17th MEETING OF THE
INTERNATIONAL ICE CHARTING WORKING GROUP

OCTOBER 24-28, 2016
OTTAWA, CANADA

Meeting Report

Prepared by John Falkingham

IICWG-XVII

October 24-28, 2016

"*From Models to Forecast Products for Sea Ice and Icebergs*"

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IICWG-XVII

October 24-28, 2016

"*From Models to Forecast Products for Sea Ice and Icebergs*"

MEETING REPORT

(Secretariat note: All of the documents, presentations, and posters referenced in this report are available on the IICWG website http://nsidc.org/noaa/iicwg/. Some presentations may have been withheld for proprietary or copyright reasons – contact the presenter directly. Presentations and posters are in alphabetic order by presenter.

Throughout this report, action items are indicated in line with the text to provide context. The action items have been assembled in Appendix Q where they are numbered for reference, assigned to individuals responsible, and given deadlines.)

Introduction

The 17th meeting of the International Ice Charting Working Group (IICWG) was held in Ottawa, Canada, October 24-28, 2016. The meeting was hosted by the Canadian Ice Service. Ninety-six attendees representing 48 organizations from 13 countries participated. The theme for the meeting was "*From Models to Forecast Products for Sea Ice and Icebergs*".

The organizing committee for the meeting was chaired by John Falkingham and included:

- Dave Jackson (Canadian Ice Service)
- Neal Young (Antarctic Climate and Ecosystem Cooperative Research Centre)
- Pascale Bourbonnais (Fednav)
- Jürgen Holfort (German Ice Service, BSH)
- Gabrielle McGrath (International Ice Patrol)
- Keld Qvistgaard (Danish Meteorological Institute)
- Vasily Smolyanitsky (Arctic and Antarctic Research Institute)
- Eric Madsen (National Oceanographic and Atmospheric Administration)
- Klaus Strübing (Member Emeritus of the IICWG)

The meeting took place from Monday October 24 to Friday October 28, 2016 at the Novotel Hotel in downtown Ottawa. The Science and Operations Workshops were held on Monday. The open parts of the meeting were held Tuesday through Thursday. The business part of the meeting, which involved only the national ice services and invited guests, was held Friday afternoon.

A technical tour of the Canadian Ice Service was offered on Wednesday. On Friday morning, 50 of the participants took part in a technical tour to the Gatineau Satellite Station and Canadian Data Processing Facility hosted by MDA Corporation.

On Monday evening, an icebreaker reception was held at the Novotel sponsored by Fednav Shipping Ltd. On Thursday evening, a no-host dinner was held at the Red Lion restaurant in the Ottawa market area.

Workshops – Monday October 24, 2016

The meeting was called to order by John Falkingham who welcomed the participants, outlined the agenda for the week, and provided local logistics information.

Operations Workshop

The Operations Workshop was organized by the IICWG Data, Information, and Customer Support Standing Committee (DICSSC) under co-chairs Antti Kangas, Caryn Panowicz, and Alvaro Scardilli. Alvaro was unable to attend the meeting.

The first session of the workshop featured a review of *Ice Forecasting in Operational Practice* with presentations by the following:

- Jürgen Holfort (German ice service – BSH)
  - Model used mainly for Search-and-Rescue drift predictions rather than sea ice
  - As an aside, demonstrated how S-411 format data was produced operationally from SIGRID-3 ice chart data
  - Where does IICWG want to go with S-411?

ACTION	Promote the availability of ice charts in S-411format with the ECDIS manufacturers.

- Antti Kangas (Finnish ice service - FMI)
  - Weekly forecasts for Finnish harbours – use Zubov to calculate ice thickness
  - 10-day forecasts describing weather and ice conditions
  - 6-month seasonal outlook updated monthly – ice and SST overview map
- Caryn Panowicz on behalf of Álvaro Scardilli (Argentine ice service - SHNA)
  - Antarctic model has been running for two years
  - Forecasting is mainly heuristic
- Darlene Langlois (Canadian Ice Service)
  - Model used to bring observations up to daily chart time
  - Text warnings for ice pressure, rapid closing of coastal leads, unusual presence of ice, difficult ice conditions
  - Iceberg program in partnership with IIP and DMI
  - Climatology used as input to seasonal ice forecasts that are not updated
- Til Soya Rasmussen (Greenland ice service - DMI)
  - Suite of weather, wave and ice models for Greenland waters
  - Ice model is same as NIC
  - No forecast ice charts yet but do produce forecast ice edge
- Denis Demchev (Russian ice service - AARI)

  - Model forecasts for sea ice concentration, thickness, drift, and deformation are produced for up to 5 days
  - Iceberg drift in Barents/Kara Seas up to 7 days
- Nick Hughes (Norwegian Ice Service)
  - Low resolution model for 72 hour forecasts
  - TOPAZ-4 model with data assimilation produces 7-day forecasts
- Caryn Panowicz (U.S. National Ice Center)
  - Forecasts are limited to the Arctic (not Antarctic)
  - Produce seasonal outlooks and daily 48 hour ice edge forecasts
  - Arctic Cap Nowcast/Forecast model used as guidance but forecasting is mainly heuristic
  - NWS Alaska Sea Ice Desk produces 5-day forecasts based on mainly heuristic methods
- Magnus Larsson (Swedish ice service - SMHI)
  - 0-10 day written forecasts for Swedish Maritime Authority and military and shipping trade based on daily observations and meteorological model
  - Ice drift and growth from NEMO
  - Plan to lengthen to 15 days this winter
- Neal Young (Antarctic Gateway sea ice service – Australia)
  - No public information is broadcast - respond to demands from customers
  - Provide "outlook" but do not "predict" because knowledge is insufficient
  - Only two people provide a service and use local knowledge to give customers a dedicated idea of what will happen; relying more and more on ensemble met forecasts
  - Very little satellite coverage over east Antarctica
- Gabrielle McGrath (IIP)
  - NAIS iceberg charts produced daily showing nowcast iceberg positions based on IIP iceberg model
  - Have extended chart to include the south Greenland area

Penny Wagner presented a report on the 5th Ice Analyst Workshop that was held at the National Ice Center May 16-20, 2016. Twenty-five participants from 10 countries engaged in several exercises aimed at GIS familiarization and Southern Ocean ice analysis. The workshop generated a number of recommendations (see presentation).

Sean Helfrich gave a presentation on *Quantifying Ice Charting Uncertainty*. Given the continuing demand from users of ice charts for measures of confidence or uncertainty, this presentation was timely. It is clear that this is not an easy issue to solve but Sean presented some useful ideas, including a suggestion that the IICWG develop a colour code for navigators based on uncertainty.

The second session of the workshop featured three presentations:

- Hai Tran (CIS); *Iceberg Modelling at CIS*
  - Showed verification results for the CIS iceberg model

  - Conclusion is that the ensemble model does not clearly yield better results than the deterministic model but, if the spread of the uncertainty (among the ensembles) is small, it gives more confidence in the forecast
- Paul Pestieau (CIS); *Sea Ice Modelling Research to Operations at the CIS*
  - Provided an overview of the ice-ocean models in use at the CIS together with verification results
- Mike Hicks (IIP); *Current and Future Iceberg Monitoring Modelling and Charting Systems*
  - Gave an overview of iceberg analysis and forecast products from ice services around world as well as interactions with academia and industry
  - Noted that, in the near future, the NAIS iceberg model will be shared with DMI and Argentina
  - On the horizon is the provision of iceberg charts in ECDIS format and the development of probabilistic iceberg products

Becki Heim (NWS Alaska) was unable to attend the meeting but provided a presentation on the NWS Alaska Sea Ice Program. It is included with the meeting presentations.

Science Workshop

The science workshop was organized by the IICWG Applied Science and Research Standing Committee (ASRSC) under co-chairs Wolfgang Dierking, Dean Flett, and Philip Reid. Phil was unable to attend the meeting.

The first session of the workshop, *The State of the Art in Ice Modelling*, featured four overview presentations:

- Bruno Tremblay (McGill University); *From Model to Forecast Products for Sea Ice and Icebergs*
  - Reviewed the equations of motion governing sea ice as well as alternative model grids and sea ice rheologies
  - Noted that deformation is critical in sea ice models; diamond-shaped deformations are characteristic of plastic materials
  - Noted that landfast ice is a new term to be included in the ECCC model soon
- Tom Carrieres (CIS) presented on behalf of Mark Buehner (ECCC) who was unable to attend the meeting; *Sea Ice Data Assimilation at Environment and Climate Change Canada*
  - Reviewed the data assimilation schemes used in coupled ice ocean models together with some model verification
  - Noted that model validation and verification is needed as an on-going activity
- Greg Crocker (Ballicator Consulting); *State of the Art in Iceberg Forecasting*
  - Presented an overview of the types of iceberg drift models and the equations of motion governing iceberg drift
  - Noted that using ensembles is useful at evaluating and quantifying uncertainty but is not useful at improving accuracy

  - Major problem in iceberg prediction is the lack of data about the important parameters affecting individual iceberg movement
- Frank Kauker (Alfred Wegener Institute); *Seasonal Arctic Sea Ice Predictions*
  - Described the Sea Ice Prediction Network objective to improve sea ice prediction on seasonal to inter-annual time-scales
  - Ice thickness observations are a significant problem for seasonal sea ice prediction; there are many sources of ice thickness data but each has its own bias; best input to seasonal ice prediction is ice thickness regression

The second session of the workshop, *Sea Ice Thickness Estimation,* featured three presentations:

- Trevor Bell (Memorial University of Newfoundland); *SMART Ice*
  - Described the Sea-ice Monitoring And Real-Time Information for Coastal Environments (SMART) Ice program – community based monitoring and information for communities
  - Local Inuit are involved in all aspects of the program which combines local knowledge and satellite technology, together with in-situ monitoring, to produce sea ice hazard maps that are updated every two weeks. These are relevant to the local people because they show areas of thin ice that is hazardous to travellers on the ice
  - Next steps are to move from a research project to a northern social enterprise and to expand to other northern communities – there is interest from Russia, Greenland and Alaska
- Patrick Eriksson (Finnish Meteorological Institute); *Modelled Sea Ice Thickness Chart Enhanced by Multi-Sensor Data*
  - Described a new product giving ice thickness with a resolution of 500m that will be available next winter; only for first year ice with concentration greater than 70% - intended for operational use by shipping
  - Use SAR and AMSR2 data to improve the modelled sea ice thickness from TOPAZ
- Olivia Mussells (University of Ottawa); *Ice Ridging and Besetting in the Hudson Strait*
  - Compared ridging patterns in Hudson Strait using Radarsat imagery with besettings of MV ARCTIC to better understand the role of ridges in besettings
  - Concluded that there is good correspondence between ridge densities and besetting but with some outliers – there is still limited understanding of the navigational hazards of pressured ice

Poster Session

Following the close of the Science Workshop, poster presenters were invited to give a one-minute introduction to their poster. Posters were on display throughout the week in the meeting room and in the foyer (although during some times when other meetings were taking place in the same area, some posters had to be removed temporarily). Following is the list of posters on display. PDF files of the posters are on the web site.

- IceNav: At the Forefront of Ice Navigation Technology
  - *Pascale Bourbonnais (Enfotec /Fednav)*
- Polar Prediction Project (PPP): Societal and Economic Research and Applications (SERA) Subcommittee
  - *Jackie Dawson, Daniela Liggett, and Machiel Lamers (WMO-PPP-SERA - World Meteorological Organization – Polar Prediction Project – Societal and Economic Research and Applications Subcommittee)*
- Polar Thematic Exploitation Platform (TEP) Project
  - *Andrew Fleming (British Antarctic Survey);*
- Development of a 3-D heterogeneous (full-physics) model to address the challenges of mapping polar composite geomaterials
  - *Cathleen Geiger (UDelaware), Allan Wienecke, Jesse Samluk, and Chester Weiss*
- Support of research vessels in the Antarctic with NRT radar information: an innovative service at DLR's Antarctic station GARS O'Higgins
  - *Kathrin Höppner, Birgit Schättler, Egbert Schwarz, Detmar Krause, Erhard Diedrich (German Aerospace Center - DLR); Michael Schröder, Christine Wesche (Alfred Wegener Institute)*
- Radar-based methods for sea ice use and hazard assessment
  - *A.R. Mahoney (University of Alaska Fairbanks), H. Eicken, D.O. Dammann, J.M. Jones and F.J. Meyer*
- Bonavista Bay Ice and Ocean Observing System
  - *Steve Mercer (Research & Development Corp)*
- Navigating Pressured Ice: Implications for winter shipping in the Hudson Strait
  - *Olivia Mussells, Jackie Dawson (University of Ottawa); Stephen Howell (Environment and Climate Change Canada)*
- Ice forecasts at DMI - input and applications
  - *Till Soya Rasmussen (Danish Meteorological Institute)*
- Estimating the Response of a Canadian Glacier to Climate Change
  - *Sameneh Ebrahimi (University of Calgary)*
- Development of a 3-D visualization tool to understand sea ice material behavior
  - *Adrienne Shumlich, Cathleen Geiger (University of Delaware); Greg Leonard (University of Otago, NZ)*
- MOSAiC - The International Arctic Drift Expedition
  - *M. Rex, M. Shupe, G. Spreen, R. Kwok, and the international MOSAiC Team*
- Overview of NRC Sea Ice and Iceberg Forecasting and Engineering Tools
  - *Denise Sudom (National Research Council of Canada)*

- Sea Ice Characteristics and the Fate of the Franklin Vessels
  - *Tom Zagon (Canadian Ice Service)*
- Arctic Marine Activities Integration & Synthesis Project (AMAIS): Enhancing Ocean Governance through the Northern Marine Transportation Corridors.
  - *Jenna Joyce, Annika Ogilvie, Natalie Carter, Jackie Dawson (University of Ottawa)*
- Arctic Sea Ice Monitoring using Multisensor SAR Parameters
  - *Suman Singha and Rudolf Ressel (German Aerospace Center - DLR)*
- Canadian Ice Service, Community Search And Rescue ICE information (CSAR-ICE) Project.
  - *Katherine Wilson, Tom Zagon, Darlene Langlois, Doug Leonard, (Canadian Ice Service)*
- Detection of Sea Ice and Open Water from RADARSAT-2 Imagery for Data Assimilation
  - *Alexander S. Komarov, Mark Buehner (Environment and Climate Change Canada)*

Open Meeting – Tuesday October 25, 2016

Official Meeting Opening

Welcome from the Co-Chairs

Vanessa Griffin, co-chair for the Americas, opened the meeting and introduced Marianne Thyrring, the new co-chair for Eurasia replacing Peter Rasch. Marianne briefly described her background leading to her current position as Director of the Danish Meteorological Institute with responsibility for the Greenland ice service.

Vanessa noted some of the highlights from the past year including the 5th Ice Analyst Workshop, advances in Southern Ocean ice charting, entreaties to ESA to increase SAR acquisitions around Antarctica and the engagement of the Arctic Council in Emergency Preparedness, Prevention, and Response (EPPR). She noted that this meeting is focused on linking modellers with operational production and understanding the needs of user the community. She asked the participants to think about the strategic vision for the IICWG: the things we are planning and how they fit into what we want IICWG to be; what are the challenges and gaps we should be addressing?

Vanessa welcomed David Grimes, Assistant Deputy Minister of the Meteorological Service of Canada and President of the World Meteorological Organization.

Welcome Address by Mr. David Grimes

David recalled that the 1st session of the IICWG was held in Copenhagen with the idea that we needed to coordinate on more scientific and especially operational levels. He has kept an eye on the remarkable progress of the IICWG over 17 years. He co-chaired the first 6 meetings noting that there were 2 common themes: how do we work better, and how do we make services to marine navigation in the north more effective? The Group also had an early concept of a planet as a single place where we should work together. He is pleased that there has been great progress in these themes.

David noted that many of the original founders of the IICWG have retired or moved on and made special mention of Ari Seinä and Hans Valeur who have passed away in recent years. He felt that they would be pleased that the mantle has been taken up by the younger participants.

He recalled that the IICWG Charter was a way to maintain senior government support for the ice services and participation in IICWG. The Charter was originally signed by 8 founding services. David has a copy of that Charter on his office wall. There are now 13 signatories and he notes that Chile is going to sign at this meeting. He expressed his satisfaction at the IICWG starting to hold some of its meetings in the Southern Hemisphere.

David pointed out that the IICWG is well recognised – within the WMO, JCOMM, IHO and elsewhere. He encouraged the Group to continue engaging other organizations. He noted that, when the IICWG came together, it was a coalition of the willing and not a product of a

bureaucratic system. The nature of the Group is to be nimble with an emphasis on working without a high transaction cost. The IICWG makes a valuable contribution to more formal organizations such as the WMO Polar and High Mountain Observations, Research and Services (PHORS) and the Global Cryosphere Watch (GCW), and the JCOMM Expert Team on Sea Ice (ETSI), as well as to space agencies and the climate change community. IICWG is contributing to a much larger landscape as the world tries to figure out how to implement the Paris accord. A big part of the discussion is how to measure and monitor the cryosphere – the IICWG can contribute to that knowledge.

As President of the WMO, he sees more activity going into areas we know little about, such as the Polar Regions. The idea of establishing a Polar Regional Climate Centre (PRCC) is important. There is a strong commitment from the Arctic nations and a similar interest from the Southern Hemisphere. The IICWG can make a strong contribution to this effort.

David congratulated the Group on how far it has come. He sees a promising future for the IICWG and looks forward to the outputs of the meeting.

Participant Introductions

Participants introduced themselves to the meeting. The list of participants is attached as Appendix A.

Adoption of Agenda

The agenda was adopted as published with some minor changes to presentation titles and authors. The agenda for the business portion was developed during the meeting. The final version of the agenda as presented is attached as Appendix B.

Signing of the IICWG Charter by Chile

The Chilean Navy Weather Service formally joined the IICWG by signing the Charter. It was signed by LT Roberto Díaz Schall on behalf of Rear Admiral Mario Montejo Orellana, Director of Maritime Safety, Security, and Operations.

Standing Committee Reports

Applied Science and Research Standing Committee (ASRSC)

Dean Flett reported on the status of the action items of the Applied Science and Research Standing Committee, attached as Appendix C.

Data, Information and Customer Support Committee (DICSSC)

Caryn Panowicz spoke to the status of the action items of the Data, Information, and Customer Support Standing Committee, attached as Appendix D.

Iceberg Sub-Committee

Gabrielle McGrath gave the presentation in Appendix E describing the accomplishments of the Iceberg Sub-Committee.

Report from the Secretariat

John Falkingham presented the report attached as Appendix F noting, in particular, the Polar Mission Requirements that were provided to ESA on behalf of the IICWG, the interaction with ESA concerning increased Sentinel-1 acquisitions in Antarctic waters, and the report on IICWG contributions to the Global Cryosphere Watch.

Reports from Other Ice Working Groups

Written submissions are attached at Appendix G. Abbreviated oral reports were presented by the following groups:

- Baltic Sea Ice Meeting - Emma Grönkvist (SMHI)
  - On-going discussion about whether to continue with Baltic chart symbology or got to WMO symbology
  - Determined that North American ice models are not yet good enough for the Baltic Sea
- European Ice Services - Antti Kangas (FMI)
  - Focus on training of ice analysts (19 participants completed a recent training course)
  - Rather than develop common ice charting tools across EIS, have decided to focus on exchanging ice chart data – Finland and Sweden will start common production next year
- North American Ice Service - Ruth Lane (NIC)
  - DMI and NWS Alaska participated in NAIS meeting
  - Meeting focused on aligning action items to NAIS goals and objectives
  - Update to strategic plan in 2018
- International Arctic Buoy Program (IABP) / International Program for Antarctic Buoys (IPAB) - Pablo Clemente-Colón (NIC)
  - Last meeting was in Korea – Korea has agreed to participate in the IPAB
  - IAPB Chair position is currently vacant – usually held by a Canadian
  - Noted the YOPP trip report submitted to the IICWG (attached at Appendix H)
- Expert Team on Sea Ice - Vasily Smolyanitsky (AARI)
  - Next ETSI meeting will be in Helsinki Feb 28-March 3, 2017; joint with the Expert Team on Marine Safety Services (ETMSS) and the METAREA coordinators

- Council of Managers of National Antarctic Programs (COMNAP) – Andrew Fleming (BAS)
    - Andrew reviewed the "COMNAP Information to the 17th Meeting of the IICWG" (attached at Appendix I) noting the current unavailability of information on regular vessel routes in the Antarctic but pointing out that COMNAP has two projects underway that could provide such information in the future for the purpose of optimizing satellite data acquisitions

ACTION	In consultation with COMNAP and IAATO, identify a set of longitude corridors around Antarctica where Near-Real-Time processing and delivery of products will coincide with the time of actual approach and passage of ships through ice, and times of deployment of field experiments. Convey this information to ESA.

Review of IICWG-XVI Plenary Action Items

The co-chairs reviewed the status of the plenary action items from the previous meeting, attached at Appendix J. Twenty-eight action items were completed over the year. Seventeen action items remain open.

Session on "Engaging the International Charter on Space and Major Disasters" (Action Item 16-21)

Because their board meeting took place in Moscow immediately before IICWG-XVII, no one from the Charter secretariat was available. Yves Crevier of the Canadian Space Agency gave the presentation.

The Charter is an agreement by the signatory space agencies to cooperate in providing satellite data in support of disaster response. The IICWG had considered whether a ship beset in ice could be considered a potential disaster and be sufficient reason to activate the Charter.

Yves noted that the Charter lists a specific set of "disasters" that can be quoted to activate the Charter and none include sea ice. He proposed that adding a phrase such as "emergencies in ice-infested waters" to the types of disasters would be useful but must be supported by the Charter signatories.

He also pointed out that only authorized users can activate the charter directly – typically Authorized Users are civil protection agencies, government and relief organizations. There is a mechanism to activate the Charter via an Authorized User on behalf of another user. It could also be done via the United Nations.

Since 2000, the Charter has been activated for 510 disasters in 119 countries. Only 4 of these activations were related to snow and ice and only 1 was for a ship in ice.

Participants raised the following questions and comments:

- The Charter secretariat does not understand the role and authority that IICWG has in disaster response. The IICWG can help the Charter because ice services cooperate actively.
- Many responders don't know about the Charter or how it can get activated. It can take several days to get the Charter activated (Yves countered that it has been activated on very short notice several times).
- If there is an emergency, ice services get alerted by emergency responders. We need to make sure that the SAR people know how to activate ice services. This protocol should be worked out in advance because in an emergency, things can happen very fast.
- The Charter mandate is supportive of the IICWG mandate in a disaster.
- In addition to requesting activation, we must also be made aware of activation by others so that ice services could use the data.
- If a service activated the Charter rather than a country, the data may not be available to all groups in the country.
- There is no connection between EPPR and Charter
- The Charter could provide images and ice services could provide the value-added product. IICWG is a collection of expertise that the Charter should be aware of.

ACTION	Explore with the secretariat of the International Charter for Space and Major Disasters the idea of including "emergencies in ice-infested waters" in the list of applicable disasters for which the Charter can be invoked

ACTION	Provide the list of Authorized Users of the International Charter to the IICWG secretariat for distribution

Table Top Exercise: Emergency Incident Response

Gabrielle McGrath, assisted by two representatives from Oil Spill Response Ltd. (OSRL), conducted a table top exercise in which all the meeting attendees took part. Gabrielle introduced the exercise with a short background presentation. A summary report of the exercise is attached at Appendix K. The general comments and findings of the exercise were:

- The Arctic is much better prepared for this situation than the Antarctic – although the scenario is much less likely to occur in the Antarctic.
- The IICWG "International Ice Services Emergency Response Numbers" list is a valuable resource that should be publicized and made more widely available, recognizing that there may be a need for two lists – one that is public and another that is only for use within the ice service community.
- The capabilities of the ice services are not universally well known in other communities, including Rescue Coordination Centers, Search-and-Rescue organizations, marine oil

spill response organizations and the insurance industry. Ice services' knowledge of satellite data availability and acquisition methods, and their image interpretation skills are strengths that could be useful if more widely known.

- In a response scenario such as this exercise, the ice services are not the main actors but are in a supporting role – which may be more or less important depending on the ice situation. The ice services must work through the lead response coordinator who, in turn, must be aware of their capabilities.
- Ice services should ensure they maintain up-to-date guidelines for operating personnel to follow in an emergency response situation.

ACTION	Prepare two versions of the "International Ice Services Emergency Response Numbers" contact list - one that is public and another containing private contact information that is only for use within the ice service community.

Open Meeting – Wednesday October 26, 2016

Plenary Session 1: Operational Forecasts - Bridging the Gap from Models to Mariners

This session opened with two introductory presentations:

- Tom Carrieres (CIS); *The Evolution of Ice Services Towards an Increased Reliance on Automated Prediction Systems*
  - Tom's presentation supported the following conclusions:
    - Automated Prediction System (APS) output is already used and this will continue to grow as a result of the expansion of observations and APS capabilities, and client requirements
    - New APS-based products will provide vital complementary support to existing services
    - Product evaluation and continuous improvement will become routine
    - The role of Image Analysts will evolve to focus efforts where there are maximum benefits
  - A comment was made that we should think about ice analysts' "functions" rather than "jobs"
- Helge Goessling (AWI); *The Year of Polar Prediction: Overview and State of Planning*
  - Presented the "why", "how", and "who" of the YOPP, outlined the YOPP timeline, and described some projects and events
  - Noted the YOPP "project endorsement" process and encouraged the IICWG participants to be involved

ACTION	Ice Services that are establishing YOPP "Desks" or undertaking other YOPP activities to report these activities to IICWG via the secretariat so that all can remain coordinated

A third presentation by Greg Smith (ECCC) on *The Year of Polar Prediction: Relationship to Ice Services* was scheduled. However, Greg had to cancel his attendance at the last minute. The presentation is included in the meeting documents.

Following these presentations, the participants broke into 8 discussion groups to explore the interactions between modellers and operational forecasters. After one hour, the groups returned to plenary and presented their deliberations. General themes from the discussions were:

- There is a general mistrust of model output – both by ice analysts and mariners. Model output needs to be continually validated against what is really happening. When it works,

the output is useful. However, it is wrong sufficiently often for it to be considered unreliable.

- An indication of the uncertainty or confidence in mode output and forecast products is an essential component of the forecast and may go a long way to overcome this mistrust
- Human forecasters are seen as critical for interpreting model output for end users and thereby increasing user confidence in forecast products
- There is a gap between mariner expectations and model outputs that can generally be attributed to the huge difference in scales between the two. Models, even regional ones, work at scales that are much larger than the very local scales of most importance to the mariner.
- This could be partially overcome by better training for mariners (and ice analysts) in the limitations and appropriate use of model output.
- Mariners would like to have additional ice parameters analyzed and/or forecast. In particular, ice thickness and ice pressure are needed.
- Model output is too complex for mariners' general use. They want forecast products that are simple and easy to understand (and accurate). Where is the ice? Where is it going? Is it increasing or decreasing? Text warnings may be more effective that graphical products.
- Good communication is absolutely necessary to build trust between all of the parties – modelers, analysts and forecasters, end users.
- Mariners are not the only users – must also consider regulators, communities, researchers, insurers, etc.

A more detailed summary of the session is attached at Appendix L.

Plenary Session 2: Addressing User Needs with Respect to Ice Forecasts and the Polar Code

The session was opened with a presentation:

- Keld Qvistgaard (DMI); *Addressing Cruise Industry Requirements for Ice Information in Greenland Waters*
    - While the season is short (3 months), it is very busy for cruise ships around Greenland
    - After numerous and close interactions with cruise industry clients, a number of key requirements were identified – not all are met by standard ice service products
    - Pilots want products very early in the morning; most cruise ships have tender operations that are very sensitive to wind, waves and visibility
    - Cruise ships want to go close to the ice but stay at a safe distance
    - Cruise ships transit at high speeds (16-17 kts), even in bergy waters
    - High resolution satellite images are desired for harbors, anchor positions, landings sites, and choke points
    - Cruise ships cross boundaries so international collaboration is important

- Any product that makes a positive difference for safety and for the passengers is welcome.

The session continued with a panel discussion moderated by Dave Jackson on the topic of user needs. Sitting on the panel were:

- Tim Keane
  - Senior Manager for Arctic Operations at Fednav Shipping
- Georges Tousignant
  - Vice President of Operations at Nunavut Eastern Arctic Shipping (NEAS) Inc
- Murray Doyle
  - Retired Master of AURORA AUSTRALIS
- Uwe Pahl
  - Retired Master of POLARSTERN

Major points made and discussed by the panel;

- Ice information quality has come a long way; it is much better than in the past especially now that we have the availability of satellite information, SAR, and others.
- Guesswork has become minimized; better forecasts are the next step to further reducing the guesswork. However, confidence in ice forecasts is not there yet.
- There is some issue with the confidence and trust placed in ice charts, but they're generally ok. If they could present actual, current ice conditions rather than ice condition at some previous point in time, they would be much better. Confidence in chart info varies with time and place. The ice charts with stage of development and concentration are useful and well understood. However, what would be better is an indication of where the ice actually is in any given area/polygon on the ice chart.
- There are different requirements for ice information depending on whether the ship is bypassing the ice or actually entering it to work.
- The ship needs the best, most current information available. Radarsat-2 imagery is great but the cost is prohibitive and is often not available at the time and place needed. There are also communication limitations with some ships.
- Ships need other information currently not provided, such as pressure, ridging, and maybe orientation of ridging. Having ice pressure information would pay big dividends.
- Ships need to be careful about becoming overloaded or overwhelmed with information. We're not sure where that point is so, generally, the more information, the better. It could be that the ship requires more assessment and evaluation of information from shore based support
- There is a bit of a gap between what the ship needs and what is provided by the ice services. Both need to understand the needs of the other and under what constraints each operates. Commercial vessels are going to a destination and have no option to avoid difficult ice in the approaches. It is important to understand the cycle of the voyage and provide the appropriate levels of information at the right times.
- An interesting discussion was also brought up regarding the scale of the chart and the amount of local and inshore information that is missing. This is a huge part of the

navigation cycle - channel and port information, localized fast ice, confined temporal and spatial ice, small geographic area and short time scale (hours).

- Automated ice classification MAY be interesting, but it seemed to everyone that a human interpretation was really required in the end.
- It is difficult to build the business case to fund further development in science and technology from a commercial perspective. It is hard to show that ice forecasting would save money. It is just the cost of doing business in the Polar Regions.

Following the panel discussion, the participants again broke into 8 discussion groups to discuss the needs of users for predictive information and explore how these needs could be met. After one hour, the groups returned to plenary and presented their deliberations. Key themes and recommendations from the discussions are:

- Communication with users is crucial to success.
- There is a wide variety of users of ice information with a broad range of needs.
- Indication of confidence or level of certainty in a forecast is important to users.
- Develop a matrix of users and requirements or a "risk matrix"
- Develop an engagement strategy to maintain two-way communications with users.

A more detailed summary of the session is attached at Appendix M.

Open Meeting – Thursday October 27, 2016

Plenary Session 3: IMO Polar Code Implications for Ice Information

There were five presentations in this session:

- Luc Tremblay (Transport Canada); *IMO Polar Code: Proposal for Incorporation in Canadian Regulations*
  - Canada will replace the existing regulation with a new one to implement the Polar Code
  - Zone/Date System and Arctic Ice Regime Shipping System (AIRSS) will remain in place; POLARIS will be added as a third mechanism to determine whether a ship can operate in a particular area
  - AIRSS will only be applicable to existing ships; POLARIS will apply to new ships
  - To be in place for the start of the 2017 Arctic navigation season
- Michael Kingston (DWF); *Implementing the Polar Code*
  - The .insurance industry would like to support marine operations in the Arctic but they must be done in a safe and sustainable way:
    - Regulations + ice regime + best practice
      = Insurance = Trade and Growth = sustainable development in the Arctic.
  - Polar Code requires vessels operating in Polar Regions to carry a Polar Waters Operations Manual that explains how the vessel crew should act in worst case scenarios; the PWOM is approved by the vessel's flag state
  - PWOM must contain full details of how the master makes decisions with respect to ice and must reference an ice regime methodology; POLARIS is the best known example of a methodology.
  - Safety standards are different globally and are woefully inadequate in some areas; in the absence of regulatory standards, the insurance industry has serious concerns about the workability of the Polar Code; in the absence of standards, best practices must prevail
  - Noted the "Forum for Best Practices" under the auspices of the Arctic Council's working group on Protection of the Arctic Marine Environment (PAME); conference to be held in London in summer 2017; encouraged IICWG participation

ACTION	Explore the idea of including Ice Service point of contact information as a required element of the Polar Code Polar Waters Operating Manuals. The Best Practices Forum will be a good place to discuss this with the responsible parties. It may also become appropriate to write to the Classification Societies who are developing the standards for the PWOM

- Rob Hindley (Lloyd's Register); *POLARIS Risk Assessment Tool*
  - Polar Code is "goal-based" not prescriptive; it is the ship owner's responsibility to define the limitations for polar operations - the Polar Code does not prescribe these limitations
  - POLARIS is a tool that can be used to determine the operating limitations of a particular ship in ice; POLARIS is not specifically referenced by name in the Polar Code because it was not ready for acceptance in time; the Polar Code requires a "methodology" of which POLARIS is one example; Russia's PASSPORT system is another example; no others have been proposed
  - POLARIS uses the ship's ice classification together with the partial concentrations of the various ice types in an area to determine a risk index; the risk index determines whether or not a vessel can operate normally in the area
  - There are some outstanding issues with POLARIS that the IICWG could help to resolve – treatment of glacial ice, brash ice, applicability in Antarctic ice conditions
  - POLARIS depends on partial ice concentrations and associated stages of development – not all ice charts have this information; POLARIS allows modification of the risk index if ice decay is reported, which is not usually shown on ice charts; many ice charts indicate Old Ice only whereas POLARIS uses separate categories for Second Year Ice, light and heavy Multi-Year Ice

ACTION	IICWG to encourage all Ice Services to standardize on the reporting of partial concentrations and stages of development on their ice charts to ensure consistent use in POLARIS.

  - Forecasts are needed as a voyage planning tool – most operators will initially use climatology
  - IMO is now the custodian of POLARIS so any changes would have to be approved by it; any national forum can propose changes; the PAME Best Practices Forum would be a good place to start the discussions
  - The Risk Assessment Index computed by POLARIS is based on the ice conditions that the Master sees – not an ice chart; the insurance industry will lean toward the most conservative numbers
- Andrew Fleming (BAS); *Polar Code Requirements for the Antarctic*
  - Need to provide clear guidance to operators on how information we provide may or may not be applicable

- Ships' masters look at imagery on the Polar View website for the best information available
- More ice charts have become available for the Antarctic recently but there are still some problems to be addressed
  - Spatial resolution is much coarser than on charts for the Northern Hemisphere
  - Temporal resolution and timeliness are lacking
  - Ice charts from different services are not exactly equivalent
  - Ice types on charts don't line up exactly with ice types used in POLARIS; cause for confusion
- Antarctic ice may not be the same as Arctic ice in terms of risk; need to get more data and feedback on this
- Limitations of ice chart information must be communicated to users; IIWG has a responsibility for the education of users

- Keld Qvistgaard (DMI); *Greenland Ice Service Polar Code Products*
  - There are many parameters in the Polar Code but there are also some that are missing – e.g. waves, pressure
  - Consider three types of vessels/voyages – those that want to stay far away from the ice, those that venture close to the ice, and those that go into the ice
  - Historical information is already available for use in the Polar Code; how can ice services make this available to mariners for voyage planning
  - DMI provides tailored products in addition to the standard products provided freely by governments; including high resolution and update frequency, destination approach products and forecasts, enhanced climatology and statistics, on-board ice advisor, training and certification
  - Shipping safety is a sum of regulations, experience, procedures, and best practices

Vanessa Griffin concluded the session by asking what the Group could do to help bring the Polar Code and POLARIS to fruition.

ACTION	Form an IICWG Task Group to participate in the continued development of POLARIS particularly with respect to its applicability in the Southern Ocean

Plenary Session 4: Polar Regional Climate Centres

Chantal Côté and Denis Bertrand, both from Environment and Climate Change Canada, and Vasily Smolyanitsky from the Arctic and Antarctic Research Institute jointly presented a brief on the Polar Regional Climate Centres. Important points of the presentation were:

- A Regional Climate Centre (RCC) must carry out mandatory functions:
  - Operational activities for long range forecasts
  - Operational activities for climate monitoring

  - Operational data services to support forecasting and monitoring
  - Training in the use of operational products and services
- WMO approved the creation of an Arctic Polar RCC network in June 2016; proposed network nodes are Northern Europe and Greenland, Eurasia, and North America
- Decision-makers in Polar Regions need information on:
  - Temperature (limited predictive skill but improving)
  - Precipitation, both liquid and frozen (likely no predictive skill for most Arctic regions)
  - Winds (not commonly a parameter for seasonal prediction, but R&D potential)
  - Sea ice (extent, thickness) (room for improvement due to higher model resolution)
  - Snow cover (some skill for Snow Water Equivalent)
  - Freeze/Thaw periods and conditions (some skill in some regions for sea ice melt-freeze dates)
- User input indicates that break-up and freeze-up remain the key ice parameters for marine transportation; ice strength and ice pressure are as important, in some instances more important, than ice thickness and ice type
- Increased predictability, accuracy, and resolution in time (sub-seasonal) and space (regional forecast) are at the centre of these needs
- Boundaries of the PRCC are defined by a combination of elements identified by the Arctic Council – permafrost, glaciers, sea ice extent, indigenous people
- The Arctic cannot be subdivided, It must be treated as a whole – the PRCC will overlap three WMO regions

Vasily submitted a second presentation entitled *GCW Support for an Arctic PRCC-Network* giving further details about the PRCC for inclusion in the meeting report.

Plenary Session 5: Observations for Ice Analyses, Models and Forecasts

There were four presentations in this session:

- Ola Gråbak (ESA): *ESA Polar Mission Concepts and more …*
  - Copernicus program is the European response to global needs to manage the environment, mitigate the effects of climate change, and ensure civil security; it comprises all of the Sentinel space missions, ground data and provision of services; data is open to all users
  - Ice community is the largest user of the Sentinel-1s and has had a strong influence on the program but the Copernicus services are evolving
  - Monitoring the polar regions is the second priority of the Copernicus expansion and the ice community needs to be better plugged into the user consultation process to have a say in how the sea ice/iceberg services will evolve; operational ice users have been absent from some key workshops recently

- Beyond 2030 will be the next generation of missions; the Polaris project (not to be confused with risk assessment tool POLARIS) gave user input to the Polar Mission Concepts; question is how to take this forward; concepts identified are:
  - A: Dual-band Radar Altimeter
  - B: Arctic Imager in High Elliptical Orbit
  - C: Multi-band SAR imager
  - D: B-static SAR imager
- Recommends that that the IICWG and the European Ice Services become better engaged with the Copernicus User Forum and Copernicus committees
  - Next workshop is November 15, 2016 in Lisbon – Copernicus Maritime Surveillance User Requirements Workshop

ACTION	IICWG must get involved in the Copernicus program by attendance at workshops. Keld Qvistgaard was nominated as the IICWG liaison with Copernicus. Anyone attending Copernicus workshops should inform the Group through the Secretariat so we can stay coordinated

- Steve Iris (CSA); *RADARSAT Constellation Mission (RCM)*
  - Evolution of RADARSAT program to ensure data continuity; 3-satellite constellation scheduled for launch in 2018
  - RCM will be government owned to meet the needs of the Canadian government for maritime surveillance, disaster management, and ecosystem monitoring
  - Data will be government owned and archived; data policy is still in development but general approach is that data will be open to all at no cost; goal is to complete the data policy in 2017
  - Acquisition will be designed to satisfy gov't needs first and then see what flexibility there is to meet other requests
  - There has been little requirement for Southern Hemisphere data but there could be some capacity in the system for SH acquisitions
- Sean Helfrich (NIC); *Joint Polar Satellite System (JPSS) and GOES R Program Products for Ice Application*
  - Examples and validation of ice products from the Visible Infrared Imaging Radiometer Suite (VIIRS) on the Suomi National Polar-orbiting Program (SNPP) satellite
  - GOES-R launch is November 16, 2016 with double the resolution of the current GOES; noted that the same instruments are used on the Japanese Himawari-8 and European Meteosat Second Generation (MSG) satellites – same processing algorithms can be used
  - Presentation contains many useful links
  - Access to data is restricted to NOAA and its partners; anyone who needs access to real-time data can apply for permission on-line at:

http://www.ospo.noaa.gov/Organization/About/access.html

- Pascale Bourbonnais (Fednav/Enfotec); *A New Approach to Remote Sensing: Using UAVs for Navigation in Ice*
  - Trialed using drones to fill the gap between satellites and ship's radar; drones fly above and ahead of the ship to get an additional perspective
  - Need specialized drones – commercial models are not robust enough to survive the harsh environment
  - High-definition optical cameras as well as thermal cameras have been tested
  - Images are excellent but there are challenges to flying drones in difficult weather – exactly when they are most needed (high winds; low visibility)
  - Next project will be to test an Aerostat balloon tethered to the ship
- Edward Lau (MDA); *RADARSAT-2 Mission Plans*
  - RADARSAT-2 remains in very healthy condition with no system failures and 92% of its fuel remaining
  - RADARSAT-2 data can be acquired for science purposes through the ESA Third Party Mission (TPM) program; applications can be made at: https://earth.esa.int/web/guest/pi-community/apply-for-data/3rd-party
  - Invited the group to the tour of the Canadian Data Processing Facility

Open Meeting Summary and Close

Approval of News Release

Further to its introduction on Tuesday, followed by off-line discussions and the deliberations of the committees, a revised version of the IICWG-XVII News Release was presented to the participants. It was approved as written. The final version is attached at Appendix L.

Summary of Proposed Actions

Eric Madsen and John Falkingham presented a draft list of actions that had been proposed throughout the course of the meeting. This list was tabled to the Friday business meeting to determine which of these proposed actions the Working Group should undertake. Only those actions which were adopted are presented in this report. Some others were placed on the Idea Parking Lot.

Comments on the Meeting and Suggestions for Future Meetings

The co-chairs invited everyone to give their impressions of the meeting and suggestions for improvements in future. The following were noted:

- Would like more time for conversation – In Chile, it was nice that we had a day off in the middle of the week for an excursion
- Keep presentations to 10 minutes maximum

- Like the breakout sessions; would like more informal breakout sessions – form our own groups or be assigned
- Congratulated Gabrielle McGrath on the EPPR table top exercise – it was very good; for future, it would be good to consider a longer session – perhaps to consider the COMNAP problem
- Not so sure that the objective of bringing modellers and forecasters closer together was achieved
- Might look at how we could re-structure the first day; there was too much information all at once; there is no problem keeping scientists all week; could spread science out over the week, perhaps 10 minute sessions in each half day to provide more variety throughout the week
- Posters were excellent
- Need dedicated time for the iceberg sub-committee to meet
- Should continue to have users involved; that was very informative
- Linkage to ETSI is good – combining ice and weather for marine users
- Because of internet we have lost contact with users; there are lots of clicks to products but we don't know who is clicking; perhaps we could use twitter or something like that to get users more familiar with us
- Probably need more time next year to discuss the Polar Code and POLARIS
- Generally need more time for discussion when we are together

Next Meeting

Neal Young, on behalf of the Antarctic Climate Ecosystem Cooperative Research Centre (ACE-CRC), invited the IICWG to hold its 18th meeting in Hobart, Tasmania, Australia during September 25-29, 2017. The meeting thanked Australia for the invitation.

Cathy Geiger suggested that we try to use interactive remote participation (Internet conferencing) and offered to help set it up.

Hand-Over to the New Co-Chair

As Vanessa Griffin is completing her 3rd year as co-chair for the Americas, under the IICWG Terms of Reference she must vacate the position. Diane Campbell of Environment and Climate Change Canada agreed to succeed Vanessa. The official hand-over will be January 1, 2017. The group thanked Vanessa for her leadership over the past three years and, as a token of appreciation, presented her with a framed satellite image of the Arctic sea ice minimum on September 10, 2016.

Presentations

Gabrielle McGrath is leaving her position as Commander of the International Ice Patrol and will no longer be participating in the IICWG. She was presented with a Certificate of Recognition for "her exceptional leadership and tireless work to further the goals of the International Ice Charting Working Group".

As a result of an organizational realignment of responsibilities in NOAA, this meeting was probably Eric Madsen's last. Eric has provided secretariat support to the IICWG since 2003. He was presented with a plaque "In recognition and appreciation of his many years of support to the International Ice Charting Working Group".

Final Words

The co-chairs expressed their thanks to organizing committee and to the hosts – both Fednav and the CIS. They thanked the users who took the time to participate in the meeting and hoped they found it worthwhile. It was especially useful to the ice information providers to have real end-users take part.

Vanessa proposed that we need to think about what we want to do in next 5 years and this will be a topic of discussion at the business meeting tomorrow. Marianne noted that climate change and the Arctic are very important. As her first meeting, she comes away with a very positive impression of the Group – we can do a lot of things together.

The IICWG charter signatories and the heads of the national ice services were invited to attend the Business Meeting the following day together with their invited guests.

End of Open Meeting

IICWG Business Meeting – Friday, October 28, 2016

Opening Remarks

The co-chairs thanked MDA for the interesting tour of the Gatineau Satellite Station and Canadian Data Processing Facility. They also congratulated the CIS staff for organizing the excellent no-host dinner the previous evening.

The agenda was adopted as presented at Appendix B.

Standing Committee Meeting De-Briefs

Data, Information and Customer Support (DICSSC)

Penny Wagner presented the DICSSC de-brief as the new DICSSC co-chair replacing Caryn Panowicz whose term has ended. Antti Kangas and Alvaro Scardilli are the other continuing co-chairs.

The Committee had reviewed their action items, closing some, merging some, assigning some to the iceberg sub-committee and adopting some new ones. The resulting list of action items is attached at Appendix O.

Iceberg Sub-Committee

Gabrielle McGrath presented the Iceberg Sub-Committee de-brief. The action items are appended to the DICSSC list at Appendix O. The Sub-Committee asked the Secretariat to ensure that time is set aside for a committee meeting at IICWG-XVIII.

Applied Science and Research Standing Committee (ASRSC)

Dean Flett presented the ASRSC de-brief from their Committee meetings. Dean will continue as ASRSC co-chair along with Wolfgang Dierking and Phillip Reid.

The action items were reviewed in Committee although Dean noted that there are still a number of old items that need to be cleaned up. The resulting list of action items is attached at Appendix N.

Business Arising

With reference to the standing committee de-briefs, Co-chair Vanessa Griffin questioned some of the vague actions taken. She suggested that the committees have regular teleconferences and set some specific milestones. The committee co-chairs present agreed to this. They also agreed to send brief updates to the secretariat for posting on the IICWG website following their teleconferences.

There remained time for only a single new business item.

Future Directions for the IICWG

Vanessa Griffin recalled that, at the last meeting, we agreed to develop a strategic plan but did not get any input from the Group. This week we have heard a lot about the need to engage our users. What is it we need to do and where do we go from here? What are your thoughts on how we should put together a plan for the future? We are looking for ideas for a vision plan that could be used to develop a frame work to guide where we want to go. For example, for how we should feed into other communities.

Diane Campbell pointed out that one of the highlights of this meeting was the number of presentations about opportunities to participate in other fora. How do we capitalize on these opportunities to make connections with our users?

Marianne Thyrring noted that many of the presenters gave us information on which way to go. David Grimes spoke about the Paris Climate Change Agreement. We discussed the Polar Code many times in terms of what it means for us and how we can cope with it. One difficult question that has been asked is "What comes after the ice egg?" Users want straight-forward information. Are we in a disruptive situation where we have models that don't exactly answer users' questions? How should we manage that situation? We must think about how we communicate with our users.

The co-chairs invited the participants to express their thoughts on the issue. The following commentary resulted:

- We are very focused on users but what are the national strategies? IICWG strategic direction needs to align with individual ice services and their parent organizations.
- What comes after the ice egg? We asked that in 2012 but did not get an answer. Have we come much further? A critical technology we need is freely available high bandwidth communications in the Polar Regions – until we get that, we are held back.
- Training of ice analysts is important - quality depends on them. The Ice Analyst Workshops are very good for all and we should endeavour to maintain and improve them. We have good training materials for ice analysts so all services are at same skill level.
- IMO e-Navigation is still quite far off in the future. The idea of combining information from all ice services is good. However we must also think about interaction with other marine service providers who produce information for the bridge.
- End users don't trust the ice charts all of the time. We need to get an indication of uncertainty into our charts. We should also link more closely with planned campaigns such as YOPP and MOSAiC.
- Good communication with end users is essential. In meeting with users, it is eye opening to see that a lot of what we do is not used by them.
- There are open questions concerning the Polar Code. It is the responsibility of individual companies to evaluate risk for the ships they want to send to the Polar Regions but what happens when things go wrong? Should we provide more assistance to shippers in planning voyages? Could we actively address commercial groups that are developing the systems?

- We should develop dynamic ice charts with the capability to zoom in to get more information. Also make ice charts more relevant to the next day through prediction.
- This meeting gave us snapshots of many things. There is downscaling of information that is provided to users but users may not understand all of the information. The Polar Code says that information must be provided to the ship but exactly what information and how is not clear. A number of international programs are relevant to the IICWG but are not visible here. We always need to address problems that have arisen and anticipate future problems. It is important for IICWG to make recommendations that to go to formal bodies, such as WMO, for enforcement.
- It is important to focus on end users and also on regulators who rely on ice charting. Recommend active participation in the Best Practice Forum - a terrific opportunity to interact with user organizations. IICWG needs to bring its work to those who can use it.
- A strategic vision should include something on what we are going to do to involve users in PRCC or YOPP. There is a lot about science and observing but how we will engage users has never gone beyond talking. We also need to consider small craft and pleasure craft not covered by the Polar Code.
- IICWG is a good group for international cooperation and collaboration but we should also make it easier to find information and data.
- IT personnel need to be more involved with IICWG so that ideas and decisions are grounded in the reality of what can be done – although it is noted that many analysts are now very technology-savvy.
- We need to make sure science activities truly reflect what operations need. Actions should be realistic and reflect what we can accomplish.
- The future of ice services is evolving. Clients want higher resolution and communication bandwidth is less of an issue. However, the techniques of ice charting are getting outdated and users are more sophisticated. The issue will be how quickly we can synthesize information and produce a product that is scalable and relevant to users' activities. This will mean a greater reliance on automation. Analysts will still play an important part in Quality Control and validation. The will also have a role in forecasting to make modellers aware of problems. We must also have a link to past data before going down the road to new products lest we destroy data that users need.
- In 2007 we updated the IICWG socio-economic statement. We should document strategic plans that individual organizations have now that could be used to formulate the IICWG strategic vision.
- As fortunate as we have been to have increasing satellite data for analysis, it is important that we continue to support in-situ data, especially the buoy programs and shipboard observing efforts. YOPP will provide a great opportunity for data collection. It will be ending in 2019 which will be the IICWG's 20th anniversary – a good time to stake stock of where we have been and where we are going.
- Users often don't trust ice charts because the analyses bounce around. We are not educating our real end users about what is available. Should we still be producing ice charts?

- It is important to think about why we are here. It is for the users and we need to develop an engagement strategy for the future. We need to engage users particularly in the event of an emergency. When developing the vision, we should look at what the ideal service would be and what is keeping us from getting there.
- Our actions are all good. The strategic plan should be aligned with what we are doing and help us to prioritize the actions. The 20th anniversary is coming up and it is a good time to look at where we are going in the next 20 years.
- We need to recruit other people to help with our action items – even sister services – don't do it all yourself.
- Over the past years, we have had themes and breakout sessions but have not gone back over them to see what we are going to do with them. What should come from our past efforts? Committees are the heart of what we do and must be connected. A vision must be real and everyone must see themselves in it. The CSA has been approached about updating and extending the 2007 socio-economic study and has accepted this for further discussion.
- This may be an ad-hoc group but people want to be here and have a common goal. The whole is greater than the sum of its parts. I continually heard five C's mentioned – collaboration, cooperation, coordination, consensus, and coherence. The Group should look at emergency response needs. Modelling to operations needs to carry over into our future. Ice analysts and forecasters must be tied into the feedback loop and involved in decision support services. User engagement is important - not just from a product perspective but also for feedback. We must stay in tune with other groups to ensure we are in tune with regulations and guidelines. We must work on e-Navigation and exploitation of higher bandwidth channels. Training, encouraging, and exchanging expertise should be included. We should also consider coastal community applications.
- We must ensure we coherently integrate all of the data into products and services that will help users make effective decisions.
- User engagement includes interaction with user organizations – not just individual users. Part of our strategy should be to attend their meetings and present ourselves.
- Space-based SAR was a paradigm shift that has not yet made it to all users. An analyst can produce a nice chart that is old or produce a quick product that is timelier. Navigating officers are important but we should also include naval architects and flag states. We now have enough SAR data to produce very detailed climatologies. We should look at microclimates that would be useful for anyone planning a voyage.

Vanessa Griffin thanked everyone for their wide-ranging thoughts and wondered how we can pull it all together. We want near term milestones before 3 years are up. How do we engage users and keep in touch with how are they changing.

ACTION	As a user outreach initiative, update the IICWG Ice Service Contact List handout and prepare a presentation for use at stakeholder meetings.

ACTION	IICWG is to participate in the Arctic Council Best Practices Forum to be held in London in May/June 2017. Secretariat to keep Group informed about the Forum

ACTION	Produce a draft Strategic Vision document for the IICWG. As background, should consider strategic plans from individual ice services as well as the North American Ice Service and the European Ice Services. The vision should also include a strategy for engagement with all stakeholders

Review of Action Items

Eric Madsen and John Falkingham reviewed the open plenary action items as well as new actions proposed during the meeting. Ten old action items were closed or cancelled during the meeting. Fourteen new actions that the Group felt were important and for which participants were willing to devote resources were assigned and due dates established. The complete list of plenary action items is attached at Appendix Q. The action item status is maintained on the IICWG website.

Next Meeting

The meeting thanked Canada for the invitation.

As announced earlier in the open meeting, the next meeting will be held in in Hobart, Tasmania, Australia during September 25-29, 2017. The following were nominated as the Organizing Committee for IICWG-XVIII:

- Dave Jackson (Canadian Ice Service)
- Gabriel McGrath (International Ice Patrol)
- Neal Young (Antarctic Climate and Ecosystems CRC)
- Penny Wagner (Norwegian Ice Service)
- Keld Qvistgaard (Danish Meteorological Institute)
- Murray Doyle (retired icebreaker captain) (tentative)
- Lisa Kelley (IAATO)
- John Falkingham, Klaus Strübing (IICWG Secretariat)

In addition to the comments made at the open meeting, the business participants voiced the following comments and suggestions:

- Everyone likes the poster sessions but to improve them:
    - Let poster authors give a brief introduction to their poster – perhaps a 10-minute poster presentation before each break
    - Give 5 minutes for poster presentations and longer time to view posters

  - Display the posters in a more permanent location where they do not have to be moved
- Instead of dedicating a full day to the workshops, consider distributing them across the week
- Give more guidance to selecting talks and posters
- Split the meeting up more to allow more dialogue and a more interactive meeting
- The Science committee could have presentations that lead into panels – 10 minute presentation and 30 minute panel
- Have shorter sessions with time for discussion followed by a break

The following were proposed as theme sessions for the next meeting:

- New technologies (drones, UAVs, etc.)
- Commercial communication in the Polar Regions
- Hear from Managers of Southern Hemisphere METAREAS on their plans and needs
- Presentation from COMNAP on their activities and needs
- Short session on YOPP and international activities
- Session to prepare for JCOMM meeting
- Future vision for the IICWG

Meeting Close

Co-chairs Vanessa Griffin and Marianne Thyrring expressed their view that this had been a very successful meeting and thanked all of the participants for their hard work to make it so. The participants once again thanked the meeting organizers and the hosts for their wonderful hospitality.

Diane Campbell expressed her personal thanks to Vanessa for keeping us focused on things that are actionable and assured her that she will still be part of the extended family because of the role she plays.

Vanessa thanked everyone and exhorted the Group to keep up the great work. This is a tremendous example of how countries can collaborate. As David Grimes said at the beginning of the week, it is a coalition of the willing.

IICWG-XVII was closed with wishes to all for safe travels home.

End of IICWG-XVII

ACRONYMS

AAD	Australian Antarctic Division	IIP	International Ice Patrol
AARI	Arctic and Antarctic Research Institute	IMetO	Icelandic Meteorological Office
ACECRC	Antarctic Climate and Ecosystems Cooperative Research Centre	IMO	International Maritime Organization
ASF	Alaska Satellite Facility	ITOPF	International Tanker Owners Pollution Federation Ltd.
ASRSC	Applied Science and Research Standing Committee	JPL	Jet Propulsion Laboratory
AWI	Alfred Wegener Institute for Polar and Marine Research	KSAT	Kongsberg Satellite Services
BAS	British Antarctic Survey	met.no	Norwegian Meteorological Institute
BSH	Bundesamt für Seeschifffahrt und Hydrographie	MSC	Meteorological Service of Canada
BOM	Australian Bureau of Meteorology	NAIS	North American Ice Service
CCG	Canadian Coast Guard	NERSC	Nansen Environmental and Remote Sensing Center
CDPF	Canadian Data Processing Facility	NIC	National Ice Center
CIS	Canadian Ice Service	NIS	Norwegian Ice Service
CLS	Collecte localisation satellites	NMI	Norwegian Meteorological Institute
CSA	Canadian Space Agency	NOAA	National Oceanic and Atmospheric Administration
COMNAP	Council of Managers of National Antarctic Programs	NRL	Naval Research Laboratory
CPOM	Centre for Polar Observation and Modelling	NSIDC	National Snow and Ice Data Center
DICSSC	Data, Information and Customer Support Standing Committee	NSOC	NOAA Satellite Operations Center
DLR	Deutsches Zentrum für Luft- und Raumfahrt (German Aerospace Center)	NWS	National Weather Service
DMI	Danish Meteorological Institute	OSRL	Oil Spill Response Ltd.
ECCC	Environment and Climate Change Canada	SAR	As used throughout this document means "Synthetic Aperture Radar" – not Search-and-Rescue
EC-PHORS	WMO Executive Council Panel of Experts on Polar and High Altitude Observations, Research and Services	SMHI	Swedish Meteorological and Hydrological Institute
ESA	European Space Agency	SHNA	Servicio de Hidrografía Naval de Argentina
ETSI	Expert Team on Sea Ice	SPRI	Scott Polar Research Institute
FMI	Finnish Meteorological Institute	UCL	University College London
IAATO	International Association of Antarctic Tour Operators	UAF	University of Alaska Fairbanks
IABP	International Arctic Buoy Program	UTAS	University of Tasmania
IPAB	International Programme for Antarctic Buoys	WMO	World Meteorological Organization