, ice breccia, compact ice and ice fields (6.1)

### *10.4 Compacting*

A decrease of separation between the individual ice floes resulting in increased ice concentration (5.2 Ed.)

### *10.5 Compression of ice*

Further stage of ice compacting after its concentration reaches 9-10/10. During compression of ice, rafting and hummocking usually occur and stuffed ice may be formed within the coastal zone. Within the zones where big and giant floes are predominant, compression of ice may start if total concentration is equal 7-8/10.

#### *10.5.1 Compression zone*

Zone where compression of ice is observed.

## 10.6 *Diverging*

The process of increasing separation between the ice fields and floes, thus reducing ice concentration and/or relieving stresses in the ice (5.1)

## 11. **Terms relating to surface shipping**

### 11.1 *Difficult area*

A general expression to indicate that the severity of ice conditions prevailing in an area is such that navigation in it is difficult (12.5)

### 11.2 *Easy area*

A general expression to indicate that ice conditions prevailing in an area are such that navigation in it is not difficult. (12.6)

### 11.3 *Ice bound*

A harbor, inlet, etc. is said to be ice-bound when navigation by ships is prevented on account of ice, except possibly with the assistance of an icebreaker. (12.2)

### 11.4 *Nip*

Ice is said to nip when it forcibly presses against a ship. A vessel so caught, though undamaged, is said to have been nipped (12.3)

### 11.5 *Beset*

Situation of a vessel surrounded by ice and unable to move (12.1)

### 11.6 *Recommended place*

A place where a ship (vessel) or a group of ships is to arrive for transportation operations, awaiting for improved ice situation, formation of a convoy, etc.

### 11.7 *Recommended path*

A motion route of a ship (vessel) or a convoy of ships the most favorable in terms of ice and hydrological conditions. The navigation risks for the given type of ships (vessels) should be absent at the recommended path.

### 11.8 *Channel in ice, made by ship*

A band of broken ice or flaw formed at ship (vessel) or icebreaker passing across landfast or drifting ice.

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## ICE CHART COLOUR CODE STANDARD

### 1. Preface

While the WMO international standard for ice charts only dealt with black and white charts, in keeping with the paper facsimile technology of the time, colour has long been used to help differentiate the various ice conditions on a paper chart. In the last decade, progress in computer processing and communication, as well as increased demands of users prompted the necessity to develop a new WMO International Ice Colour Code Standard for ice charts.

In the Russian Federation, one of the first colour coding standards for en-route and operational ice charts was included into the "Manual on Air Reconnaissance conduct" published in 1953. However, practices of routine colour enhancement of paper ice charts in support of navigation through the Northern Sea Route may be traced back to the 1930s. Subsequent editions of the stated manual included recommendations for colour coding which were very close to the original summer (blue-green-brown scheme) and winter (purple-green-brown scheme) for navigation in the Arctic Seas. The last edition published in 1981 served as one of the starting points for developing new WMO International Ice Colour Code.

Similar to the practices in the Eurasian Arctic, ice service specialists in the Canadian Ice Service coloured paper charts manually as an aid to briefing icebreaker captains. There was no standard for these colour schemes but they were generally based on some version of green-yellow-red for light-medium-heavy ice conditions. As colour technology became more commonplace, the Canadian Ice Service adopted an internal standard based on the Ice Services Specialist practices and began producing colour charts routinely. Correspondingly, Canadian practice provided another of the bases for the present standard.

The same long practice of colour coding on a national level is characteristic of the Baltic Sea ice services, e.g. ice charts have been optionally coloured by German experts from the 1<sup>st</sup> part of the XX century which served as another prototype for a colour standard for seas with seasonal ice cover. Additionally, a specific case of colour coding has been examined by Danish ice experts for Greenland waters, to contribute to an international colour standard.

The first steps in colour code standardization were undertaken by the former CMM Group on Sea Ice as early as the 1950s. After a long break, the next phase was initiated by the International Ice Charting Working Group (IICWG), an ad-hoc group closely related to the JCOMM Expert Team on Sea Ice. The IICWG-II Meeting (October 2000) started with initial ideas and principles. IICWG-III (November 2001) drafted the basis for agreement on the standard with refinements based on comments from Ice Services who tested the proposal during the first half of 2002.

During 2003, IICWG and ETSI experts proceeded with editing and testing the standard, which in its final version includes two separate colour codes with options for use on ice charts:

- 1) one based on total concentration (CT) intended for use when the stage of development is relatively uniform but concentration is highly variable (e.g. arctic summer navigation);
- 2) one based on stage of development (SoD) intended for use when the concentration is relatively uniform (high) but the stage of development is variable (e.g. arctic winter navigation).

The CT and SoD Colour Code Standards are given below as tables 1 and 2 respectfully. For the convenience of users, definitions of basic symbols in WMO oval form are repeated in Table 3.

Section 2 provides notes for utilizing the Colour Code Standard.

Application of the Standard is exemplified in the sample ice charts from national ice services included in Annex I.

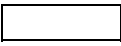



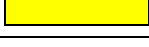



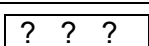



## **2. Ice Chart Colour Code - Notes**

- 1) Two separate colour codes are mutually exclusive - only one or the other should be used on a single chart.
- 2) A legend depicting the colour code used should be included on every chart.
- 3) The optional colour indicating 9+-10 tenths of nilas or grey ice should only be used to indicate level ice, mainly on leads; it should not be used for ice broken into brash or ice cakes or for concentrations less than 9+ tenths.
- 4) Undefined ice is used when it is known that ice is in an area but its characteristics are not known - this is different from "No Information" which indicates that nothing at all is known about the area.
- 5) No specific colour is assigned to areas of "No Information"; such areas should be clearly indicated on ice charts - text annotation may be used where appropriate; an assigned colour within the code should not be used to indicate "No Information".
- 6) Colour codes do not preclude use of black and white hatching patterns or egg codes; egg codes and/or black and white hatching may be used along with colours.
- 7) If properly documented, other symbols may be used in addition to the standard colours to depict special ice conditions under national practice.

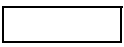







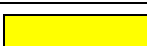








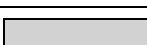
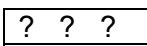


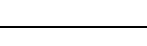
The present document is an integral part and extension of the WMO Sea Ice Nomenclature, Supplement No. 4 (WMO - No. 259) currently in force.



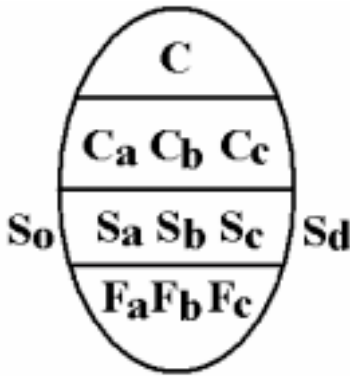
**Table 1. Total Concentration Colour Code Standard**

Colour		RGB colour model	Total concentration (definition from WMO Nomenclature)	Number from WMO Nomenclature
alternative	prime			
		000-100-255	Ice free	4.2.8
		150-200-255	Less than one tenth (open water)	4.2.6
		140-255-160	1/10 - 3/10 (very open ice)	4.2.5
		255-255-000	4/10 - 6/10 (open ice)	4.2.4
		255-125-007	7/10 - 8/10 (close ice)	4.2.3
		255-000-000	9/10 - 10/10 (very close ice)	4.2.2
		150-150-150	Fast ice	1.1.1
		210-210-210	Ice shelf	10.3
		255-255-255	Undefined ice	-
<b>Optional</b>		255-175-255	7/10-10/10 new ice	2.1
		255-100-255	9/10-10/10 nilas, grey ice (mainly on leads)	2.2, 2.4
<b>Areas of No Information are annotated accordingly</b>				

**Table 2. Stage of Development Colour Code Standard**

Colour		RGB colour model	Stage of development (SoD)	Number from WMO Sea Ice Nomenclature
alternative	prime			
		000-100-255	Ice free	4.2.8
		150-200-255	<1/10 ice of unspecified SoD (open water)	4.2.6
		240-210-250	New ice	2.1
		255-175-255	Dark nilas	2.2.1
		255-100-255	Light nilas	2.2.2
		170-040-240	Young ice	2.4
		135-060-215	Grey ice	2.4.1
		220-080-235	Grey-white ice	2.4.2
		255-255-000	First-year ice (FY)	2.5
		155-210-000	FY thin ice (white ice)	2.5.1
		215-250-130	FY thin ice (white ice) first stage	2.5.1.1
		175-250-000	FY thin ice (white ice) second stage	2.5.1.2
		000-200-020	FY medium ice	2.5.2
		000-120-000	FY thick ice	2.5.3
		180-100-050	Old ice	2.6
		255-120-010	Second-year ice	2.6.1
		200-000-000	Multi-year ice	2.6.2
		150-150-150	Fast ice of unspecified SoD	2.6
		210-210-210	Ice shelf	10.3
		255-255-255	Ice of undefined SoD	-
		255-255-255	Drifting ice of land origin (icebergs)	10.4.2
<b>Areas of No Information are annotated accordingly</b>				

**Table 3. Definitions of Basic Symbols in Oval Form** (according to WMO Sea Ice Nomenclature, Suppl. No 4, WMO-No.259)



**Concentration (C)**

C – Total concentration of ice in the area, reported in tenths (see symbols in table 3.1).

Note: Ranges of concentration may be reported.

$C_a C_b C_c$  – Partial concentrations of thickest ( $C_a$ ), second thickest ( $C_b$ ) and third thickest ( $C_c$ ) ice, in tenths.

Note: Less than 1/10 is not reported. 10/10 of one stage of development is reported by C,  $S_a$  and  $F_a$  or C  $S_a F_p F_s$ .

**Stage of development (S)**

$S_a S_b S_c$  – Stage of development of thickest ( $S_a$ ), second thickest ( $S_b$ ) and third thickest ( $S_c$ ) ice, of which the concentrations are reported by  $C_a$ ,  $C_b$ ,  $C_c$  respectively (see symbols in table 3.2).

Notes:

(1) If more than one class of stage of development remains after selection of  $S_a$  and  $S_b$ ,  $S_c$  should indicate the class having the greatest concentration of the remaining classes (see also Note (2))

(2) Reporting of  $S_a$ ,  $S_b$  and  $S_c$  should generally be restricted to a maximum of three significant classes. In exceptional cases, further classes can be reported as follows:

$S_o$  – stage of development of ice thicker than  $S_a$  but having a concentration of less than 1/10;

$S_d$  – stage of development of any other remaining class.

(3) No concentration are reported for  $S_o$  and  $S_d$ .

**Form of ice (F)**

**(a) First variant**

$F_a F_b F_c$  – Form of ice (floe size) corresponding to  $S_a$ ,  $S_b$  and  $S_c$  respectively (see symbols in table 3.3).

Notes: (1) Absence of information on any one of these forms of ice should be reported with an “x” at the corresponding position.

(2) When icebergs are present in sufficient numbers to have concentration figure, this situation can be reported with  $F_a = 9$ , the appropriate symbol for  $S_a$  and the corresponding partial concentration  $C_a$ .

(3) In situation when only two stages of development are present, a dash (-) should be added in place of  $F_c$  to separate these situations from those when  $F_p$  and  $F_s$  are being reported.

**(b) Second variant**

$F_p F_s$  – Predominant ( $F_p$ ) and secondary ( $F_s$ ) floe size, reported independently from  $S_a$ ,  $S_b$  and  $S_c$  respectively (see symbols in table 3.3).

Note: If only the predominant floe size (form of ice) is reported, only the symbol for  $F_p$  shall be reported.

Table 3.1  
Total concentration of ice (C)

Concentration	Symbol
Ice free	
Less than one tenth	0
1/10	1
2/10	2
3/10	3
4/10	4
5/10	5
6/10	6
7/10	7
8/10	8
9/10	9
More than 9/10 less than 10/10	9+
10/10	10
Undetermined or unknown	x

Table 3.2  
Stage of development and thickness ( $S_a S_b S_c S_o S_d$ )

Number from WMO Sea Ice Nomenclature	Element	Thickness	Symbol
	No stage of development	-	0
2.1	New ice	-	1
2.2	Nilas; ice rind	< 10 cm	2
2.4	Young ice	10-30 cm	3
2.4.1	Gray ice	10-15 cm	4
2.4.2	Gray-white ice	15-30 cm	5
2.5	First-year ice	30-200 cm	6
2.5.1	Thin first-year ice	30-70 cm	7
2.5.1.1	Thin first-year ice, first stage	30-50 cm	8
2.5.1.2	Thin first-year ice, second stage	50-70 cm	9
2.5.2	Medium first-year ice	70-120 cm	1•
2.5.3	Thick first-year ice	> 120 cm	4•
2.6	Old ice		7•
2.6.1	Second-year ice		8•
2.6.2	Multi-year ice		9•
10.4	Ice of land origin		▲•
	Undetermined or unknown		x

Table 3.3  
Form of ice ( $F_a F_b F_c F_p F_s$ )

Element	Floe size	Symbol
Pancake ice	-	0
Small ice cake; brash ice	< 2 m	1
Ice cake	2-20 m	2
Small floe	20-100 m	3
Medium floe	100-500 m	4
Big floe	500 m-2 km	5
Vast floe	2-10 km	6
Giant floe	> 10 km	7
Fast ice	-	8
Icebergs, growlers or floebergs	-	9
Undetermined or unknown	-	x

## **Annex I**

# **Sample ice charts from national ice services**

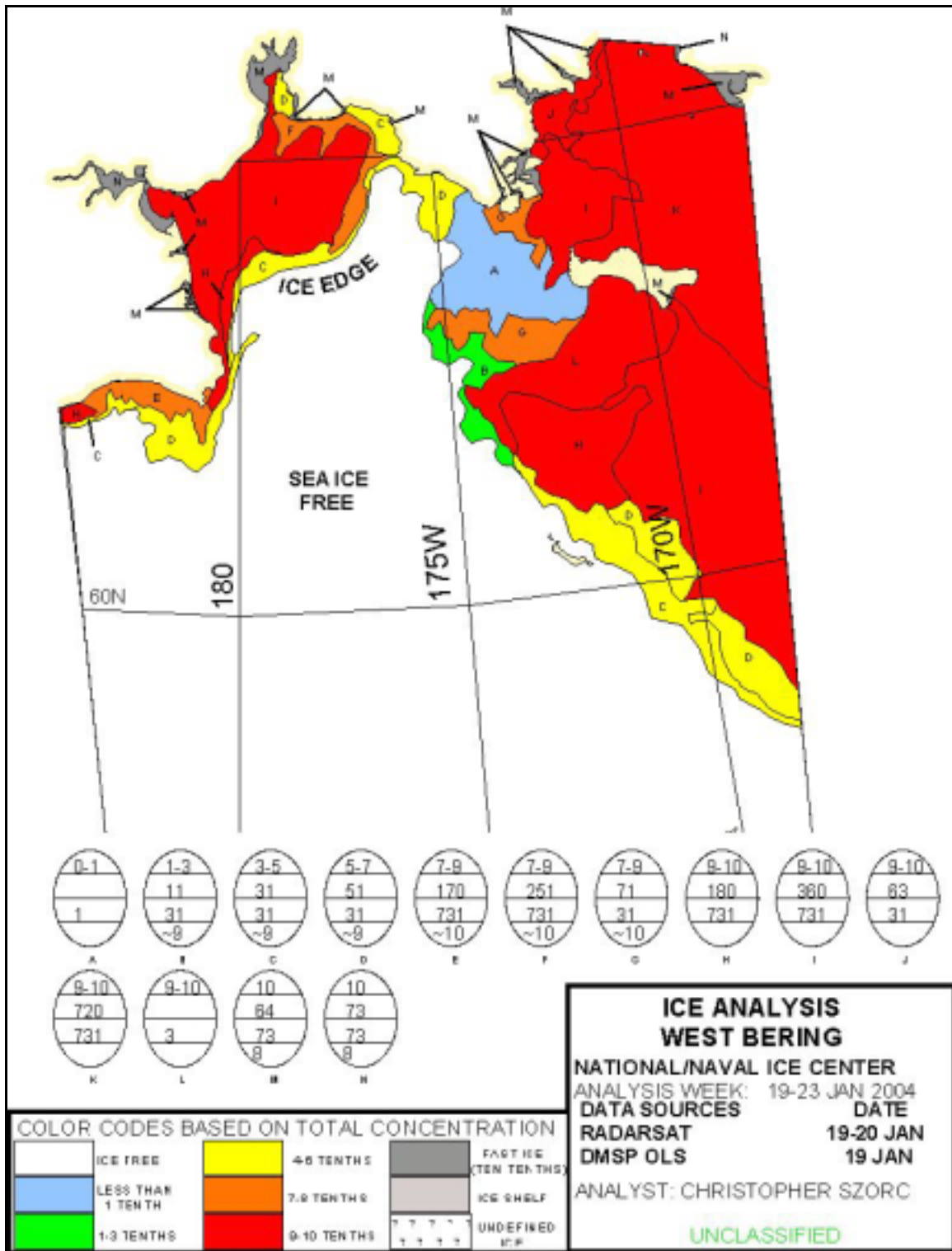


Fig. 1. Bering Sea western part ice chart for 19-23 January 2004 produced by USA National Ice Center. Ice chart is based on Total concentration Colour Standard.

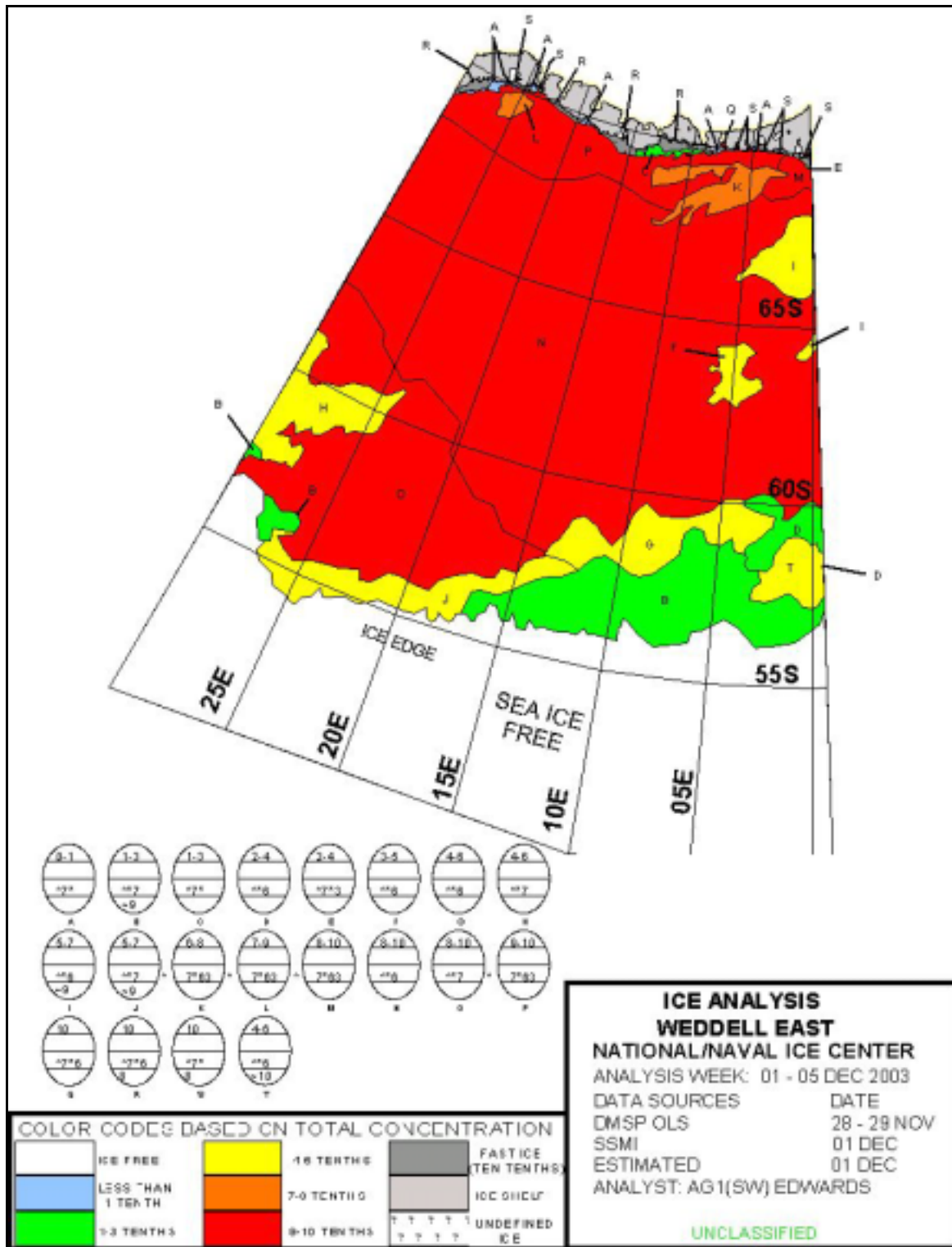


Fig. 2. Weddell Sea eastern part ice chart for 01-05 December 2003 produced by USA National Ice Center. Ice chart is based on Total concentration Colour Standard.

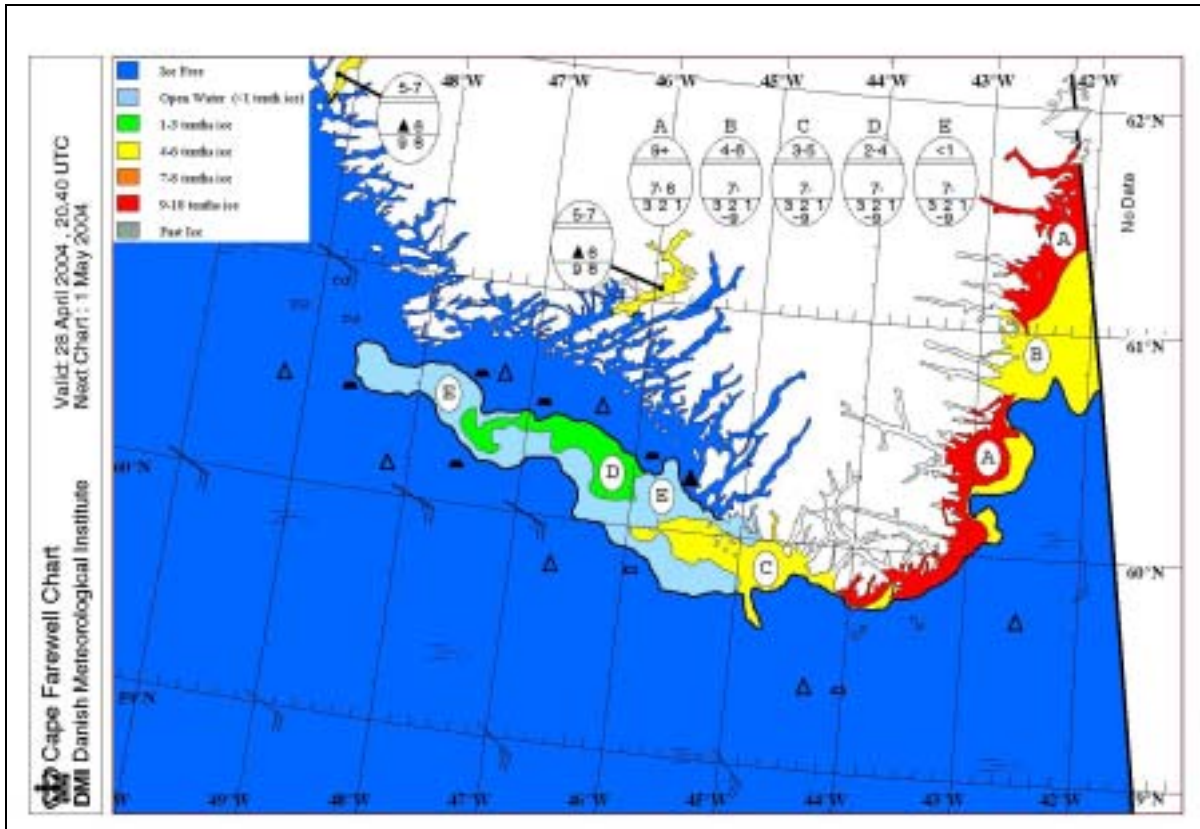


Fig. 3. Cape Farewell ice chart for 28 April 2004 produced by Danish Meteorological Institute. Ice chart is based on Total concentration Colour Standard.



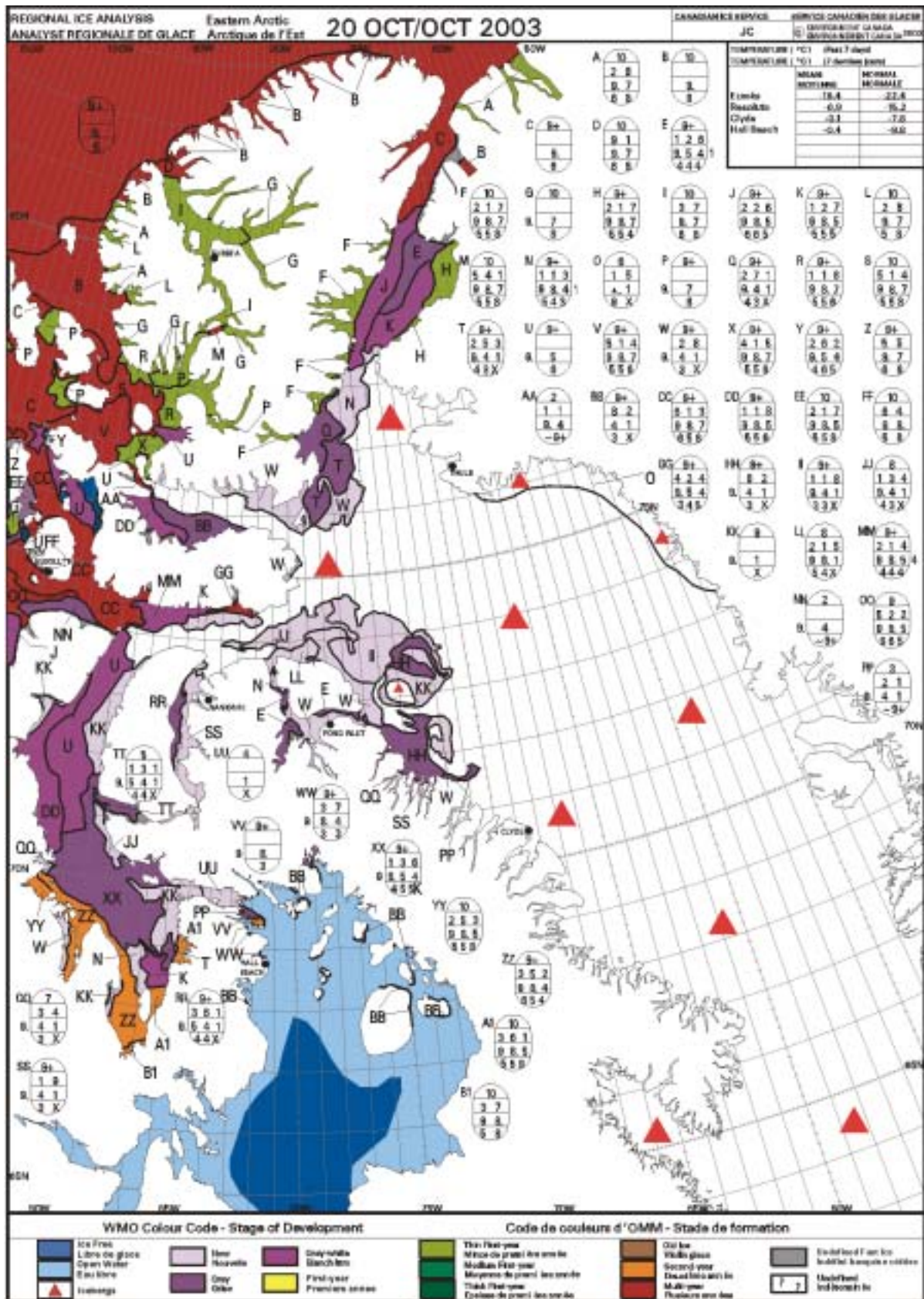


Fig. 4. Eastern Arctic ice chart for 20 October 2003 produced by Canadian Ice Service. Ice chart is based on Stage of Development Colour Standard.



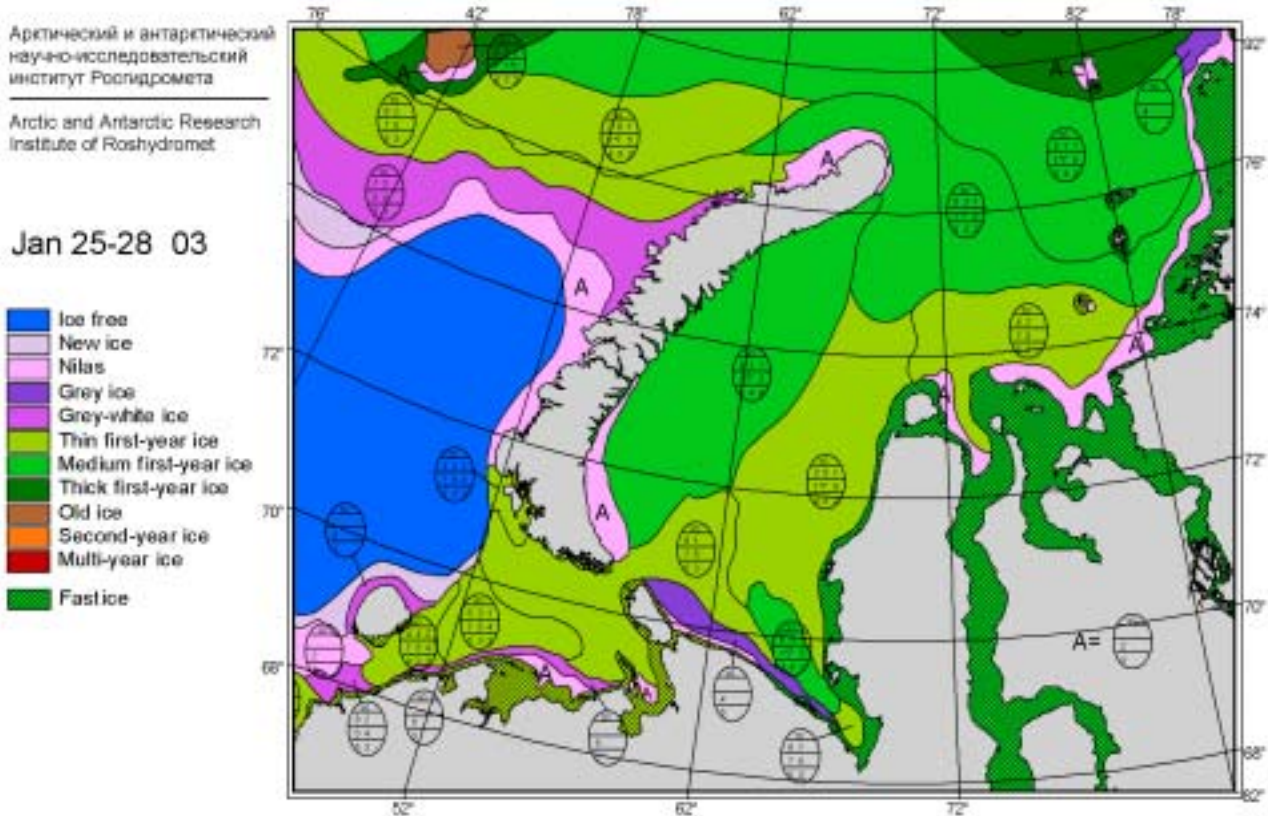


Fig. 5. Barents Sea ice conditions chart for 25-28 January 2003 produced by Arctic and Antarctic Research Institute, Russian Federation. Ice chart is based on Stage of Development Colour Standard with optional hatching of fast ice.

**PROPERTY CHANGES OF FIRST-YEAR ICE AND OLD ICE DURING SUMMER MELT**

See separate .pdf file pp. 86 - 134.

**DATA COLLECTION PROGRAM ON ICE REGIMES**

See separate .pdf file pp. 135 - 144.

**WORK PLAN OF THE EXPERT TEAM ON SEA ICE**

**ACTION SHEET ON DECISIONS OF ETSI-II**

(Hamburg, Germany 15-17 April 2004)

**ETSI Chairman**

<b>Ref.</b>	<b>Subject</b>	<b>Action proposed</b>	<b>With whom</b>	<b>Target</b>
Para 2.4.3	IICWG, BSIS and ETSI collaboration	To continue development of ETSI and IICWG, BSIS collaboration	IICWG, BSIS	Continuous
Para 2.5.1	WMO Sea Ice Nomenclature	To implement appropriate changes in the nomenclature in order to use it as an official French and Spanish versions on sea ice symbols and glossary	Secretariat	Intersessional period
Para 2.5.4		To approve the database and software of the English/French/Russian/Spanish electronic versions for the nomenclature;	Secretariat	ASAP
Para 2.5.5		(i) To conduct a review of the nomenclature section by section by correspondence;	Members	Intersessional period
		(ii) To submit a report on the progress of the review on the new updated version nomenclature	Secretariat	JCOMM-II
		(iii) To continue development for discussion in a final form at ETSI-III	Members	ETSI-III
Para 2.5.7		To develop a new version of the illustrated Glossary of Sea Ice Terms	Members	ASAP
Para 2.5.8	WMO publicación No. 547 Sea Ice Information in the World	To revise WMO publication No. 547- Sea Ice Information in the World to be published in an electronic form as JCOMM Technical Report Series	Members, Secretariat	Once per year

<b>Ref.</b>	<b>Subject</b>	<b>Action proposed</b>	<b>With whom</b>	<b>Target</b>
Para 2.5.14	CIS amendment to the nomenclature	To incorporate CIS amendment on Ice Decay/Stages of Melting into the work on the new Sea Ice Nomenclature	J.Falkingham	JCOMM-II
Para 3.5	ETSI and GCOS coordination	(i) To develop close coordination between ETSI and GCOS with respect to sea ice observations;  (ii) To designate ETSI to be the responsible body for information and assessment of sea ice as an Essential Climate Variable (ECV)	Secretariat	JCOMM-II
Para 3.10	Blended sea ice data sets	To extend blended sea ice data set based on the new available data	AARI	Continues
Para 4.8	IHO Ice Objects and ETSI	To contact IHO to get additional information for the future ETSI activities on the establishment of the IHO Ice Objects register	J.Falkingham, M. Picasso	ASAP
Para 5.1	Date and place of the next meeting	To finalize arrangements for the timing and venue for the next ETSI-III and GDSIDB-XI sessions in due course, and notify group members accordingly	Secretariat	2006

**Team  
Members**

<b>Ref.</b>	<b>Subject</b>	<b>Action proposed</b>	<b>With whom</b>	<b>Target</b>
Para 2.5.5	WMO Sea Ice Nomenclature	(i) To conduct a review of the nomenclature section by section by correspondence;	Chairman	Intersessional period
		(ii) To continue development for discussion in a final form of the nomenclature	Chairman	ETSI-III
Para 2.5.7		To develop a new version of the illustrated Glossary of Sea Ice Terms	Chairman	ASAP
Para 2.5.8	WMO publication No. 547 Sea Ice Information in the world	To revise WMO publication No. 547- Sea Ice Information in the World to be published in an electronic form as JCOMM Technical Report Series	Chairman, Secretariat	Once per year
Para 4.8	IHO Ice Objects and ETSI	To contact IHO to get additional information for the future ETSI activities on the establishment of the IHO Ice Objects register	J.Falkingham, M.Picasso	ASAP

**2 Other**

<b>Ref.</b>	<b>Subject</b>	<b>Action proposed</b>	<b>With whom</b>	<b>Target</b>
Para 2.4.3	IICWG, BSIS and ETSI collaboration	To continue development of ETSI and IICWG, BSIS collaboration	Secretariat	Continuous
Para 2.5.5	WMO Sea Ice Nomenclature	To prepare an electronic version of the documents to facilitate comparison of the old and new publication	AARI	May 2004
Para 2.5.14	CIS amendment to the nomenclature	To incorporate CIS amendment on Ice Decay/Stages of Melting into the work on the new Sea Ice Nomenclature	Chairman	JCOMM-II

<b>Ref.</b>	<b>Subject</b>	<b>Action proposed</b>	<b>With whom</b>	<b>Target</b>
Para 3.10	Blended sea ice data sets	To extend blended sea ice data set based on the new available data	Chairman	Continuous
Para 3.13	CIS historical charts	To provide scanned copies of CIS historical charts starting from 1956 in GIF format	CIS	Intersessional period
Para 3.15	Swedish ice charts	To transfer all available digitized sea ice data from SMHI to the GDSIDB in SIGRID-3 format	SMHI	End 2004
Para 4.3	National Sea Ice services and IPY	To submit updated historical sea ice charts and documents to the GDSIDB	CIS,DMI, NIC	Before IPY

#### Secretariat

<b>Ref.</b>	<b>Subject</b>	<b>Action proposed</b>	<b>With whom</b>	<b>Target</b>
Para 2.4.3	IICWG, BSIM and ETSI collaboration	To continue development of ETSI and IICWG, BSIS collaboration	IICWG, BSIS	Continuos
Para 2.5.1	French and Spanish versions of the WMO Sea ice nomenclature	To implement appropriate changes in the nomenclature in order to used it as an official French and Spanish versions on sea ice symbols and glossary	Chairman	Intersessional period
Para 2.5.4	Electronic version of the WMO Sea Ice Nomenclature	To approve the database and software of the English/French/Russian/Spanish electronic versions for the nomenclature	Chairman	ASAP
Para 2.5.5	WMO Sea Ice Nomenclature	(i) To conduct a review of the nomenclature section by section by correspondence;  (ii) To submit a report on the progress of the review on the new updated version nomenclature	Chairman  Chairman	Intersessional period  JCOMM-II
			Chairman,	ETSI-III

Ref.	Subject	Action proposed	With whom	Target
		(iii) To continue development for discussion in a final form at ETSI-III	Members	
Para 2.5.8	WMO publicación No. 547 Sea Ice Information in the World	To revise WMO publication No. 547- Sea Ice Information in the World to be published in an electronic form as JCOMM Technical Report Series	Chairman, Members	Once per year
Para 3.5	ETSI and GCOS coordination	(i) To develop close coordination between ETSI and GCOS with respect to sea ice observations;  (ii) To designate ETSI to be the responsible body for information and assessment of sea ice as an Essential Climate Variable (ECV)	Chairman	JCOMM-II
Para 5.1	Date and place of the next meeting	To finalize arrangements for the timing and venue for the next ETSI-III and GDSIDB-XI sessions in due course, and notify group members accordingly	Chairman	2006



**WORK PLAN OF THE STEERING GROUP FOR THE GLOBAL DIGITAL SEA ICE DATA**

**Work Plan for cooperation between the members of the Steering Group for the Global Digital Sea Ice Data Bank Project for 2004 - 2007**

**1. Technique Development**

The experts from the GDSIDB centers will continue to make available data browsers, translating and other necessary software for processing data in SIGRID, various GIS, and EASE-grid formats, and will develop tools for working with the new SIGRID-3 format. NSIDC plans to develop software to translate from SIGRID-3 to EASE-Grid files of total, multi-year, first year and thin ice concentration.

**2. Data Exchange.**

2.1 Data sets anticipated to be contributed by GDSIDB members, on a schedule dictated by available resources, during the intersessional period 2004 - 2007

	<b>Institute</b>	<b>Region</b>	<b>Time interval</b>	<b>Exchange date (notes)</b>
1.	AARI	Antarctic  Arctic	1971-1990 (10-days period)  1933-1949  2004, ongoing, forward in time	SIGRID, EASE-GRID  SIGRID, EASE-GRID, After availability of data at WDC Obninsk SIGRID
2	Argentine Navy Hydrographic Service	Weddell and Bellingshausen Seas	Current observations	Point observations in NIC-code in .db format, submitted with weekly interval to NSIDC and AARI ftp-servers
3.	SMHI	Baltic Sea	1980 – up to present, twice a week  2004, ongoing forward in time	By the end of 2004, SIGRID-3  SIGRID-3, TBD
4.	CIS	Canadian Arctic	Ongoing charts  Weekly Regional charts from 1968 to present  Historical weekly ice charts 1956 to 1974;  Daily charts (~2000 to present).  Observation chart collection from 1956	SIGRID, SIGRID-3  .GIF format, SIGRID-3  .GIF, .e00, SIGRID-3  .e00  .GIF
5	State Oceanic Administration of China	Bohai Sea	Before 1998, after 2001	TBD
6.	DMI	Greenland waters	2004, forward in time	SIGRID-3 (once a year, for the whole ice season)

7.	Federal Maritime and Hydrographic Agency (BSH)	Baltic Sea (south of 56°N and to the west of 14°20' E)	3 times a week, 1960-1996	Ice Map Format, to be submitted during intersessional period after QC
8	Icelandic Meteorological Office	Icelandic waters	1971-1974  2002, ongoing forward and back in time	Published reports and charts  From IMO, Iceland, web-site
9	UK BAS	Antarctic ship observations	1950s forward in time	Metadata
10.	JMA	Sea of Okhotsk	Every 5 days, forward in time	Once a year in SIGRID-2 format
11.	NIC	Arctic, Antarctic  Arctic  Antarctic	emispheric bi-weekly charts, 2003 forward time emispheric 1997 and 2001  Corrected and updated version of hemispheric 1973-2001 weekly ice charts  2001-2004 bi-weekly hemispheric ice charts	SIGRID-3, .e00  e00, ~40 charts still require QC  .e00, end of 2007  .e00, August 2004 All data are available on-line via NIC web-site
12	BSIM	Baltic sea	Ice observations from the "climatological" BSIM stations.	As published on BSIM web-page

## 2.2 Technical assistance.

2.2.1. Experts from AARI and NSIDC centers of GDSIDB will continue to provide assistance to data contributors and data users who wish to use formats other than SIGRID (EASE-grid, Contour, etc.) provided that resources are available.

2.2.2 NSIDC and AARI will continue to provide guidance on preparation of metadata and other necessary documentation accompanying data submitted or to be submitted to GDSIDB.

## 3. Modification of formats for data exchange

3.1 The GDSIDB centers will work with the ice services to assist with the implementation of SIGRID-3

3.2 NSIDC and AARI, with the assistance of experts from operational centers, will prepare a report on the given activity for the next IICWG-VI meeting in 2005.

## 4. Use, validation and intercomparison of GDSIDB data

4.1 Experts from the GDSIDB will continue joint activity on development of blended sea ice data sets and sea ice climate estimates from the GDSIDB data.

4.2 GDSIDB members will endeavor to establish linkages with the other programs and projects concerning the development of climate estimates, validation and intercomparison of GDSIDB data, in particular GCOS/GOOS, IPY, WCRP CliC

## **5. Future activity**

5.1 The GDSIDB will advertise the ASPeCT data of ice observations from Antarctica.

5.2 The GDSIDB will request members to update contributions of ice thickness data in time for the forthcoming IPY.

5.3 The GDSIDB will construct monthly series of statistics on sea ice based on GDSIDB data and submit them to the WMO Secretariat so that the WMO Secretariat can encourage the scientific community to use these data in climatological studies and reanalysis.

## REGISTER STRUCTURE AND REGISTRATION PROCESS FOR AN IHO OBJECT REGISTER

### Abstract

This document describes the proposed register structure and registration process for the IHO S-57 object data dictionary register. This structure makes use of the ISO 19126 standard for data dictionary registers, which is based on the ISO 19135 standard procedures for registration of items of geographic information. The IHO registry is a compound registry that supports four independent but related registers that share a common code space but are managed by separate organizations. Other similar registers could be added to this compound registry if developed through the IHO Maritime Information Objects (MIO) committee. The registers share a common structure and a common access policy.

### 1. Introduction

The IHO has maintained a catalogue of hydrographic objects and attributes as part of the IHO S-57 standard for many years. This is a very mature object catalogue; however, it is only suitable for use within the context of the IHO S-57 standard edition 3.1 because it is closely bound to that standard. IHO has adopted a policy of building edition 4 of S-57 based on the ISO TC211 suite of standards to better integrate S-57 with other geographic information standards and support tools. This includes the restructuring of its object catalogue into the form of a data dictionary register that is in conformance with the ISO TC211 standards.

The benefit of structuring the S-57 object catalogue in conformance with the ISO standards is that it allows for re-use of the objects in a broader context, beyond the Electronic Nautical Chart, and the use of objects defined by other organizations together with those defined by IHO. A feature data dictionary is simply a list of the features, attributes and enumerants that may be combined to define a real world entity. A catalogue is a list of features together with their bound attributes and domain values (enumerants). A catalogue is used in a specific product specification such as the ENC product specification. Other product specifications may be defined with separate catalogues based on the same feature data dictionary. For example, a feature may have a large number of attributes in one product, and only a few associated attributes in a similar product intended for use at a different scale.

A register is simply a managed list. The ISO register standards provide a schema for the structure of the list and a process for the management of its contents. This increases consistency, reduces errors, and makes the list easily machine searchable. It also allows for linkage with other lists addressing similar topics that are managed in accordance with the same standards.

ISO has developed two separate standards for registration of geographic information. The first standard, ISO 19135, addresses procedures for the registration of items of geographic information. The ISO 19126 standard is built upon the procedures defined in 19135 and addresses specifically items in feature data dictionaries and feature catalogues.

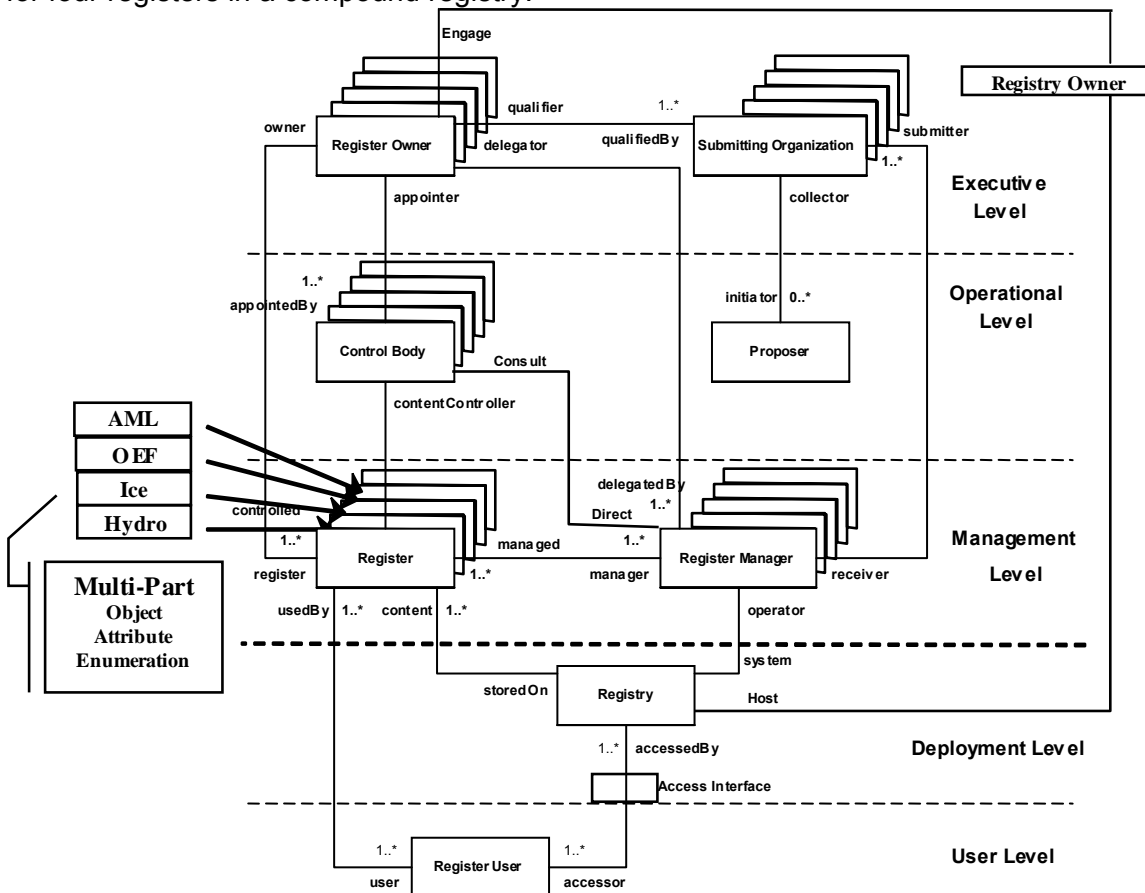
These registered items have codes assigned that facilitate data interchange (e.g. acronyms or numeric identifiers). In the context of IHO we have at least four communities that have complementary applications that need to work within the same code space. Historically it has been difficult to coordinate these four communities. One of these is the official IHO list of features, attributes and enumerants used in the S-57 object catalogue and the ENC product specification. This is under the authority of the IHO TSMAD committee and needs to be closely regulated. The Open ECDIS Forum (OEF) provides an extension mechanism that allows industry and other users to build upon the IHO object definitions, to address other applications. It is managed in a more open manner. The World Meteorological Organization ICE committee has a very specific responsibility for the procedures for describing sea ice in ICE charts. These objects need to work together with the objects defined by IHO for the ENC. These form a third parallel set of data within

the same code space. A fourth community is the military hydrographic community that requires additional military objects (AML) that also build upon the IHO object definitions. Additionally the military objects also need to operate within other military defined contexts and may live within multiple code spaces. In particular, the military objects would also have a direct parallel in the DGIWG Feature and Attribute Coding Catalogue (FACC). The military objects are defined by the NATO Ad Hoc Hydro Working Group (AHHWG).

The TSMAD S-57 Extensions Sub-Working group proposes to address this cross-community requirement by establishing a compound registry within IHO that supports four registers in accordance with the ISO defined structures and procedures.

## 2. Registration Procedure

The following diagram is based on the procedure diagram given in ISO 19135 (Figure 1 - Organizational Relationships). This diagram has been extended to address the IHO requirement for four registers in a compound registry.



**Figure 1 - Organizational Relationships**

In the context of IHO the following allocation of roles and responsibilities would apply.

The **Registry** is the Information System on which registers are maintained. Typically, a registry is an information system such as a database on a physical computer system. For the purposes of IHO the registry may exist at the IHB or at some location under contract to the IHB. The database would be partitioned into four parallel registers.

The **Registry Owner** is the organization that is responsible for the registry. It has the authority to host the registers and establish the policy for access. In this situation the registry owner is the IHO

Access to the Registry is through a **Registry Interface**. The IHO registry interface will support:

- a) Web access interface;

- b) Printed output (which could be part of web access interface);
- c) An exchange format for the register contents in XML.

A **Registry User** is any person or organization interested in accessing or influencing the content of a register. There are at least three types:

- Users of currently valid items
- Those interested in historical information
- Potential submitters of proposals to change the content of the register

The IHO registry will be open for access to all Users.

A **Register** is a partition of the registry database containing item identifiers and associated information constituting the managed lists. The IHO registry will contain the following four partitions:

- 1) List of IHO official hydrographic objects (features, attributes and enumerates)
- 2) List of OEF (Open ECDIS Forum) objects (features, attributes and enumerates)
- 3) List of ICE objects (features, attributes and enumerates)
  
- 4) List of AML objects (features, attributes and enumerates)

The **Register Manager** is responsible for the administration of the register content. In accordance with ISO 19135 the manager:

- Maintains registers of items within the item classes for which it is responsible (may manage more than one register in one registry)
- Distributes an information package containing a description of the register and how to submit proposals
- Provides reports to the register owner at intervals specified by the register owner
- The contents of the registers are made available to the public under the terms and conditions set by the register owner.

In the IHO registry there will be four separate register managers, one for each of the registers. These are:

- 1) IHB
- 2) 7Cs on behalf of the OEF
- 3) IHB on behalf of the ICE working group
- 4) UKHO on behalf of the NATO AHHWG

The **Register Owner** is an organization that:

- Establishes one or more registers
- Has primary responsibility for the management, dissemination, and intellectual content of those registers
- May appoint another organization to serve as the register manager.

In the IHO registry there will be four separate register owners, one for each of the registers. These are:

- 1) IHO
- 2) OEF Board of Patrons
- 3) WMO / ICE Committee
- 4) NATO

A **Control Body** is a group of technical experts appointed by a register owner to decide on the acceptability of proposals for changes to the content of a register. They include representatives from both the register owner and submitting organizations.

In the IHO registry there will be four separate control bodies, one for each of the registers. These are:

- 1) TSMAD
- 2) OEF
- 3) WMO/ ICE Committee
- 4) NATO AHHWG (Ad Hoc Hydro Working Group)

A **Submitting Organization** manages the submission of proposals for registration from within the respective communities or organizations. It is qualified under criteria determined by the register owners to propose changes to the corresponding register.

In the IHO registry there are four separate submitting organizations, one for each of the registers. These are:

- 1) IHO member states and IHO liaison organizations
- 2) OEF participants
- 3) WMO/ ICE Committee member states
- 4) NATO AHHWG and associated NATO and NATO affiliated WGs

**Proposers** are members or participants in the submitting organizations.

### 3. Management of a register

The following is text extracted from ISO 19135 that describes how a register is to be managed.

#### *Clarification of registered items*

Submitting organizations may submit requests for clarification of registered items. Clarifications correct errors in spelling, punctuation, or grammar. A clarification shall not cause any substantive semantic or technical change to a registered item. Otherwise it shall be treated as a modification. The control body shall handle editorial clarifications at their discretion. Approved clarifications shall be promulgated by the register manager, and shall be recorded in a note attached to a registered item as additional information.

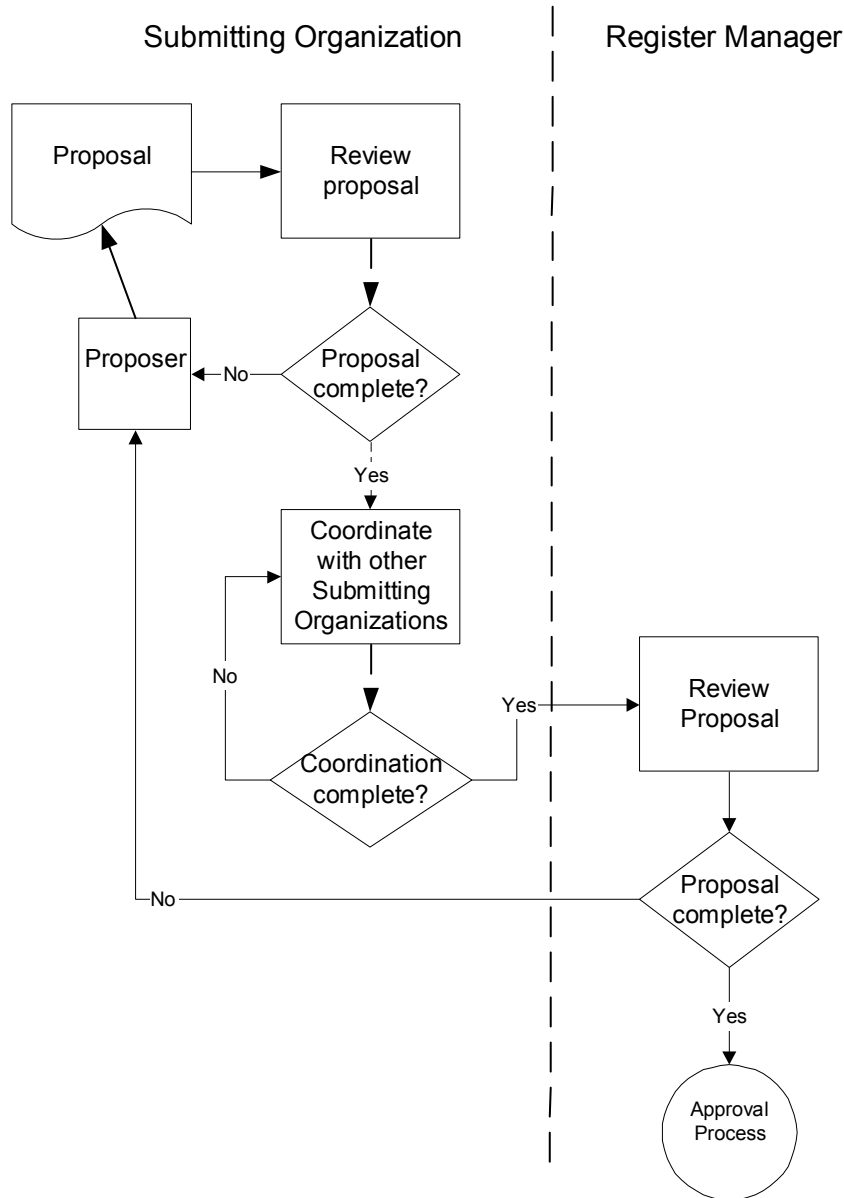
#### *Modification of registered items*

Submitting organizations may submit requests for modification of registered items. Modification of an item results in substantive semantic or technical change to the item. Modification shall be effected by including a new item in the register with a new identifier and a more recent date. The original item shall remain in the register but shall include the date at which it was superseded, and a reference to the item that superseded it.

#### *Retirement of registered items*

Submitting organizations may submit requests for retirement of registered items. Retirement shall be effected by leaving the item in the register, marking it retired, and including the date at which it was retired.

*Processing of proposals*



**Figure 2 – Submission of proposals for registration**

***Submission of proposals***

The process for submitting proposals for registration of items of geographic information is illustrated in Figure 2.

Submitting organizations shall:

- receive proposals for the registration of items of geographic information from proposers within their respective communities or organizations;
- ensure that all proposals are complete;
- coordinate proposals with other submitting organizations, if desired;
- forward to the appropriate register manager those proposals that have the support of the submitting organization; and
- explain proposals to the register manager or register owner, if necessary.



The register manager shall:

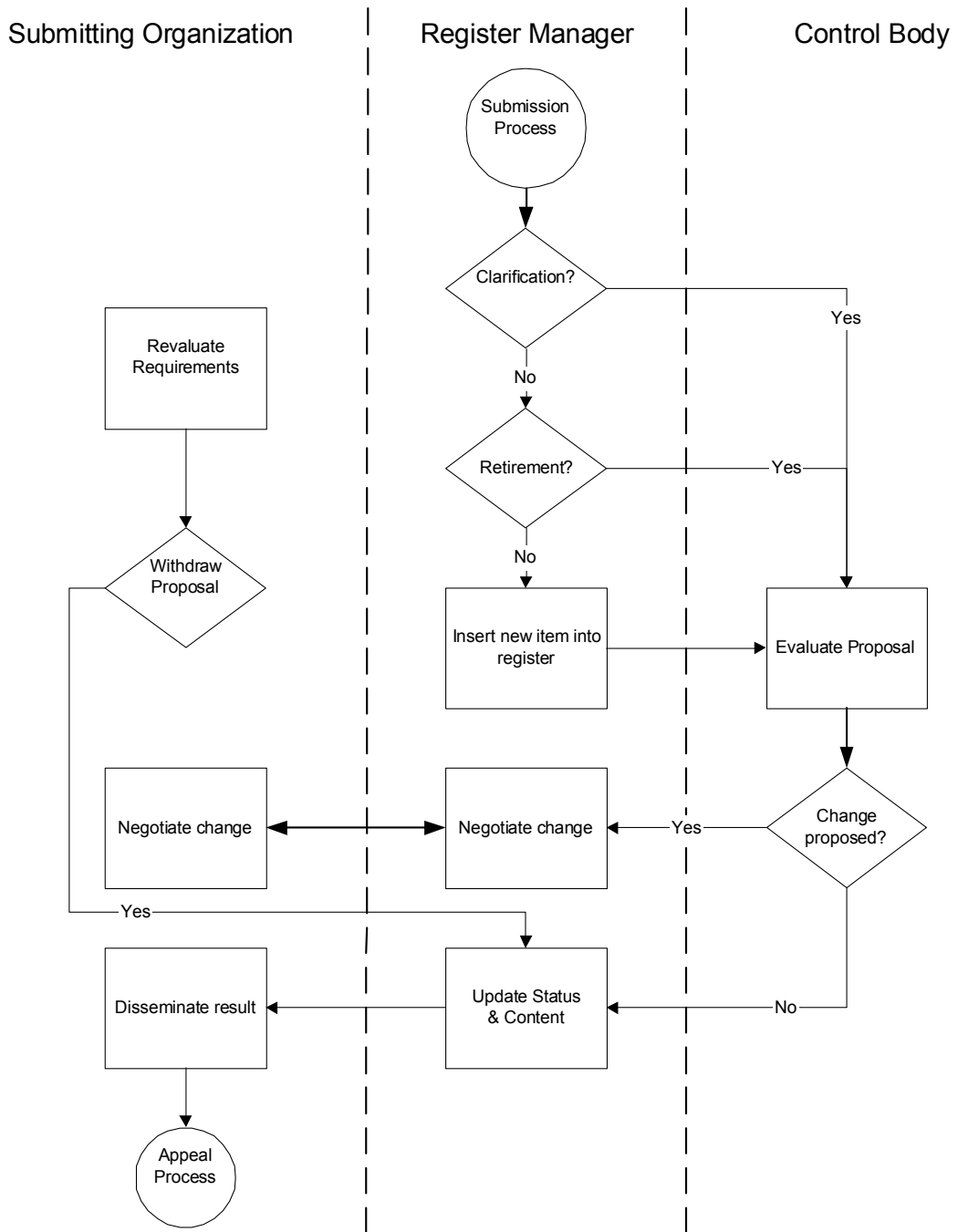
- a) receive proposals from submitting organizations;
- b) review proposals for completeness; and
- c) return proposals to the submitting organization if incomplete.

***Approval process***

The process for determining the acceptability of proposals is illustrated in Figure 3.

Submitting organizations may:

- decide to withdraw a proposal at any time during the approval process;
- The register manager shall:
- if the proposal is for clarification or retirement of a registered item, forward the proposal to the control body;
- if the proposal is for registration of a new item of geographic information or modification of an existing registered item:
  - assign an identifier to the new item;
  - insert the new item into the register, appending the date of inclusion in the register ;  
and
  - forward the proposal to the control body.



**Figure 3 – Approval process**

The control body shall:

- decide whether the proposal should be accepted, accepted subject to changes negotiated with the submitting organization, or not accepted. Criteria for not accepting a proposal include:
  - 1) the submitter is not a qualified submitting organization;
  - 2) the specification of the item is incomplete or incomprehensible;
  - 3) an identical item already exists in the register;
  - 4) the proposed item does not belong to an item class assigned to this register manager; and

5) the justification for the proposal is inadequate.

- inform the register manager of the decision, and the rationale for the decision, within a time limit specified by the register owner.

The register manager shall:

- negotiate with the submitting organization with regard to any changes proposed by the control body;
- append the date on which a proposal was withdrawn or on which the decision as to whether or not to accept the proposed item was made;
- update the status field of the registered item, and make approved changes to the content of the registered item.
- If a proposal is not accepted, the status of the item shall keep the value "proposed" until the appeal process is completed. If the decision not to accept the proposal is confirmed, the item shall be retained in the register with a status of "not accepted."
- inform the submitting organization of the results of processing a proposal within a time limit specified by the register owner.

Submitting organizations shall:

- negotiate with the register manager with regard to changes proposed by the control body as a condition of acceptance; and
- make known within their respective countries or organizations the decisions taken on proposals as transmitted to them by the register manager.

#### *Appeals*

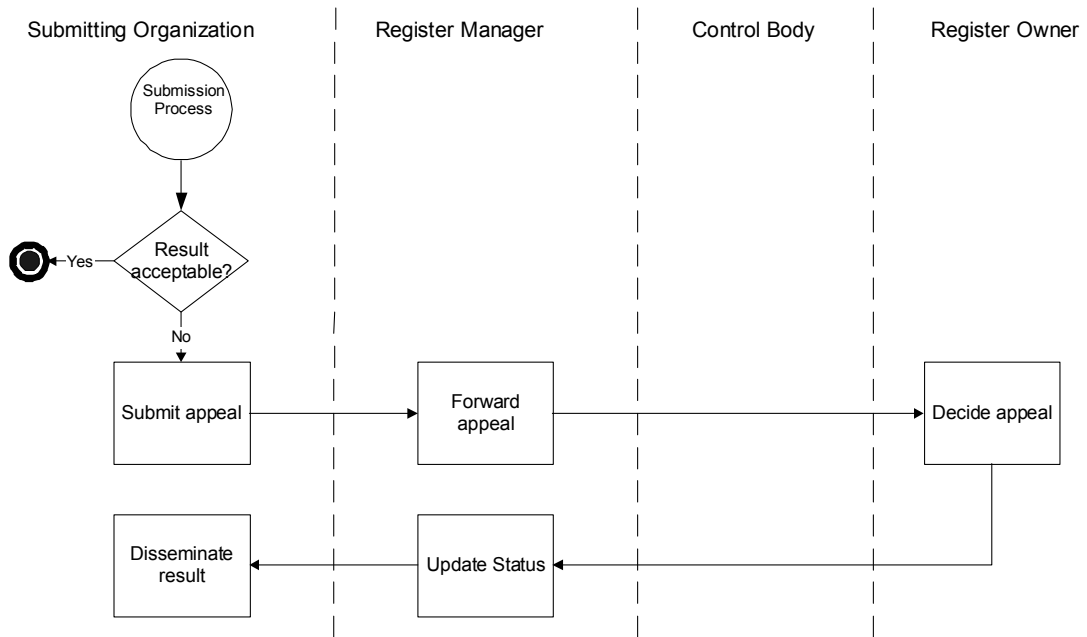
A submitting organization may appeal to the register owner if it disagrees with the decision of a control body to reject a proposal for addition, clarification, modification, or retirement of an item in a register. An appeal shall contain at a minimum a description of the situation, a justification for the appeal, and a statement of the impact if the appeal is not successful. The appeal process is illustrated in Figure 4.

The submitting organization shall:

- determine if the decision regarding a proposal for registration is acceptable; and
- if not, submit an appeal to the register manager.

The register manager shall:

- forward the appeal to the register owner.
- The register owner shall:
- process the appeal in conformance with its established procedures ; and
- decide whether to accept or reject the appeal.



**Figure 4 – Appeal process**

The register manager shall:

- update the status of the registered item, and provide the results of the decision to the control body and to the submitting organization.

The submitting organization shall:

- make the results of the appeal known within their community or organization.

*List of submitting organizations*

A register manager shall maintain and publish a list of all qualified submitting organizations that have submitted proposals for changes to the content of each register that it manages. The list shall include the name and the contact information for each submitting organization.

*Publication*

A register manager shall maintain each register that it manages so that it is accessible to users through an internet web site or other electronically processable form, within appropriate access constraints. A register manager shall also provide copies of each register and associated documents to members of the public for the cost of reproduction. Such copies may be provided on paper, or as digital data on a physical distribution medium.

*Integrity*

A register manager shall ensure, for each register that it manages, that:

- a) all aspects of the registration process are handled in accordance with good business practice;
- b) the content of the register is accurate;
- c) only authorised persons can make changes to the register;
- d) the register is secured against loss caused by damage to the system on which that register is maintained;
- e) a softcopy of the register is sent to the register owner at least once a year; and

f) confidential information is safeguarded.

### Open ECDIS Proposal Process

The draft process for handling proposals for the management of the OEF and IHO registers is given in Figure 5 below. This is based on the current operation of the OEF.

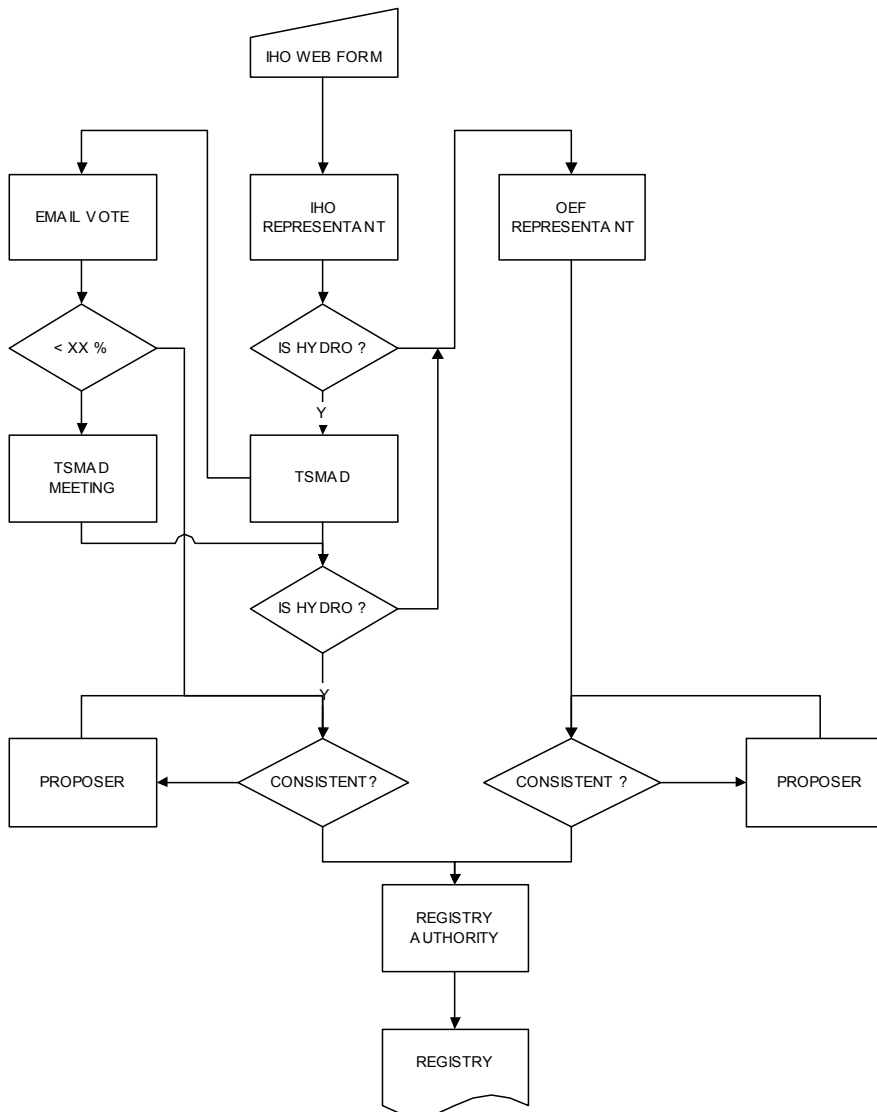


Figure 5 - OEF process

### Resolutions

In the IHO TSMAD S-57 Extensions sub-working group meeting, held in Australia in September 2003, it was agreed to develop a register structure in accordance with the ISO standards as described in this document.

- a) IHO shall establish a compound registry to accommodate multiple owners of content within the same registry structure, i.e., official IHO hydrographic objects, additional OEF objects, ICE objects, and AML objects.
- b) IHO shall coordinate the four register owners to ensure that they share common policies, procedures, code space and register structure.

The action items identified by the working group are:

- Investigate a service interface to the registry including an XML file exchange mechanism, web based access mechanism, and report generation mechanism.
- Submit comments as appropriate to ISO TC211 against ISO 19135 CD and ISO 19126 WD3 in order to ensure that the requirements of IHO are met.
- Review the reports generated from the prototype implementations of the S-57 and ICE registers of the IHO compound registry. These reports will be available for review in the December time frame. Results of the review will be due no later than end of February 2004.
- Chris Roberts, of the Australian Hydrographic Office has volunteered to serve as an S-57 domain expert and point of contact to work with Paul Birkel (The MITRE Corporation) to ensure correct representation of the S-57 edition 3.1 object catalogue content in the registry schema.

The Future objectives and general requirements identified by the committee are:

- The committee needs to identify the domain of each of the registers to ensure that the appropriate items are included in the feature data dictionary registers in the registry.
- The committee needs to address the extension of the registry concept to encompass catalogue requirements in support of product specifications. This needs to include the implications for portrayal.
- The committee needs to leverage the capability for source referencing to establish a greater degree of consistency between items in related registers, e.g., the DGIWG FACC and the IHO S-57 data dictionary.

## LIST OF ACRONYMS AND OTHER ABBREVIATIONS

AARI	Arctic and Antarctic Research Institute
AIRSS	Arctic Sea Ice Regime Shipping System
AMSR-E	Advanced Microwave Scanning Radiometer- Earth Observing System
APT	
ASAR	
AVHRR	Advanced Very High Resolution Radiometer
AWI	Alfred - Wegener Institute for Polar and Marine Research (Germany)
BAS	British Antarctic Survey
BSH	Bundesamt für Seeschifffahrt und Hydrographie (Germany)
BSIC	Baltic Sea Ice Code
BSIM	Baltic Sea Ice Meeting
BSIS	Baltic Sea Ice System
CASES	Canadian Arctic Shelf Exchange Study
CCGS	
CEADO	Argentine Center of Oceanographic Data
Cg	WMO Congres
CIS	canadien Ice Service
DBCP	Data Buoy Cooperation Panel (WMO-IOC)
DMI	Danish Meteorological Institute
DMSP	
EC	Executive Council
ECDIS	Electronic Chart Display Information System
ECIMO	Russian Unified System Information on the World Ocean Conditions
ECV	Essential Climate Variable
ENC	Electronic Navigation Charts
ENVISAT	Environnemental Satellite
ET	Expert Team
ESA	European Space Agency
ESRI	
ETSI	JCOMM Expert Team on Sea Ice
EUMETSAT	European Organization for the Exploitation of Meteorological Satellites
FIMR	Finnish Institute of Marine Research
FNMOC	Fleet Numerical Meteorology and Oceanography Center (US Navy)
GCOS	Global Climate Observing System
GDSIDB	Global Digital Sea Ice Data Bank
GIS	Greenland Ice Service
GMES	Global Monitoring for Environment and Security Project
GOOS	Global Ocean Observing System
HRPT	High Resolution Picture Transmission
IABP	International Arctic Buoy Programme
ICES	International Council for the Exploration of the Sea
IHO	International Hydrographic Organization
IICWG	International Ice Charting Working Group
IMO	Iceland Meteorological Office
IOC	Intergovernmental Oceanographic Commission (of UNESCO)
IPY	International Polar Year
JCOMM	Joint WMO/IOC Technical Commission for Oceanography and Marine Meteorology
JMA	Japan Meteorological Agency
MODIS	Moderate Resolution Imaging Spectroradiometr
NASA	National Aeronautics and Space Administration (USA)
NAVTEXT	International system for reception of marine safety information
NDBC	National Data Buoy Center
NEARGOOS	North-East Asian Regional GOOS
NESDIS	National Environmental Satellite, Data and Information Service
NIC	National Ice Center (USA)

NMEFC	National Marine Environment Forecast Center (China)
NOAA	National Oceanographic and Atmospheric Administration (USA)
NSIDC	National Snow and Ice Center (USA)
NWS	National Weather Service (NOAA)
OLS	
PIPS	Polar Ice Prediction System
SAF	Satellite Application Facilitent
SAR	Synthetic Aperture Radar
SIGRID	Format for the archival and exchange of sea-ice data in digital form
SHN	Naval Hydrographic Service (Argentina)
SIGRID	Sea Ice GRID code
SIMS	Sea Ice Mapping System
SLAR	
SMARA	Glaciological Division of the Argentine Navy Meteorological Service
SMHI	Swedish Meteorological and Hydrological Institute
SSMI	Special Sensor microwave Imager
ULS	Upward Looking Sonar
UNESCO	United Nations Educational, Scientific and Cultural Organization
USIABP	US Interagency Arctic Buoy Programme
WMO	World Meteorological Organization





Group photo of ETSI-II and GDSIDB-X Sessions participants, from left to right: Dr Thor Edward Jakobsson (Icelandic Meteorological Office), Dr Jonathan Shanklin (British Antarctic Survey), Prof Roger G. Barry (National Snow and Ice Data Center, USA), Mr John Falkingham (Canadian Sea Ice), Mr Mikhail N. Krasnoperov (World Meteorological Organization), Dr Vasily Smolyanitsky (Arctic and Antarctic Research Institute, Russian Federation), Mr Klaus Struebing (German Federal Maritime and Hydrographic Agency), Dr Henric Steen Andersen (Danish Meteorological Institute), Mr Paul A. Seymour (National Ice Center, USA), Mr Manuel Hipolito Picasso (Argentine Navy Hydrographic Service), Dr Ivan Frolov (Arctic and Antarctic Research Institute, Russian Federation).