THE INTERNATIONAL ICE CHARTING WORKING GROUP

An Historical Perspective After 13 Years

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Attachment - IICWG Charter and Terms of Reference

Introduction

At the time of writing this document, the International Ice Charting Working Group (IICWG) has been meeting for 13 years, since 1999. During this time, the group has been successful at developing a collegial working relationship amongst the majority of the world's ice information services – those governmental organizations that provide information about sea ice, lake ice and icebergs for the safety of marine operations. After thirteen years, many of the original founders of the IICWG have retired or moved on to other endeavours and participation in the group has passed to their successors. This infusion of new talent and ideas is invigorating and essential but also comes with a loss of historical context and appreciation for the founding principles of the IICWG.

The purpose of this paper is to document the history of the IICWG and to celebrate its accomplishments to serve as a foundation upon which to build for the future.

What Is The IICWG?

Mission

The IICWG was formed as an *ad-hoc* working group of northern hemisphere national ice services primarily for the purpose of exchanging information and ideas to help one another better serve their clients. The preamble to the Terms of Reference adopted at the very first meeting in 1999 clearly and succinctly defines why the IICWG exists and what it does:

> *"Recognizing the ongoing interest of the nations influenced by ice covered seas in the use and protection of these seas; and further recognizing the value and economics of cooperative activities in operational ice services supporting maritime navigation; the ice charting nations of the world hereby form the International Ice Charting Working Group.*
>
> *"The International Ice Charting Working Group provides a forum for coordination of ice matters, including icebergs, acts as an advisory body for the relevant international sea organizations and programs, in particular, WMO/IOC JCOMM, CLiC, GCOS and IHO, and offers non-binding recommendations to senior management as appropriate …"*

Following the preamble, the Terms of Reference outline the activities that are of interest to the IICWG:

- *Data and Product Exchange*
- *Terminology, Data and Mapping Standards*
- *Operations and Customer Support*
- *Training*
- *Technology for Analysis and Forecasting*
- *Applied Science, Research and Development*

Of central importance in defining the IICWG's mission is the notion that it is concerned primarily with "operational ice services supporting maritime navigation". While research activities and climatological investigations are critical components of an ice service, they are not the main focus of the IICWG. The IICWG founders felt that these peripheral aspects were adequately addressed in other fora. It was in the coordination and development of *operational* services that the IICWG was filling a gap and where it should focus its attention. This intention is instilled throughout the Terms of Reference.

Commercial Vessels Being Assisted by a Canadian Coast Guard Icebreaker

Members / Participants

Throughout its history, the IICWG has been an open group without a sense of formal membership. Representatives of the national ice services form the core of participation in the annual meeting and undertake the bulk of its work. However, private ice services have also taken an active role in the working group. Space agencies, as the suppliers of ice monitoring data, are regular participants in a two-way dialogue with the ice services – providing information about earth observation programs and accepting requirements for ice monitoring. Client groups take part in the IICWG to inform the ice services of their information needs and to influence the services' activities and initiatives accordingly. Research communities join in the group as well to share their findings and learn of operational requirements that can help direct their research towards useful goals.

Clients

From its beginning, the IICWG has maintained a strong focus on the clients of the ice services. Marine transportation operators and regulators, including national maritime administrations and icebreaker operators, shipping companies, Coast Guards, Navies, offshore oil and gas operations, fishing fleets and field research campaigns are the primary customers of the ice services that participate in the IICWG. Meteorological organizations, policy-makers, marine engineers and residents in ice-affected regions represent more diverse client sectors. The IICWG tries to understand the needs of their clients by offering a forum for them to interact directly with the ice services. The group has shared many instances of best practices in serving clients and has undertaken several actions to improve the availability and usability of ice information globally.

Ad-hoc-ness and the JCOMM Expert Team on Sea Ice

As an *ad-hoc* working group, the IICWG is independent and free to establish its own working rules, set its own agenda and take action in areas its participants deem worthwhile. Individuals and organizations participate at their own expense. The IICWG has no budget of its own and can reach its objectives only when its individual participants are willing and able to undertake the necessary work. This *"ad-hoc-ness"* has both good and bad aspects. On the positive side, it has allowed the group to work quickly to address concerns without the burden of overhead imposed by a bureaucratic organizational structure. However, it also presents difficulties for some participants to get support for IICWG initiatives within their parent (national) organizations and has the disadvantage of uncertain support for on-going activities. To respond to these downsides, the IICWG has positioned itself as an *advisory body* to the JCOMM Expert Team on Sea Ice (ETSI). JCOMM (Joint Technical Committee for Oceanography and Marine Meteorology) is a joint committee of the Intergovernmental Oceanographic Commission and the World Meteorological Organization and enjoys the support of both of those esteemed bodies. However, as a result, the ETSI is encumbered by IOC/WMO rules, finances, membership limitations and infrequent meetings. The IICWG is not so encumbered and is well positioned to react quickly to an arising need, undertake necessary groundwork and subsequently have a solution incorporated into international practice by referring it to the ETSI for international deliberation and acceptance. Coordination between the IICWG and the ETSI is achieved by maintaining a high degree of overlap in membership and participation.

History

Origins

Prior to the formation of the IICWG, the only global body focusing on operational sea ice information services was the World Meteorological Organization's Sub-Group on Sea Ice (SGSI), a working group of the WMO Commission for Marine Meteorology. Dating from the 1960's, the SGSI was responsible for developing the WMO Sea Ice Nomenclature, the International Sea Ice Symbology and SIGRID – the Sea Ice Grid format for archiving ice chart information in a digital format for climatological purposes. The SGSI also initiated the Global Digital Sea Ice Data Bank (GDSIDB) project to assemble and integrate ice charts from many countries. However, by the 1990's, the SGSI was meeting less frequently and was primarily focused on the GDSIDB. As a result, communication and coordination between the national ice services on operational matters had suffered.

The countries bordering the Baltic Sea had been meeting regularly in the Baltic Sea Ice Meeting since 1925. Since the 1980s, the United States and Canada had developed a robust forum for collaboration between their ice services in the U.S.-Canada Joint Ice Working Group (JIWG - forerunner of the North American Ice Service). At the 1998 JIWG meeting, the co-chairs, Nancy Cutler (Canada) and Helen Wood (U.S.), noted the success of the JIWG and challenged the group to extend it in an international forum. At a Seattle workshop on ice charts for Arctic climate studies later that same year, Cheryl Bertoia of the U.S. National Ice Center and Keld Qvistgaard (Hansen) of the Danish Meteorological Institute (DMI) together with Mike Manore

of the Canadian Ice Service and Dennis Conlon of the U.S. Office of Naval Research Europe discussed the possibility of extending the JIWG concept to other national ice services. The outcome of that discussion was an invitation from DMI to host a meeting under the sponsorship of the three organizations with funding from ONR-Europe.

The first meeting of the International Ice Charting Working Group was held October 5-7, 1999 at the DMI offices in Copenhagen. Forty participants from 11 ice services including Canada, Denmark, Finland, Germany, Iceland, Japan, Norway, Sweden, Russia, the United States and the International Ice Patrol gathered under the chairmanship of David Grimes (Canada), Helen Wood (U.S.) and Erik Boedtker (Denmark). The focus of the first meeting was largely on information exchange as the group tentatively explored areas of common interest and how this new group might complement the more formal SGSI. The agenda sessions of that first meeting are instructive as to the interests and intentions of the founders:

Inaugural IICWG Meeting

- Sea Ice Observation, Data Sources and Analysis Techniques – report from each service
- Satellites for Sea Ice Monitoring
- Ice Operations, Analysis and Forecasting Techniques
- International Ice Terminology and Symbology
- Use of GIS in Ice Chart Production
- Icebergs
- The Future of Ice Information in Electronic Navigation Chart Systems

The first meeting also discussed the future of the group and, in agreeing that it could fulfill an important need, decided upon a Terms of Reference and established two standing committees. Co-chair Mr. Grimes stated in his closing remarks that he "believed that the meeting had been a rousing success". The participants agreed and accepted Iceland's invitation to host a second meeting the following year.

Annual Meetings

In October 2000, the IICWG convened again in Reykjavik. The meeting was hosted by the Icelandic Meteorological Office and was chaired by Trausti Jónsson (Iceland), David Grimes (Canada) and Zdenka Willis (USA). As testament to the rapid recognition of the IICWG's

importance, this second meeting attracted 53 participants representing 25 organizations in 11 countries, including the World Meteorological Organization. Thus began a familiar pattern for IICWG meetings. Representatives from the northern hemisphere national ice services formed the core participation with regular involvement from other organizations including space agencies and satellite data suppliers, universities and research organizations, client groups and international organizations with interests in Arctic marine activities. The linkage between operations and science was discussed from the beginning and, starting with IICWG-III, Science Workshops became a regular feature of the meetings.

The following table lists the meetings that have been held up to 2012.

MEETING	DATE	LOCATION	HOST	CO-CHAIRS
IICWG-I	October 1999	Copenhagen, Denmark	Danish Meteorological Institute	Erik Boedtker (Denmark) David Grimes (Canada) Helen Wood (USA)
IICWG-II	October 2000	Reykjavik, Iceland	Iceland Meteorological Office	Trausti Jónsson (Iceland) David Grimes (Canada) Zdenka Willis (USA)
IICWG-III	November 2001	Tromsö, Norway	Norwegian Meteorological Institute	Helge Tangen (Norway) David Grimes (Canada) Zdenka Willis (USA)
IICWG-IV	April 2003	St. Petersburg, Russia	Arctic and Antarctic Research Institute	Ivan Frolov (Russia) David Grimes (Canada)
IICWG-V	April 2004	Hamburg, Germany	Federal Maritime and Hydrographic Agency	Klaus Strübing (BSH) David Grimes (Canada)
IICWG-VI	October 2005	Ottawa, Canada	Canadian Ice Service	David Grimes (Canada) Richard Barazotto (USA)
IICWG-VII	September 2006	Helsinki, Finland	Finnish Ice Service	Ari Seina (Finland) Doug Bancroft (Canada) Gary Petti (USA)
IICWG-VIII	October 2007	Frascati, Italy	European Space Agency	Gary Petti (USA) Jens Sunde (Norway)
IICWG-IX	October 2008	Luleå, Sweden	Swedish Ice Service	Kathy Kelly (USA) Jens Sunde (Norway)
IICWG-X	October 2009	Geneva, Switzerland	World Meteorological Organization	Kathy Kelly (USA) Jens Sunde (Norway)
IICWG-XI	October 2010	Washington, USA	National Ice Center	Kathy Kelly (USA) Jens Sunde (Norway)
IICWG-XII	October 2011	Cambridge, U.K.	British Antarctic Survey	Diane Campbell (Canada) Juhani Damski (Finland)
IICWG-XIII	October 2012	Tromsø, Norway	Norwegian Meteorological Institute	Diane Campbell (Canada) Juhani Damski (Finland)

Organization

The Charter

At the 6th meeting in 2005, the IICWG undertook a review of its first five years and determined that its accomplishments were impressive enough to warrant continuing. It was decided that

commitment to the group should be formalized and over the next two years the Charter was developed. At the 8th meeting in 2007, in a rather low-key ceremony, the Charter was signed by the original nine participating ice services, including the:

- Canadian Ice Service (Environment Canada)
- Finnish Ice Service (Finnish Institute for Marine Research)
- German Ice Service (Federal Maritime and Hydrographic Agency)
- Greenland Ice Service (Danish Meteorological Institute)
- International Ice Patrol (United States Coast Guard)
- Norwegian Ice Service (Norwegian Meteorological Institute)
- Arctic and Antarctic Research Institute (Russian Federal Service for Hydrometeorology and Environmental Monitoring)
- Swedish Ice Service (Swedish Meteorological and Hydrological Institute)
- National Ice Center (United States National Oceanographic and Atmospheric Administration)

The Charter is a rather innocuous document that merely states the intention of the signatories to "participate in the activities of the IICWG to the best of their abilities" with no legal or financial obligation. Nevertheless, it has served the group well in solidifying the commitment of the signatories and establishing the IICWG as a significant force in the sea ice and iceberg community.

The Charter has come to represent membership in the working group. While many actions are proposed and opinions offered during the open meeting, it is the Charter signatories who decide on what positions to adopt and what actions to undertake. Up to 2012, three additional ice services have signed the Charter:

- Icelandic Meteorological Office, 2008
- British Antarctic Survey, 2011
- Polish Institute of Meteorology and Water Management, 2012

Terms of Reference

Absent from the original Terms of Reference was any prescription for how the IICWG would organize itself and operate. Partly this was a reflection of its origins. There was a sense that bureaucratic encumbrance was one of the reasons that the WMO Sub-Group on Sea Ice had lost touch with the operational ice services. The group wanted to maintain its flexibility and "*ad-hoc-ness*" to avoid that pitfall. Undoubtedly, there was also some uncertainty about the sustainability of the new group.

As the IICWG matured and proved itself to be a valuable continuing group, an Annex to the Terms of Reference was adopted in 2007 to establish a more formal arrangement for the IICWG co-chairs. Until that time, the appointment of co-chairs had been somewhat arbitrary with Canada and the U.S. taking a primary role along with a third co-chair from the host organization. The Terms of Reference Annex sets out that there should be two co-chairs – one from Eurasia and the other from the Americas. It also specifies that the co-chairs should be at an organizational level higher than the heads of the represented ice services, prescribes the

responsibilities of the co-chairs and stipulates that the co-chairs should rotate every three years, preferably not at the same time.

Standing Committees

At the first meeting in 1999, concurrent with the adoption of the Terms of Reference, the IICWG established two standing committees - the Applied Science and Research Standing Committee (ASRSC) and the Data, Information and Customer Support Standing Committee (DICSSC). The somewhat unwieldy names of the committees reflect the discussion that led to their creation. Considering the activities of interest as outlined in the Terms of Reference, as many as seven standing committees were initially proposed. However, accepting the realities of IICWG participation possible from each ice service, it was agreed that two committees were most appropriate but that these two committees should embrace the range of IICWG interests. The ASRSC and DICSSC have informally been known as the "science committee" and "data committee" ever since.

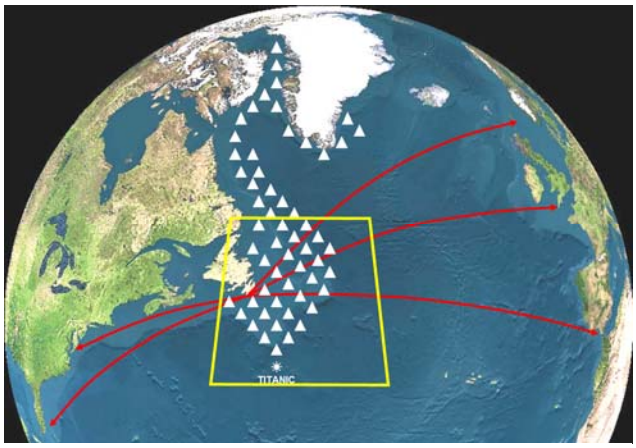
Website

The IICWG website (http://nsidc.org/noaa/iicwg/) has been hosted by the National Snow and Ice Data Center since 2000. IICWG business is documented as much as possible on this site and includes reports from all of the annual meeting, lists of action items, reports that have been prepared and relevant documents that have been collected. The site is open freely to the public at large in the spirit of education and cooperation.

Accomplishments

Iceberg Information in Europe

At the first meeting in 1999, a concern was raised by Klaus Strübing of the German Ice Service about the availability of iceberg information for the North Atlantic. Trans-Atlantic ships faithfully use the International Ice Patrol (IIP) "Limit of All Known Ice" to determine their course across the ocean. While these charts were broadcast on a daily basis from radio stations in North America, they could not be reliably received by ships leaving Europe until they were midway across the Atlantic – after they had already set their great circle sailing route. Mr. Strübing noted that if ships had access to the IIP chart sooner in their voyage, they would be able to plan a safer and more efficient passage. The German Ice Service had mitigated this problem somewhat by constructing twice weekly iceberg charts



International Ice Patrol Area of Operations

based on the IIP iceberg bulletins. These “second-hand” charts were transmitted within the regular schedule of the radio-facsimile broadcast of the German Marine Weather Service. An additional difficulty was that the IIP only operated during the “iceberg season” when icebergs were expected south of latitude 48N. In 1999, no icebergs had come south of this latitude and the IIP did not produce any charts. They had referred mariners to the Canadian Ice Service which prepares iceberg charts further north but not all mariners received this referral.

As a result of the discussion at the IICWG, arrangements were made for the IIP and the Canadian Ice Service to send their iceberg charts directly to the German Weather Service for retransmission within the regular Marine Radiofacsimile Broadcast Service from the European side of the North Atlantic. Vessels were able to receive the latest iceberg information before setting out and plan the optimum trans-Atlantic route to North America.

International Ice Chart Colour Standard

One of the first collaborative initiatives that the IICWG undertook was to standardize the colours used on ice charts. At IICWG-I in 1999, Klaus Strübing noted that the international standard for ice chart symbols had been developed in the era of hatching schemes to depict ice concentration and stage of development. It had not been updated to account for new communication technologies that permitted an effective use of colour. Most ice services had started producing coloured ice charts without reference to one another

After three years of deliberation and negotiation, a colour code scheme was adopted by the IICWG. In its first formal act as an “advisory body”, the IICWG recommended this colour code as an international ice chart standard to the JCOMM Expert Team on Sea Ice. It was subsequently adopted as such and published as JCOMM Technical Report No. 24 in 2004.

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	-
Optional		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
Areas of No Information are annotated accordingly				

International Ice Concentration Colour Code

SIGRID-3: A Vector Archive Format for Sea Ice Charts

The Sub-Group on Sea Ice had previously developed the SIGRID (“Sea Ice Grid”) format for archiving ice chart information. SIGRID-1 and -2 both used grid-point schemes for capturing the information on an ice chart. While this format was amenable to digital archiving and large scale climatological analysis, it had the serious drawback of reducing a continuous ice chart to a series

of grid point values with no information about the ice conditions between grid points and no possibility to re-create the original chart.

At IICWG-II, a proposal was made for a new archive format based on vector shapefiles, an open Geographic Information System (GIS) format. The introduction of GIS technology at most ice services made it an easy process to produce shapefiles which could be read by many popular GIS programs to faithfully reproduce the original ice chart without loss of detail. An IICWG sub-group was struck to adapt the shapefile format to SIGRID and, after two years, SIGRID-3 was born. SIGRID-3 preserved the ice-specific database terminology of the previous SIGRID but adapted it to describe the ice within shapefile polygons rather than at grid points.

SIGRID-3 was adopted by the IICWG in 2003 and recommended to the ETSI as an international ice chart archiving and exchange standard. It was subsequently adopted as such and published as JCOMM Technical Report No. 23.

Ice Information Services: Socio-Economic Benefits and Earth Observation Requirements

Earth observation data from satellites is critical to the monitoring activities of all ice services and so it is not surprising that the IICWG meetings included sessions on satellite missions as early as its second meeting. At that time, Synthetic Aperture Radar data was used sparingly by most services because of its high cost. (The single exception was the Canadian Ice Service which had access to large quantities of SAR data from the Canadian government RADARSAT program.) Much discussion took place concerning the possibility of reducing the cost through bulk purchases and shared access to data. About the same time, the European Space Agency (ESA), in its planning for Envisat, was heading towards a commercialization policy for its new Envisat SAR data which would have been financially detrimental to the ice services.

The IICWG invited Mark Doherty, Director of Earth Observation at ESA, to its 5th meeting in Hamburg in April 2004 to present ESA's views and become better informed on those of the ice services, the largest single group of users of satellite radar data. As a result of this discussion, the IICWG decided to prepare a document that outlined the socio-economic benefits of freely available ice information as well as the

specific requirements of the ice services for earth observation data. The target of this document was squarely on the intergovernmental Group on Earth Observations (GEO) and the ESA Global Observations for Environment and Security (GMES) program. When the document was completed, it was sent to both of these organizations along with a covering letter from the co-chairs. The "*Ice Information Services: Socio-Economic Benefits and Earth Observation Requirements*" proved to be a valuable tool in discussions with several space agencies. It was updated in 2007.
(http://nsidc.org/noaa/iicwg/docs/IICWG_2007/IICWG_SE_2007_Update_Final_.pdf)

Aside from the concrete socio-economic benefits document, the IICWG has achieved much success in dealing with the space agencies throughout its history. In the early years, the major concern, aside from the cost of SAR data, was the availability of SAR data in the long term. The IICWG co-chairs communicated with various space agencies over the years stressing the need for continuity of data, offering advice on sensor attributes and operating scenarios. The space agencies, most notably the European and Canadian Space Agencies have regularly turned to the IICWG for advice on the requirements for future missions.

The free and open exchange of earth observation data, especially Synthetic Aperture Radar that has become common since 2010 is due, in no small way, to the continuing efforts of the IICWG.

Ice Information for Electronic Navigation Charts

The notion that ice information should become compatible with Electronic Navigation Charts (ENCs) and Electronic Chart Display and Information Systems (ECDIS) was raised at the very first IICWG meeting. Initial work on this initiative had already been started by Canada, Germany and the United States and the IICWG was quick to recognize its importance. Sessions on ECDIS were held at each of the meetings from 2000 to 2004. It was obvious to all that ENCs represented the future of marine navigation and, since floating ice presents a major navigation hazard in the polar and sub-polar seas, the information traditionally portrayed in ice charts should be available to mariners' ENC systems.

By the meeting in 2006, a draft Catalogue of Ice Objects had been prepared and subjected to critical review. The Catalogue describes, in rigorous detail, the ice features that can be displayed on an ENC together with their attributes and represents the first major step towards the ability to provide ice information compatible with Electronic Navigation Charts. The 2006 meeting asked that the draft Catalogue be submitted to the Expert Team on Sea Ice for approval as the formal standard for exchanging ice information in a format compatible with ENCs. The ETSI had been denoted the "authority" for ice information in ENCs by the International Hydrographic Organization (IHO). ETSI approved the initial version of the Ice Objects Catalogue at its meeting in March 2007. It has been through several revisions since then and will continue to do so as ENC standards evolve.

This project serves to highlight the beneficial working relationship between the IICWG and the ETSI. The ETSI is constrained by World Meteorological Organization rules and finances to meet only once every four years. The IICWG is able to meet more frequently and, in this case, was able to develop the catalogue in relatively short order. The fact that many of the ETSI members are the same individuals who worked on the Catalogue through the IICWG ensures easy

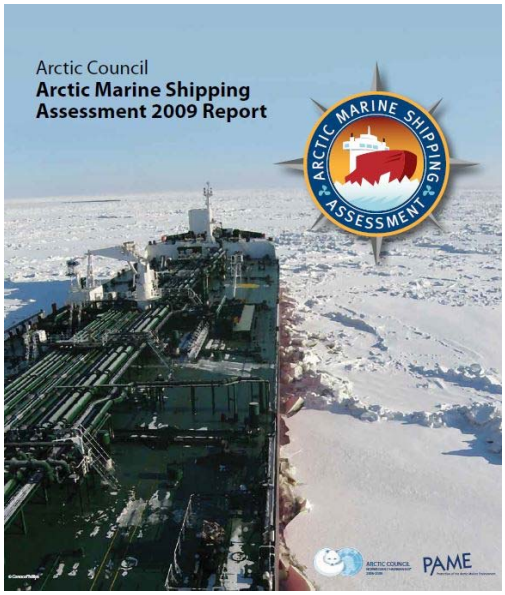
acceptance of the recommendation. On the other hand, the international community needs the stability of an established organization such as the WMO to be the formal keeper of the standard. The IHO would be unlikely to invest an *ad hoc* organization like the IICWG with the authority to maintain the international standard.

Ice Logistics Portal

As 2007-2008 approached, the IICWG members were considering what they could contribute to the third International Polar Year (IPY). While the IPY was essentially focused on scientific research, the ice charting experts of the world felt that they had a valuable role to play. At the Helsinki meeting in 2006, the group determined that its best support to the IPY would come from making its regular ice charts more easily available to those planning logistics for field research campaigns in ice covered waters. The vision was to create an "Ice Logistics Portal" under the auspices of the JCOMM that would provide a convenient single point of access to all of the ice charts produced for every region of the globe. Individual ice services would submit their charts in electronic form to the portal which would provide an elegant user interface by which to access them. There were discussions about digitally integrating all of the charts to create a single "best" global ice chart but that idea was quickly abandoned as unworkable within the time frame available. Polar View, a European Space Agency project, offered to be a partner in the Ice Logistics Portal and, in fact, funded the development of the website.

After the end of the IPY, the IICWG decided that the Ice Logistics Portal should be maintained to provide a continuing useful information source for those planning operations in icy waters. While the ice charts available on the Portal are also available on individual ice service web sites, it is not always obvious to users how those web sites can be accessed. The Ice Logistics Portal allows a user to simply select a region on a hemispheric map and get instant access to all of the current ice charts produced by every service for that region. No attempt is made to rationalize differences between charts from different services. Perhaps that is a development for the future.

After developing the web site, Polar View hosted the Ice Logistics Portal for the first few years. However, since the Polar View project-based funding was somewhat uncertain from year to year, the IICWG decided to move the web site to a more stable organization. The German Ice Service offered to host the site and has done so since 2010 (http://www.bsis-ice.de/IcePortal/).



Arctic Marine Shipping Assessment

The Arctic Marine Shipping Assessment (AMSA) was initiated by the Arctic Council to conduct a comprehensive study of current and future shipping activity in the Arctic. Lawson Brigham, the lead author for the AMSA, briefed the IICWG meeting in 2006 about the study and solicited input from the participants. John Falkingham subsequently agreed to be a lead

author on the Marine Infrastructure chapter. In the course of the next three years, Mr. Falkingham solicited the assistance of IICWG members who made significant contributions, reviewed numerous drafts and ultimately approved the sections on ice information services that appear in the report. The AMSA has become a much-referenced work since it was published in 2009 and the influence of the IICWG can be seen throughout much of it.
(See http://www.arctic.gov/publications/AMSA.html)

Training and the Ice Analysts' Workshops

In the Terms of Reference, training of ice analysts and forecasters was identified as a key activity of the IICWG. The group recognized that, despite regional differences, there was much commonality between the ice services with respect to the production of ice information. Operational staff in all of the services do very much the same work and need essentially the same training. The exchange of training information, practices and materials has been a regular part of IICWG activities.

Ice Analysts' Workshop

At the 2006 meeting in Helsinki, a special session was devoted to the Global Climate Observing System (GCOS) and the role that ice charts could play in observing changes in global climate. One of the outcomes of that meeting was the commitment to hold a workshop to address inter-calibration and standardisation of ice charts – an essential prerequisite to using ice charts from different services in climatological analysis. As a result, the first Ice Analysts' Workshop convened in Rostock in June 2008. Since then, two more workshops have been held and a fourth is planned for 2013. The workshops have been extremely successful in promulgating best practices among the operational ice services, introducing working-level ice analysts to new tools and techniques and devising effective solutions to operational problems. For example, at the third Ice Analysts' Workshop, a complete working-level strategy was developed to coordinate ice information for the Arctic METAREAs among the ice services so that differences in ice analyses would not be evident at the boundaries between adjacent METAREAs.

Operational Collaboration

Every ice service faces financial, people and time constraints and, from the beginning, the IICWG participants recognized the benefits that could be achieved by working together to eliminate duplication and optimize their collective efforts. Collaboration at the operational level is not an easy task in a multi-national environment where every organization has its own policies, procedures, technology and products, not to mention different languages and corporate cultures.

While fundamentally similar at a high level, myriad small differences manifest themselves at the working level.

It has taken over a decade of small incremental steps for the IICWG to reach a point where true operational collaboration is at hand. Learning one another's technologies, implementing common standards and adopting best practices has gradually moved the organizations closer to shared ground. In 2011, both the U.S. National Ice Center and Russia's Arctic and Antarctic Research Institute demonstrated capabilities to produce global ice charts based on an integration of charts from foreign ice services. Mechanisms are being established to further this capability and formalize it with the vision being the regular production of a common global ice analysis based on local analyses by agencies in the best position to produce them. Ice services can concentrate on their local area of responsibility, devoting resources to making the best ice analyses and forecasts for that area, and benefit from similar actions of their partners in the IICWG.

The "Soft" Successes

Along with all of the tangible accomplishments of the IICWG, the value of getting to know one another on a personal level, as well as on a corporate level, should not be under-estimated. It has resulted in fast, non-bureaucratic, practical solutions to problems in the past. Barriers of the unknown have been broken down so that ice service staff are less reticent to seek information or advice from their foreign counterparts. People find it easier to refer clients to other ice services when they understand how those services work and what they are capable of. Overall service to the global shipping community has improved due to the spirit of collaboration that has been developed within the IICWG.

Moving Forward

There have been three rather indistinct phases in the IICWG's history up until now. The first phase, roughly spanning the first 3 or 4 years, can best be characterized as "getting to know one another". Even though some of the participants had long-standing relationships, none of the parties were familiar with everyone. As with any group that comes together for the first time, there was some suspicion, even some distrust, about one another's motives. Annual meetings were characterized by sessions devoted to sharing information about each other's organizations, procedures and technology. This phase was passed rather quickly however as the participants realized they had much in common – in both strengths and weaknesses. They soon realized that they all had something to gain from working together. This sense of mutual trust and kinship grew stronger over the next half dozen years as the group tackled and resolved a number of issues. The annual meetings were focused more on setting goals for the group, conducting working sessions on identified problems and establishing task teams to produce solutions. This period represented the most productive second phase during which most of the successes described earlier were achieved.

A plateau of sorts was reached after about a decade when the easier problems had been solved and uncertainty arose about how to confront the more complex challenges. During this phase, the annual meetings became more focused on information gathering – not about one another but about external organizations and challenges. While there was no lack of issues needing attention,

there was doubt about how the group should proceed. The remainder of this section is devoted to identifying the challenges in an effort to bring them into focus.

The Changing Polar Regions

The summer of 2012 saw another new record low ice extent, a record number of commercial vessels transit the Northern Sea Route, unabated development of Arctic oil and gas resources and non-ice-strengthened cruise ships carrying thousands of passengers into Arctic waters. The ice infested waters of the Arctic are seeing more and more activity, for longer periods of time and in less predictable ice conditions. The need for ice information in the Arctic has never been greater and yet the resources of many ice services have never been stretched thinner.

At the same time, southern hemisphere ice services are largely provided by countries to support re-supply voyages to their own Antarctic research stations. Cruise ships, fishing vessels and transiting ships are largely on their own when it comes to ice information.

The International Maritime Organization (IMO) has recognized this increasingly hazardous situation and has undertaken the development of a mandatory Polar Code. This Code should, among other things, specify what kind of ice information ships in the Polar Regions must have, the technology they will need to receive this information and the training their officers will require to safely navigate in polar waters. In the interest of marine safety in ice covered waters, the IICWG needs to lend its expertise to the development and implementation of the ice information aspects of the Polar Code.

Commitment to Continued International Collaboration

One of the drivers behind the IICWG is the notion that shipping is international in nature. By the very nature of the business, thousands of ships travel from one national jurisdiction to another every day. When it comes to ice information, the IICWG believes that mariners should be able to receive the same level of ice information no matter where they voyage. “Level of information” implies the same quantity and quality, the same parameters in the same format and comparable means of accessing the information. Achieving that ideal requires continuing close collaboration among the ice services. In a rapidly evolving work environment, the ice services need to progress together to keep the vision of globally congruent ice information a reality.

The ultimate expression of this collaboration would be the production of a common global ice “chart” created and shared by all. The technology to facilitate this is readily available in most ice services. It is currently happening on a limited bilateral basis between the U.S. and Canada and among the Baltic countries. At the 2012 meeting, Russia, Norway and the United States agreed to investigate integrating their production of ice charts for Antarctica.

While there remain policy issues as well as practical challenges, the benefits of such collaboration are the efficiencies that could be achieved and the improvement in service to users.

Engaging the Southern Hemisphere

The original participants and focus of the IICWG was clearly on the northern hemisphere where there is a large volume of ship traffic and offshore operations in the vicinity of sea ice and

icebergs. By contrast, ship traffic in the Southern Ocean largely stays well north of the ice with the exception of re-supply voyages to the Antarctic research stations. These latter are supplied with voyage-specific ice information by their host nation and the IICWG felt its energies would be better expended on northern issues.

That is not to say that international cooperation has been absent when situations demanded. When the M/V "Magdalena Oldendorff" became beset in Antarctic pack ice in June 2002, several ice services cooperated in the successful rescue operation.

M/V Explorer Sinking in Antarctic Waters

However, in the past decade there has been a boom in cruise ship tourism in the Antarctic with large cruise ships carrying thousands of passengers into icy waters with little or no ice information. The sinking of the cruise ship *M/V Explorer* on 23 November 2007, fortunately without loss of life, underlined the need for improved ice information around Antarctica. The IICWG is now actively working to help bring southern hemisphere ice information to a level comparable to the north with an emphasis on the prevention of disasters rather than response.

Interoperability of Data / Standards / Policies

Being able to provide a consistently high level of ice information around the world is greatly facilitated by having compatible standards and policies regarding data and products. Being able to exchange data and products between ice service systems and work seamlessly with them affords a tremendous advantage in maintaining compatibility between ice information products. As data sources, client needs, technology and scientific understanding change, maintaining the relevancy of standards requires a continuing effort.

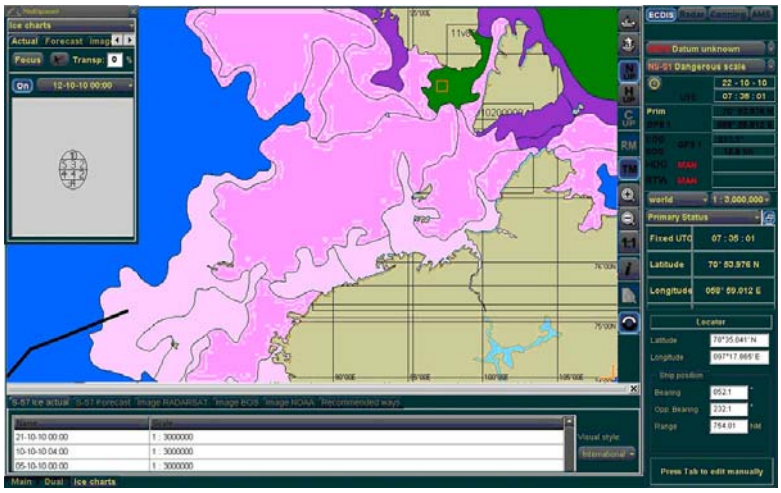
Training

There have been significant efforts to share training resources and promulgate best practices, such as through the Ice Analysts' Workshops. The next stages are to more formally identify common curricula, gather or develop core training materials and possibly adopt common certification criteria so that partners and clients can understand the competencies of ice analysts and forecasters. An initial step towards this goal was taken at the IICWG meeting in 2012 where the Data Committee agreed to collect training materials and determine if there were any gaps that need filling.

Customer Support – e-navigation

While the IICWG has made considerable progress in developing ice chart information for Electronic Navigation Charts (ENCs) as noted above, there is still much work to be done before these are effectively in the hands of mariners. The technology to transform SIGRID-3 format

files into S-57 and S-10x formats suitable for ENCs has been demonstrated but is not in operational use at any of the member ice services of the IICWG. The SIGRID-3 version that is thus supported contains only a basic subset of the possible ice information objects that could be used in ENCs. An expansion of SIGRID-3 has been proposed but has not yet been vetted and approved. Furthermore, an accepted set of display symbols has not yet been developed for ice objects in ENC systems, an obviously essential component. And importantly, a mechanism for delivery, including the frequent updating, of ice information to ENC systems aboard ships has yet to be determined internationally.



Ice Chart on ENC System Display

The world of international shipping is rapidly moving to electronic systems for the display of navigation information. To serve this important segment of the ice services' clientele, the ice service community must join this movement to continue to play its part in ensuring the safety of navigation in ice inhabited waters.

Integration of Weather–Ice–Ocean and Ice Navigation Models

The importance of short term ice forecasting and related modelling to the future of national ice services was recognized at IICWG-3. Since then, improved cooperation in the development of sea ice models and related data assimilation has been a priority within IICWG. Operational ocean forecasting is now becoming a reality around the world, just as weather forecasting has been for many decades. Ice, conveniently sitting at the interface between atmosphere and ocean, can benefit from the integration of atmospheric and ocean models. Modellers know that they must incorporate a realistic ice cover if they hope to be successful at forecasting the weather or the ocean. Ice services must provide observed ice conditions to the models with temporal and spatial resolutions tuned to the models. Short term ice forecasts, out to two weeks or so are now available. Seasonal and inter-annual predictions are the subject of much current research. The IICWG can inform these research efforts about operational priorities as well as contribute to the research process through test beds and pilot projects.

Beyond the integration of physical environment models, integrating with client business models presents yet another step in service delivery. Ice navigation models considering special ship parameters such as ice class, propulsion power and hull form along with ice conditions will be an additional new opportunity and challenge.

Support for Integrated Decision Making (Incident Management)

An emerging requirement for ice services is to be able to more effectively support decision makers dealing with marine incidents. Whether it involves a ship becoming disabled or worse, an oil spill, a search-and-rescue incident or a security issue, if it involves ice in the ocean, the ice services will be implicated. Depending on the nature of the incident, multiple and varied responders will need ice information critical to their response. Depending on the location of the incident, two or more ice services could become entangled in the information flow.

As activity in the Polar Regions increases, the probability of such an incident occurring is rising. It would be beneficial to all concerned if the ice services could develop appropriate protocols for cooperation, handling of information and sharing resources before a crisis happens. The IICWG can play a facilitating role to bring about such agreements.

Partnering in New Ways

At one time in the not-too-distant past, national (or international) ice services were the only organizations with the resources to monitor sea ice and icebergs. More recently, with the wide availability of satellite earth observations, this is changing. Some clients, such as the oil and gas industry operating in ice-covered waters, are developing in-house capacity for ice observing as part of their overall environmental monitoring strategy. Companies offering commercial ocean routing services are starting to include ice information in their suite of products. Satellite data providers themselves are offering ice analysis services to complement their raw image products. The IICWG has always welcomed these other organizations to its meetings but the invitations, with a few notable exceptions, have been largely unanswered. With safety of marine operations at the root of all of these various endeavours, it is incumbent upon the IICWG to find new ways to work with other providers of ice information beyond the governmental services in order to involve them in the process of cooperation and harmonization of products for the benefit of the marine community.

Conclusion

For thirteen years now, the IICWG has brought the national ice services together with their clients and partners in a growing bond of cooperation and collaboration. This paper has attempted to trace the path that the group has travelled and chronicle its achievements. While much has been accomplished, there are still many challenges to be met and the future will undoubtedly reveal many more. Building on the solid foundation that has been established, the IICWG is well positioned to address these challenges with solutions that are both innovative and pragmatic.

As long as ice floats in the ocean, there will be a need for ice information and a role for the International Ice Charting Working Group to bring the information providers together in the interest of safety in the icy seas.

CHARTER OF THE
INTERNATIONAL ICE CHARTING WORKING GROUP

Recognizing the ongoing interest of the nations influenced by ice covered waters in the use and protection of those waters; and further recognizing the value and economics of cooperative activities in operational ice services supporting maritime navigation; the ice charting services of the world formed the International Ice Charting Working Group (IICWG).

The IICWG provides a forum for coordination of ice matters, including icebergs, and offers non-binding recommendations to senior management as appropriate.

After reviewing the Terms of Reference for the IICWG, Attachment One, the signers of this Charter intend to participate in the activities of the IICWG to the best of their abilities. It is understood that membership in the IICWG is not binding and does not imply any legal or financial obligation on their part.

Any signatory may end its relationship with the IICWG at anytime by giving 60 day written notice to the IICWG Co-Chairs.

Date: 23. 10. 2007

Person/Title: Ari Seina, Head of Finnish Ice Service
For: Finnish Institute of Marine Research

Date: 23/10/2007

Person/Title: Anette Jönsson, Head of Swedish Ice Service
For: Swedish Meteorological and Hydrological Institute

Helge Tangen

Date: 23.10.2007

Person/Title: Helge Tangen, Regional Director
For: Norwegian Meteorological Institute

Erik Buch

Date: 23.10.2007

Person/Title: Erik Buch, Director, Centre for Ocean and Ice
For: Danish Meteorological Institute

Date: 10/23/07

Person/Title: Commander Scott Rogerson, Co-Director North American Ice Service,
Commander International Ice Patrol, United States Coast Guard

For: North American Ice Service (International Ice Patrol)

Date: 23 oct 07

Person/Title: Commander Raymond Chartier Jr., Co-Director North American Ice Service,
Director National Ice Center, United States of America

For: North American Ice Service (National Ice Center)

Date: 23 OCT 07

Person/Title: Douglas Bancroft, Co-Director North American Ice Service,
Director Marine and Ice Services, Environment Canada

For: North American Ice Service (Canadian Ice Service)

Date: 23.10.07

Person/Title: Ivan Frolov, Director

For: Russian Federation Arctic and Antarctic Research Institute of Roshydromet

for Jürgen Holfort
i.V.

Date: 23.10.2007

Person/Title: Jürgen Holfort, Head, German Ice Service

For: Federal Maritime and Hydrographic Agency of Germany

Date: 31.10.2008

Person/Title: Magnús Jónsson, Director General

For: Icelandic Meteorological Office

Date: 18th october 2011.

Person/Title: Professor Nicholas Owens, Director

For: British Antarctic Survey

Date: 10/08/2012

Person/Title: Tomasz Balcerzak, Director
For: Institute of Meteorology and Water Management
National Research Institute, Maritime Branch in Gdynia

Date: _____

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For:

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For:

ATTACHMENT ONE
to the
CHARTER
of the
INTERNATIONAL ICE CHARTING WORKING GROUP

International Ice Charting Working Group Terms of Reference

Adopted October 7, 1999, amended October 26, 2007

Recognizing the ongoing interest of the nations influenced by ice covered seas in the use and protection of these seas; and further recognizing the value and economics of cooperative activities in operational ice services supporting maritime navigation; the ice charting nations of the world hereby form the International Ice Charting Working Group.

The International Ice Charting Working Group provides a forum for coordination of ice matters, including icebergs, acts as an advisory body for the relevant international sea organizations and programs, in particular, WMO/IOC JCOMM, CLiC, GCOS and IHO, and offers non-binding recommendations to senior management as appropriate, working under the following Terms of Reference:

Data and Product Exchange

- Coordinate ice information, data exchange, supporting research, and communications for operational analysis and forecasting of sea ice and icebergs.
- Propose, and establish procedures for, data and product exchange agreements for the enhancement of services at all ice centers.
- Coordinate collection, maintenance, and distribution of archived sea ice and iceberg information, including climatological information, and recommend common practices where appropriate.

Terminology, Data and Mapping Standards

- Identify established standards at ice centers governing data and product format, data transfer, metadata, and other geographic information such as attributes and coastlines.
- Recommend adoption of common methodologies among ice centers where practical.
- Develop recommendations for possible changes to standards for forwarding to appropriate international organizations for consideration.

Operations and Customer Support

- Develop an understanding of each ice center's unique customer base and its impact on operations.

- Monitor customer requirements for ice services and make recommendations for generic strategic development that will allow ice centers to meet evolving customer needs.
- Identify and provide a mechanism for coordinating customer feedback to the operational process.
- Examine information dissemination processes within the ice centers and recommend efficiencies and new technologies where appropriate.
- Recommend the establishment of customer education initiatives that serve to enhance the ice centers' collective operational effectiveness.

Training

- Encourage exchange of technical knowledge through shared training initiatives, personnel exchange programs, and the loan of applicable equipment and tools.

Technology for Analysis and Forecasting

- Monitor development and implementation of advanced information technology as applied to new digital sea ice analysis and production techniques.
- Identify technology applications supporting efficient dissemination and exchange of data, products, and ice information services.
- Recommend areas of potential common interest for technology sharing.
- Identify emerging capabilities supporting sea ice and iceberg analysis and forecasting and recommend their integration into operations as appropriate.

Applied Science, Research and Development

- Identify research priorities for improved analysis and forecasting capabilities, and communicate and promote these priorities within national and international funding agencies.
- Identify research technologies available for transition to operations, and coordinate efforts to encourage their transition and validation through funding, logistical support, and cooperative verification and validation processes.
- Report on operational initiatives, and research and field programs, of broad interest across the ice charting community.
- Encourage and facilitate coordinated efforts in supporting ice research and development, including numerical ice prediction models, remote sensing applications, and digital image processing capabilities.

ANNEX 1
to the
TERMS OF REFERENCE
of the
INTERNATIONAL ICE CHARTING WORKING GROUP
(Adopted October 26, 2007)

ROTATION OF CO-CHAIRS

A. International Ice Charting Working Group Co-Chairs

1. The International Ice Charting Working Group (IICWG) will be chaired by two Co-Chairs.

2. For the purpose of designating Co-Chairs the IICWG members will be divided into two geographic groups. The first group is Eurasia, which is made up of those members in Europe and Asia. The second group is the Americas, which is made up of those members in North and South America, and Australia.

3. Each geographic group will determine the Co-Chair for the group through consensus of the members of the geographic group.

4. The Co-Chairs will be at a higher organizational level then the Director/Head of the represented ice services.

B. Responsibilities of the IICWG Co-Chairs

1. Ensure the organization of the IICWG meetings,

2. Chair the IICWG meetings,

3. Represent the IICWG in national and international forums,

4. Guide the IICWG in the response to international requirements.

C. Rotation of IICWG Co-Chairs

1. Each Co-Chair will serve for a term of three years.

2. In order to insure the greatest continuity for the IICWG the Co-Chairs should offset the rotation of their terms of office.

3. If a Co-Chair leaves before the end of their term that Geographic group will chose a successor.

D. International Ice Charting Working Group Meetings

1. The IICWG meetings will be chaired by the two Co-Chairs plus the Director/Head, or their designee, of the hosting institution.
2. The meetings will be held at a regular basis at the call of the Co-Chairs. Typically the meetings are held every 12 to 18 months.
3. The organization of the IICWG meeting including:
   a. Developing organizing committees,
   b. Sending out meeting invitations,
   c. Developing the meeting agenda,
   d. Determining location and logistics for the meeting,
   e. Ensuring meeting reports and action items are recorded and distributed.