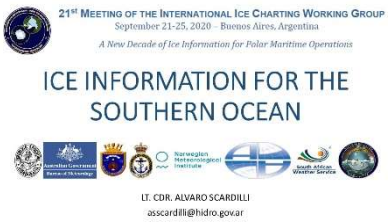
Appendix H: Maritime Operations in the Southern Ocean

APPENDIX H: SESSION 5 – MARITIME OPERATIONS IN THE SOUTHERN OCEAN

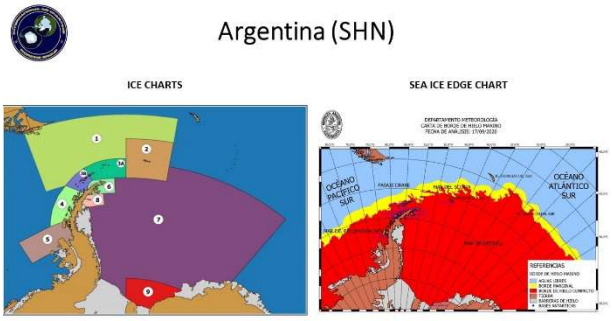
Presentation

Alvaro Scardilli (SHNA) – Ice Information for the Southern Ocean

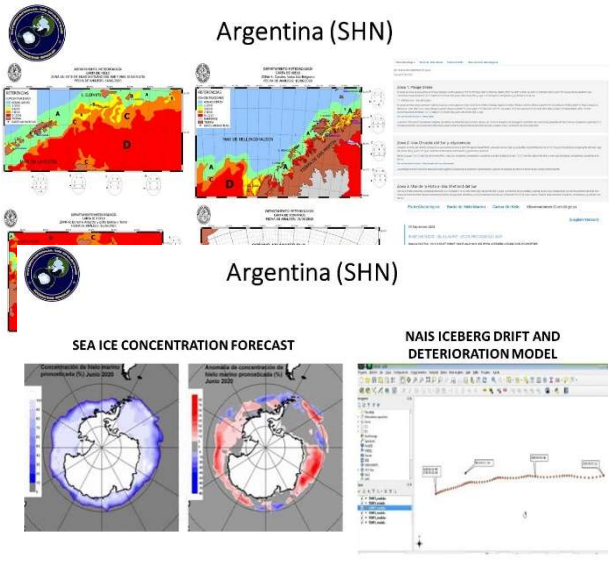


I will talk about the different ice services or national services that are involved in the elaboration and distribution of ice information for the Southern Oceans. As you can see in the logos, not only Southern Hemisphere countries are involved. Northern Hemisphere countries also provide information. I will present these in alphabetical order. I want to thank all my colleagues that kindly provided the information. To my colleagues, please feel free to correct me in the chat box or to add more information if I made any mistake.

You can access the products and services of the Argentine Naval Hydrographic Service through its websites. Here, you will find all the ice information - iceberg charts, ice charts, reports, some Bibliography, etc. It's only in Spanish so far but we are working on an upgrade of the website so it will be available also in English.



In our case, ice charts are divided in nine different areas. Each area has a specific importance for maritime traffic. The Antarctic Peninsula is one of the most visited areas of Antarctica for tourist ships. A lot of fishery activities are going on in Drake Passage, Bellingshausen and north of Weddell Sea so we are most focused on those areas. We also present a general chart for the NAVAREA-6 that includes the sea ice edge, the marginal ice zone, and the pack ice information.

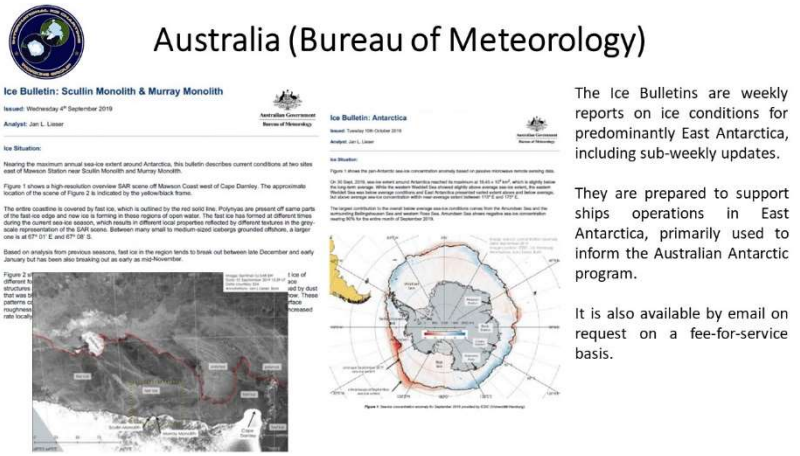


Here are some examples of the ice charts we produce. We use the color code of WMO, egg codes for the stage of development, type of ice, presence of icebergs, and partial concentrations. We have a specific product for icebergs where we observe the position of icebergs greater than 10 nautical miles and smaller ones that we can track by satellite images. One of our latest upgrades is to show iceberg risk areas using the definitions of isolated, few, or many icebergs in areas of one degree of latitude by one degree of longitude. It's very important information for mariners and it's a product that has very good feedback for them. We also have text reports where you can see ice conditions in text format

from all these nine different areas. And you can also see the reports of each station with their ice observations. So, if you have to go into a bay or gulf, you can see what is going on there by the report of a trained ice observer.

You can also access the information of the sea ice concentration forecast and soon the information from the iceberg model will be available. These were the two presentations from yesterday, so I will not talk about that.

Our next country is Australia. In the Australian Bureau of Meteorology website, if you go into the high seas forecast and choose the southern area shown in the red box, you will access this forecast where the approximately position of the ice edge is given. That is the kind of information that they provide in this format. Also available are the technical reports that are a resume of all the ice bulletins that are produced by Jan Lieser during the different Antarctic shipping seasons. But, of course, these are fir the past shipping seasons.



In this specific operational task, Jan Lieser produced these great ice bulletins. You can see here two examples - a general one for the entire Antarctica and some specific ice bulletins for different areas of interest. You see imagery and sources of data. So, it's a very complete ice bulletin. These are weekly reports with sub-weekly updates, mostly focused on East Antarctica that is the area of interest of the Australian Antarctic program. It's also available by email on request on a fee for service basis.

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Chile (Navy Weather Service)

Chile (SERVIMET)

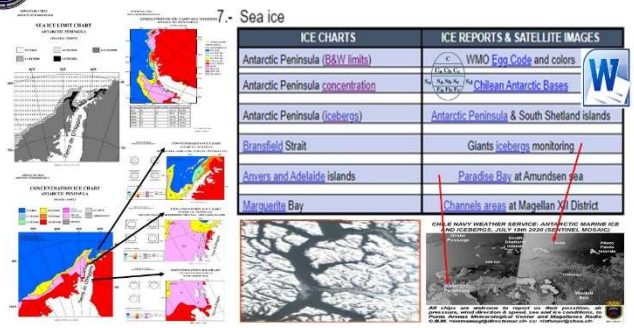
Save this file as a simple version designed for mariners and internet users with low bandwidth access.

1	Warning bulletins (Weather, Gale Winds, Storms, Swell-Surge)
2	Broadcast schedules and frequencies
3	Geostationary satellite images GOES (Eastern South Pacific)
4	Synoptic analysis Surface charts
5	Marine weather forecast (.txt)
6	Models – GFS, NWW3, WRF (charts, meteograms, radiosondes)
7	Sea ice • http://web.directemar.cl/met/jturno/indice/english.htm#Hielos
8	Real time weather data
9	Contact points
10	External links to other official sites related to marine weather

New Zealand (Royal Navy and Met Service)

- No national ice service
- Royal New Zealand Navy support to Antarctic operations sourced from:
  - University of Bremen
  - Antarctic Climate & Ecosystems Cooperative Research Centre, University of Tasmania
  - PolarView
  - US National Ice Center
- NZ MetService (Text only)
- High Seas forecasts for the Southern Ocean
- From 55S to "ice edge", between 160E and 120W
- Includes:
  - Gale warnings
  - Ship ice accretion forecast
  - An indication of the ice edge location, but marked *"Ice edge not for navigational purposes."*

Chile (SERVIMET)



The Chilean Navy Weather Service website has a link to the English version which you can see in the right part of the figure. Here, you can access all the products they have for mariners in English. Inside here, you have option seven sea ice. Here, you will go to all their products. This includes sea ice limit charts, concentration ice charts for the entire Antarctic Peninsula Bellingshausen and part of the Weddell Sea. You can also access specific products for Bransfield Strait, Anvers and Adelaide Islands, and Marguerite Bay with colored ice charts. They also have some reports in text format. Satellite images are available. They monitor giant icebergs and have specific considerations for Paradise Bay at Amundsen Sea, and the channel areas of the Magellan District. So, it's a very complete website inside the Chilean Navy Weather Service.

New Zealand does not have an ice service. The operations of the Royal New Zealand Navy are supported by the University of Bremen, the University of Tasmania through the Antarctic Climate and Ecosystem Cooperative Research Center, Polar View, and the US National Ice Center. They do include the approximate position of the ice edge but with the remark that it's not for navigational purposes. Something that I found really interesting is that they also have the ship ice accretion forecasts. Really interesting, but that's all the information they provide from their own country. They mostly use services from other countries.

The Norwegian Ice Service has a website where you can access ice chart products. For both Arctic and Antarctic. On the right figure, you can see the red boxes where you can access all the ice charts. There is a general one for the entire Antarctica but you then have specific areas where you can access those products.

Norway (Norwegian Ice Service)

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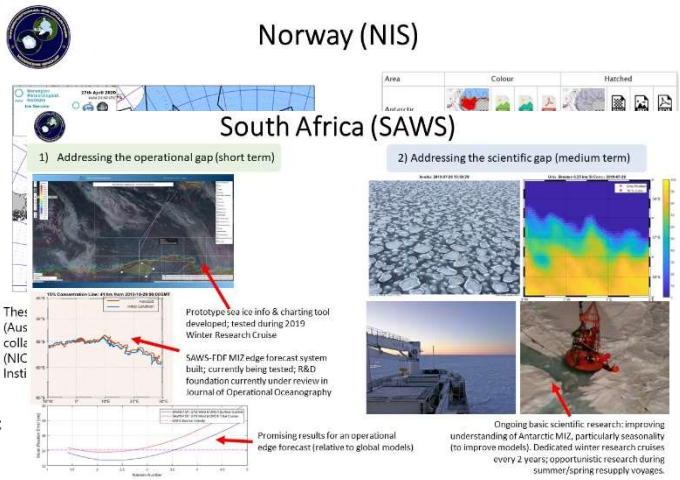
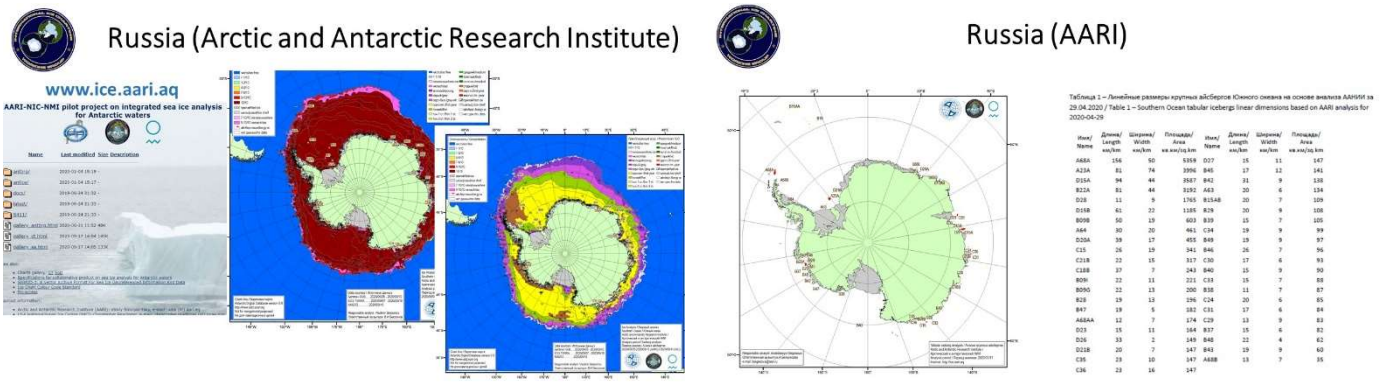
Here are some examples. On the left is the general chart for most of the Bellingshausen, Weddell and part of East Antarctica and, of course, the Antarctic Peninsula. The specific ice charts are for Adelaide Island, Bransfield Strait, Antarctic Peninsula specifically, and Weddell Sea East. These are available in color and hatched. These are created in the austral summer, between October and April, and as a collaboration project with the US and Russia Arctic and Antarctic Research Institute



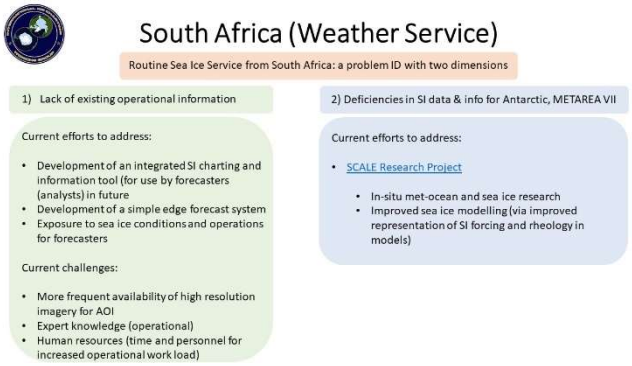
And now we have the Russian products. The Arctic Antarctic Research Institute is in charge of this. They have a collaborative project with the US and Norway but I'm talking specifically about the products of each country. They have bi-monthly ice charts for the entire waters around the Antarctic continent. And they have specific



charts with ice concentration and stage of development separately. They are both very detailed ice charts.

And they also have an iceberg chart where they locate icebergs bigger than 10 nautical miles or more than 20 square nautical miles in area. These are the positions of those icebergs and they also have a text document with more detailed information on each iceberg.

South Africa conducts its ice information activities through the South African Weather Service. They are really working on the implementation of ice charting and research and development activities. They still have some issues they are attempting to resolve like, for example, the lack of operational information and deficiencies in sea ice data and information. METAREA-7 is their responsibility. They are currently working to develop sea ice charting tools. They need to acquire high resolution imagery, expert knowledge, more human resources, and develop met-ocean and sea ice research programs. They have been



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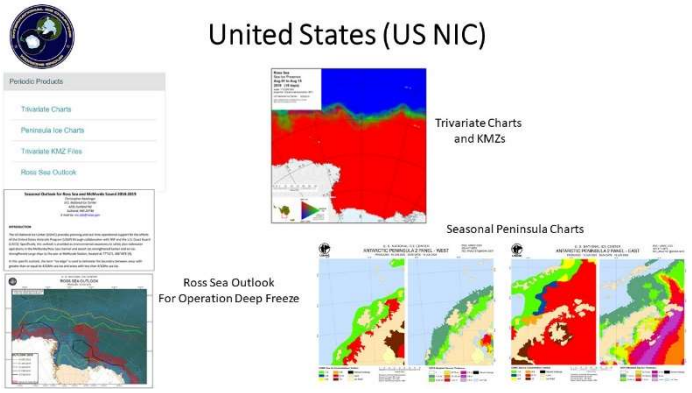
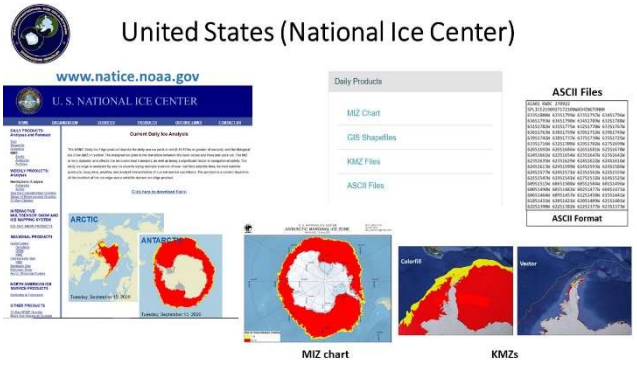
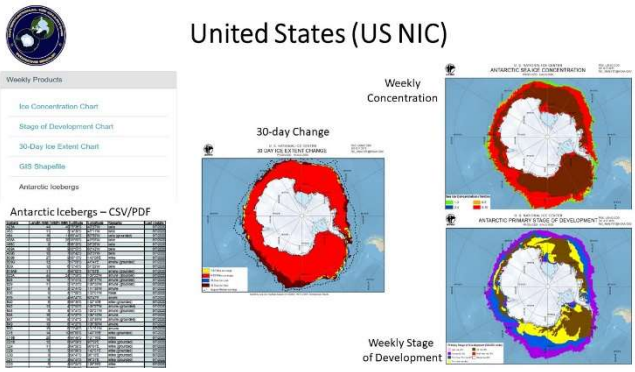
doing some testing of prototypes of sea ice charting tools. They tested if during the 2019 winter research cruise with very good results. They are also working on a marginal ice zone edge forecast that's been tested with very promising results. I found this very interesting. They are also conducting research activities in the Antarctic margin ice zone during summer research cruises and in winter also. In each season, they can access these cruises.



Finally, the United States. Through the National Ice Center website, you can access Arctic and Antarctic products. In the Antarctic products, I will show different timescale products. There is daily information on the pack ice and marginalize ice zone. This information is also available in GIS, shapefiles, KMZ and ASCII formats. You can choose which format and download the information.

In the weekly products link, you will find the sea ice charts for Antarctic waters for ice concentration and stage of development, as we have seen in other ice services. This is updated on Fridays. There's also a very good product - the 30-day change charts which are a graphical





representation of the change in sea ice extent over the last 30 days. Also, you can see the iceberg table documents with detailed information on the position and size of icebergs greater than 10 nautical miles.

The periodic products that you can access in the NIC website includes the trivariate charts derived from the USNIC archive data to provide a characterization of analyzed sea ice conditions in the polar regions, the Peninsula ice charts that provide sea ice conditions for the cruise industry during summer, and the Ross Sea outlook that's the analog product that provides a prognosis of ice conditions during the Ross Sea melt season in support of the US Antarctic program.

I have tried to summarize all the information of the countries that are mainly involved. There are some other countries, of course, that have research activities but I have not been able to reach the correct person. I know, for example, that Brazil has an important presence during the summer with ships and also with their station. I know they use some products of all of us.

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But these are the countries that are involved in the production and distribution of routine ice products.

I didn't mention anything about Polar View because Andrew is going to do a specific presentation. I didn't want to be a spoiler about anything on Polar View. But it's one of the most important sites for ice products, of course, and was our first support to our activity.

CHAT LINE

[7:24 AM] Bjørn Kay
Helpful and nice overview - but which one is the best one - which can I recommend to the mariners as best or do you all have the same results in the end? Great job Alvaro! Thanks, learned a lot!

[7:26 AM] Jan Lieser
Bjorn, I think that we have to encourage mariners to get comfortable with the idea of using all available information. The redundancies, in this case, is very important. And of course, you can see that some Ice Services have specific products for small areas that can be more useful

[7:33 AM] Greg Stuart
It sounds like there is an opportunity for ice service providers in the Southern Ocean to collaborate and focus areas of expertise/geographic regions to support each other so that we provide the best coverage across the entire Southern Ocean?

[7:39 AM] A.J. Reiss (USA - NOAA)
IRT Greg Stuart question. on similar products over similar area, does each ice service update on the same day or each a different day? If the latter, frequency would increase of updates.

[7:46 AM] Nick Hughes (MET Norway)
AJ and AS: Yes, the issue of what days charts are produced should be looked into again. Another Task Team?

[7:41 AM] Alvaro Scardilli (SHN Argentina)
AJ I believe we do in different days. Collaborative work could be a very important objective of this WG to increase frequency of updates

[7:51 AM] Alvaro Scardilli (SHN Argentina)
AJ and NH, collaborative work could help all us to develop better products. Yes, for a task team!

[8:27 AM] Keld Qvistgaard (DMI)
Ice analysis update frequency seems to be a major challenge in Antarctica. How to address this? Include regional data, for example from Argentina and other ice services?

[8:29 AM] Heather Quilenderino (USNIC)
Keld, I think merging data from ice services is one possibility. We could also look at coordinating frequency, as has been mentioned.

[8:29 AM] Greg Stuart
It sounds like a potential role for Global Ocean Observing Systems.

[8:41 AM] Neal Young

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Marianne and John In a previous meeting there was a proposal for SH task team .....

Panel Discussion

Introduction

The panel was comprised of users of ice information who have been asked to provide their views on what kind of ice information is needed in the Southern Ocean and what is missing from currently available information. The moderator directed prepared questions at each of the panelists in turn and invited questions and comments from all panel members and the audience.

Moderator:

- Penny Wagner (Norwegian Ice Service)

Panelists:

- Mark van der Hulst (IAATO)
- Miguel Angel Ojeda (COMNAP)
- Capt. Karl Robert Røttingen of RV Kronprins Hakon
- Capt. Duke Snider (Martech / NI)
- Capt. Alan Gross of MV Ushuaia

Unfortunately, although he tried, Duke was unable to participate. He was aboard *RV Mirai* in a typhoon off the coast of Japan. The only place he could get an Iridium telephone signal was outside on deck – much too dangerous in the severe weather conditions.

Key Messages

- Mariners navigating Antarctic waters get as much information as they can from many sources to make their navigating decisions. They make the best of whatever information they can get.
- Ice charts are not available as frequently as needed in some areas of the Antarctic.
- Growlers and bergy bits, especially if they are embedded in concentrated sea ice are the greatest hazard to ship in the Antarctic. Knowing where they are is a crucial need.
- Forecast ice information including ice drift and concentration, for at least 24 hours, is the most critical information gap. For some voyages, multi-day forecasts are needed.
- Captains and officers are generally knowledgeable about ice information and navigating in ice. Vessels are generally manned by competent personnel at the present time. There is, however, concern that there will be a shortage of competency when all of the new polar yachts and cruise ships being built are put into service
- Except for departure and arrival dates and ports, cruise ship captains in Antarctica have a lot of freedom about where to take their ships.

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Session Transcript

Penny Wagner

I want to say a virtual hello to the panel. I think this is going to be a very interesting panel because it's the first panel where we have all end users. You can access the background document in the folder and follow along. I would like to select someone to answer some of these questions first, but then I would ask the full panel to answer. So, I'll start with number one. From your own experience, and that of other ice navigators you know, what is the most widely used and reliable source of ice information for Antarctic waters? And why?

Alan Gross

We use all the information that we have. I would say that the three that we use most are the Argentine Navy Hydrographic Service, the Chilean one, and we support that information with the NASA Earth View page. They provide the very good satellite images. One of the problems that that page has is the clouds. When it's cloudy, you don't have a good image. It has a very good zoom-in with a very clear image in that webpage. Those are basically the three services that we use on this ship.

Karl Røttingen

From Norway, we use one of our own solutions together with the Norwegian Polar Institute. We send our request to them on email and get the ice images back. They are very compressed so it's no problem to receive them through Iridium mail. Then we sample those pictures in this freeware mapping system. The fantastic thing about this is that we have our own position, but we can also offset our position. So, when we recognize the type of ice floe or something, we offset our position. Because the image is only updated maybe once a day, then we offset our own position and we think that's a good solution. We have tried it mostly in the Northern Hemisphere, but also in Antarctica. We are very, very pleased with that. Thank you.

Mark van der Hulst

Good afternoon, everybody. Our company is operating five vessels in the polar regions. We've seen in the previous presentation, basically all the data that our captains access. It also depends a little bit on which captain you're talking to because, of course, they all have their own preferences in the various data available. They are shopping around for the various data available, comparing it, and making judgments based on these different resources.

Miguel Ojeda

Good morning, everyone. From the COMNAP community perspective, I think that we have to say the same as others. We are using most of the sources that are available. Depending the flag of the ship, they sometimes use their own native services because they're confident in the language used, in the case of South American users. In the whole COMNAP community, we are close to 30 countries in national programs with more than 15 ships working at the same time. I'm in Antarctica during the summer. We try to use all of the services that are available. I guess that the gaps may be in the Indian sector, in feedback from all the users to the ice services, to be able to feed map information to us. Someone said that the images are only updated once a day and to have a large fleet working in the same area, at the same time, could feed a lot of information about the ice back to the services.

CHAT LINE

[8:29 AM] Chris Readinger USNIC
Imagery in East Antarctica is a major problem but could possibly be done more regionally.
[8:39 AM] Jamie Treleaven
We are in discussion with the Australian Copernicus hub about Antarctic coverage and access via API's to develop products

Penny Wagner

I think the overall answer is that everyone uses what is available and tries to figure out other reliable methods to augment the times you don't have information. I think we have lost Duke so I will provide his input on this. He really wanted to stress that satellite connectivity is still an issue. They, as well, will take every type of source available in Polar View. The US National Ice Center charts and information is one of the main sources of information they use. He said that, even though they have V-SAT, it still drops off in some areas. So, this still remains a problem.

I'm going to go on to the next topic which is actually focused on the confidence you have when approaching icy waters. Are you confident that, when approaching icy waters, you'll have reliable and accurate ice information? And are there specific areas where information providers should aim to have a lot more frequent coverage?

Mark van der Hulst

That's a good question. We have a rough idea, when we are sailing into an area, of what kind of ice we might expect. But unfortunately, sometimes the data is not accurate. Maybe there is not daily satellite coverage. So, you can see in some areas, especially in Antarctica, where you know that there's not a daily satellite picture. The high density areas are better covered. For example, the Western Peninsula is much better covered with satellite images. That, of course, will lead to more trustworthy ice charts. But other areas like, for example, the Ross Sea or the Weddell Sea, are less frequently covered by satellites and ice information is not updated as much. Sometimes, when we are sailing into an area it's not what we expected. That's what you have to deal with of course. Fortunately, we are from an industry where we don't need to go from A to B but can divert or go back or whatever. But if you are in a high density ice area, more accurate ice information is better - it helps safe navigation.

Miguel Ojeda

I fully agree with what was said before. We are moving in a very dynamic environment so, depending on the accuracy of the updates, we will find more accurate information or not. As you know, in Antarctica, weather changes very rapidly and so do the conditions at sea and in the ice. Not where the ice compact, but where the information regarding the icebergs is very dynamic. The more up-to-date the ice information is, the more confident we would be.

Alan Gross

In the last years, in my opinion, the information has improved a lot, especially for the regular satellite connection. One of the things that are very good is the weather forecast. That can give you an idea about the wind and that can tell you how the sea ice will move in a few days. One interesting thing that I think would be useful is if the ships can upload information, in some format, to the hydrographic service. But it has to be easy to upload with maybe a few pictures and a few very specific important information about the kind of ice and the density of ice is in some special area. If that information can be available in real time, I think that would be useful.

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CHAT LINE

7:43 AM] Bjørn Kay
Have you tested 5G sat communication INMARSAT from ice services in Antarctica to RV vessels?

[7:46 AM] Neal Young
Alvaro, Alan Gross made a generous offer that needs promotion. Systematic collection of ice data will be invaluable, provided it can be implemented in an easy but robust way. There are mariners here from a range of organizations that can carry the message back. N

[7:48 AM] Ivan Sitnikov
The ice information from ship can be automatically retrieved from ice type radars, integrated onboard and sent to server for share with others. dKart Ice Navigator system was tested with this data from Ice Vision radar.
[7:48 AM] Neal Young
IceCam upgraded https://www.sciencedirect.com/science/article/pii/S2590123019300362
Can put data into IceWatch (NMI)

[7:48 AM] Richard Hall (RICHH)
Can a computer see what an ice expert sees? Multipliable ice objects classification with convolutional neural networks
Computer-aided scene analysis has drawn much attention, especially in autonomous navigation and advanced navigation assistance systems for surface vessel…
www.sciencedirect.com

[7:51 AM] Neal Young
Hi Richard, there will be icecams and ice-cams and so we will get variations in what we see from the same ice. Still needs onboard obs to help with interpretation.

[7:53 AM] Richard Hall (RICHH)
Neal Young the paper is about automated classification of images captured by webcams. The ice classification is sent back to the ice agency for interpreting satellite images used to construct the ice chart

[7:53 AM] Nick Hughes (MET Norway)
NY and RH - ASPeCt, IceWatch, and SIGLAC (Argentina) for shipboard obs. Scope for AI tools to automatically extract parameters from photographs. IceWatch has an app in development to make taking photos and submitting data easier, this will also make it possible to send a satellite image or ice chart back to the observer.

[8:30 AM] Bjørn Kay
with good 5G you can validating the CTV from ship into the other information like they do in SCANNEX which we saw last year in CPH!

[8:34 AM] Nick Hughes (MET Norway)
BY - 5G in the polar regions would be nice but will probably be only from a few niche providers. Lots more focus on the more populated lower latitudes markets.

[8:38 AM] Bjørn Kay

5G Inmarsat marine services: https://www.rivieramm.com/news-content-hub/inmarsat-tests-iot-5g-satellite-communications-60678
Inmarsat tests IoT 5G satellite communications
Trials prove 5G can be used in conjunction with satellites for non-terrestrial IoT
www.rivieramm.com

[8:41 AM] Bjørn Kay
https://paxex.aero/2019/07/inmarsat-gx-arctic-coverage/#:~:text=Inmarsat scores high speed polar coverage with new GX satellites,3 July 2019&text=The satellites will operate in, and capacity in the Arctic.
Inmarsat scores high-speed polar coverage with new GX satellites
Inmarsat continues its GX network expansion plans, announcing another pair of payloads to deliver high speed service in the Arctic region.
paxex.aero

[8:41 AM] Bjørn Kay
The new Inmarsat sats will change GMDSS Naveareas hopefully!

[8:52 AM] Anna Telegina
Yes, Bjørn, thanks for sharing a link! I think such online GIS systems as Scanex provides where not only different ice products and imagery are presented but also AIS data, ships' reports on Sea ice thickness and power load with pictures (automatically) etc. are very convenient for validation. Based on our work with Sovcomflot on the Northern Sea Route this year we managed roughly to compare sea ice reports' thickness information with ice thickness from products of AWI and NOAA. Quite interesting results we got on what product is actually would be more useful for operational use in this area and in what regions.

Karl Rottingen

I agree with Mark when he said missing data is one of issues. Of course, when you're there, you have to do the best you can. I absolutely agree with him that you have some days without any data and if the ice is moving towards current and wind, we really don't know what will meet us. So, I just have to agree absolutely.

Penny Wagner

I'll respond to what Duke also said because it looks like everybody's in agreement on this. We also need more frequent coverage in the Weddell and the Ross Sea and that we do have better coverage around the Peninsula, but that could be improved. Also, we would like a lot more coverage around the Weddell and Ross Sea. I haven't heard much feedback from the eastern part of Antarctica so things are a lot more in demand.

I guess this brings me to the next topic. Looking at what current ice information is available, are there certain ice characteristics that you wish were better described or included in the product? This also applies to icebergs or iceberg information.

Miguel Ojeda

The more information we have, the safer is our operation. I think one obvious issue for navigation is drift ice. I think that this is one of the greatest requests for information needed during summer

operations in the area of the Peninsula of Antarctica. I guess that drift ice is a really nice information to have.

Mark van der Hulst

That's what I hear as feedback from my captains as well. It's ice drift charts or better ice drift projections of what they can expect in the days ahead. Of course, we always plan days ahead and that would help really help out if they had that information. And I couldn't agree more with what was previously said that the more information we have helps us all. So, any information that's not available now would assist better, safer navigation.

Alan Gross

I have to agree with the with Miki and with Mark, as much information as we can have, we can plan and navigate safely. Better predictive models would help a lot. I know it's very, very difficult to predict in Antarctica but that is what we would like.

Karl Rottingen

I just have to agree with the others. My concern is that the people building these models don't have experience. So, when we navigate, the model may not be correct. If someone would provide a model that you can have, for instance, one layer over another in the same model that would be useful. So, you can see that the people who made it have the wrong assumption due to wind or something. For example, I see other places where they have this forecast where the model is wrong. It's based on, for instance, the ice drift due to wind.

CHAT LINE

[7:44 AM] Thomas Kræmer
Are there anyone testing out running models on the ship?

Penny Wagner

I think that's true because we do have a lot of products that are developed for this include drift, but we don't have a lot of validation information for that. So, it is nice to know how well it represents real life conditions. I think we have time for some questions now.

CHAT LINE

[7:33 AM] Folomeev Oleg (AARI)
Thank you Alvaro Can be comment on such a question from your side...what else is necessary to ensure the safety of navigation other than ice conditions and icebergs? For example, the forecast of swells in waters infected with icebergs and ice ... anything else

[7:35 AM] Bjørn Kay
Great question OLEG! Agree on Mark comments- closer knowledge about the needs is important to get a faster and more reliable ice info! also for SAR if necessary!

[7:38 AM] Alvaro Scardilli (SHN Argentina)
Oleg, great question! Swell forecast in ice-infested waters is a great issue to be include in METAREAs forecast. Ice accretion in ships, as NZ does, also a good idea. Visibility effects in pack ice maybe very difficult but also interesting, especially with help ops

[7:48 AM] Sean Helfrich

SAR wave spectrum algorithms are quite mature for the open ocean. This could be tested further to see of the algorithm works well along the MIZ

[7:49 AM] Marc DeVos
That would be good Sean. Many global spectral wave models simply mask out the suspected MIZ. This is a problem with up to 8 m significant wave height signals having been observed propagating far into the MIZ (in the SO during winter)

John Falkingham

There are a couple of good questions in the chat line related to the type of information that is available. For example, in addition to just ice, what about waves and swell information in the vicinity of ice and icebergs? Is that something you get? Do you need it? I'd throw that to the panel if anyone would like to respond.

Miguel Ojeda

Well, if I can answer, obviously, yes. In a rough sea, you cannot see the floating ice very well. So, more information is again better.

John Falkingham

Is that information available to you now?

Mark van der Hulst

Not always. Not always accurate. Not always timely. As I said earlier, we get as much information as is available and from that we make our best judgment. The more we get, the better developed is the judgment you can make. Is it workable now? Yes. Can it be better? Absolutely. That's the whole thing.

Alvaro Scardilli

What do you think about this? Is the officer of the watch on all ships familiar with ice products? Do they know about the color code and he egg code? Different interpretation of ice charts? Are they familiar? I mean, not only the captain or the first officer, but maybe the one that is doing the watch in the middle of the night. Is he familiar with what he has to understand from an ice chart?

Miguel Ojeda

I just say that they should. We don't want to have someone on the bridge who doesn't understand the ice information ahead.

Mark van der Hulst

I would agree. I can only speak from my own vessels but my internal procedures are such. Of course, people have to have the Polar Code basic and advanced qualifications. But we have internal company procedures where they will get an extra education. And they're not allowed to sail alone, unless they have gained the experience in real life because there's a difference between learning things in school and bringing them into practice. So, I would only hope that everybody understands them. I can only speak for my company, my vessels and my crew. That's certainly the case. I would say that's normal seamanship to do that.

CHAT LINE

Keld Qvistgaard (DMI)

Appendix H: Maritime Operations in the Southern Ocean

With reference to the Polar Code ships can be divided in to three groups, ice avoidance, operations near ice, operations ice.... creates very different ice information requirements. I would be happy to assist.

Alan Gross

I can speak for the ship, that I navigate. And yes, all the officers are able to interpret the ice charts and navigate in certain ice conditions. Of course, if it's a heavy ice condition or some difficulty, the captain will be on the bridge. But yes. Regarding with the codes that we use, for example, egg code, I think that it is a little bit tricky or difficult to understand. It's not so easy to interpret for a new officer - not the senior officer with several years of ice experience.

Penny Wagner

But right now, I'd like to ask about forecast ice conditions. We've talked a little bit already and it seems unanimous - everybody would like to have drift information. And everybody is familiar. Most navigators are familiar with looking at actual imagery and they prefer that, but when it comes to looking at the forecast ice conditions, what would you like to have in an ice forecast, and then, also, what period would be most important for you?

Alan Gross

The period can be always be better. In our case, the most useful data is the kind of ice, the quantity, and especially if it's growlers or bergy bits. That kind of ice is the most dangerous for the ship. The big icebergs are not a problem. You're going to see them on the radar. You're going to see them at night. The problem is the multiyear ice, the sea ice in heavy concentration and, especially in that concentration of ice, the growlers and bergy bits. So, a prediction and a good image or a good description if you don't have an image, of the ice situation I think is the most useful and in our kind of navigation.

Karl Røttingen

I agree with that and, of course, I also mentioned earlier that the forecast is to have accurate drift for these growlers. If it's a northerly wind and you have growlers coming up on the open sea, then it's better to know if you will meet the ice much earlier than expected. So, a good forecast. Also, there is a big difference in the ice pressure due to tidal currents and I don't think any model has that included.

Mark van der Hulst

I would agree with what Alan has said and what Karl said as well. Talking about time zones, it depends on where you are. If you are doing Western Peninsula in 24 days, 24 hours ahead is more than sufficient because it's a more open area. If you are doing a Ross Sea passage where you go into the Ross Sea and you need to find a way out, it's multiple days that you want to have the information on. So, it really depends but 24 hours, at least, is a minimum that you will want to have.

Miguel Ojeda

I want to add one more thing. Sometimes research vessels are not doing the same things as tourist ships, going from point to point. We need to stay on station for more than four or five or six hours, depending on the science we are doing. So, the continuous information about the sea and weather mixed with the ice prediction is really important when you need to stop in a certain position for hours.

Penny Wagner

So, we see that it's regionally dependent but various levels of short to potentially midterm types of forecasts would be helpful.

I really want to kind of expand on the user's, or the navigator's, competencies to understand information and their experience when embarking in ice encumbered areas. Alvaro asked if navigators fully understand the egg code in the ice charts, but what we also want to know is, are you confident that the majority of ice captains and navigators sailing in Antarctic waters are competent for polar operations? What we've heard all week is that there's a lot of variation in mariner training and the Polar Code. Just because someone has a certificate does not mean that they're fully qualified. Is this the case for the Antarctic as well? Or do you think that most navigators have full competency?

Miguel Ojeda

It is difficult to say. But I should say that we need to be confident in our people driving such big and expensive machines to do science. I can imagine some of our countries or national programs have less fully qualified ice navigators or captains. I think that is true that in the Polar Code, certificates and training are maybe poorly defined, but I have to believe that we are doing well. We are contracting the right people.

Penny Wagner

But if there's a single group that could be targeted for better training, could you say right now who that could be. Could it be fishing or cargo vessels or maybe non-research vessels?

Miguel Ojeda

I don't know. I can talk about research because I know that they're quite qualified. But we don't have the same pressure from companies. We are delivering science so maybe it is a different issue. If you are running a cruise ship, or maybe fishing, you have to (*inaudible*).

Penny Wagner

I would like to turn to Mark to answer that from the IAATO perspective because I know you deal with some pleasure yachts, as well as the larger Polar Tourism vessels.

Mark van der Hulst

Of course, I can only speak for the experience and knowledge of my own captains. I know that when I sent one of my captains to do additional courses, his status changed from student to teacher within three hours after the start of the course, because he had more knowledge than the person that was in front of the class at the beginning. I think it's a misunderstanding that there's a lot of pressure on the commercial vessels or the cruise ships that they need to go in the ice. We don't need to go into the ice. We only have a schedule where we know where we depart with the vessel and when we need to return with the vessel. What happens in between, is flexible and open. If we see ice conditions that we are not comfortable with, we don't need to go there. A lot of vessels in the IAATO fleet will avoid ice. If you talk about the larger cruise vessels, they have a routine or an internal procedure that they do not touch ice at all. So that's just open water navigation. The smaller yachts stay away from the ice. They're not built to go into the ice and they have even much more flexibility in moving around that the bigger vessels. I think the industry has proven that they do have the experience and knowledge. Many of them, including myself, have been participating

in the development of the Polar Code. A lot of input came from people with field experience. That was also something new within IMO where sometimes decisions are being made by people not having the in-field experience. I think we are good.

Alan Gross

I agree completely with Mark. We are the captains in the tourist industry in the IAATO fleet in Antarctica. We don't have pressure, or I don't ever feel pressure, from the owner to get into an unsafe condition for navigation. We have a departure date from Ushuaia and an arrival date. In the middle, it's flexible. I think that the Polar certificate is important and improved. It's very, very good. But you learn to navigate in ice conditions by navigating in ice conditions with a good captain and senior officers with experience. It's something that you're not going to learn in the class itself. You can learn theoretical things in class.

Karl Røttingen

I agree about today's situation but I am a little bit more concerned about the future. We see a lot of yacht and passenger vessel being built for expedition in Arctic and Antarctic. My concern is where will they get all the experienced people from? Because there are not many ice navigators. So, I'm a little bit concerned about the future because we see also in Norway and in Europe, there are a lot of pleasure and yacht and cruise liners being built especially for expedition in Arctic and Antarctic.

Penny Wagner

This is something that we're really trying to focus on. So, I would like to end this panel session. I really thank the panelists so much for all your input beforehand and during this panel. It was extremely helpful and informative for all of us. So, thank you.

CHAT LINE

[7:45 AM] Helen Beggs
So great to hear from the Antarctic ship masters and their experiences and needs relating to ice information. This is the first oceanographic workshop/conference I have attended where we have heard from ship captains! I have a question: If modelers can provide validation statistics for sea ice models using reliable sea ice observations would this be something that you would be able to use?

[7:59 AM] Phillip Reid
Helen - COMNAP held a nice workshop in Hobart a few years back where sea ice people and operators including ship masters attended. There is a report here: https://www.comnap.aq/documents/COMNAP_Sea_Ice_Challenges_BKLT_Web_Final_Dec2015.pdf

[8:02 AM] A.J. Reiss (USA - NOAA)
AGREE. The IICWG Panels with Masters/Captains of polar operating ships is so valuable to ground us in reality and to help us prioritize our activities. Recommend this kind of panel every IICWG or in between every IICWG. The exchange to them and from them would greatly inform and shape IICWG tasks and priorities.

Appendix H: Maritime Operations in the Southern Ocean

Presentation

Polar View in the Southern Ocean - Andrew Fleming (BAS)

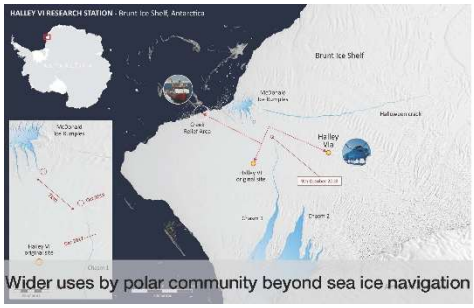
Hello, everybody. My aim today is to give an overview of Polar View in the Southern Ocean. Following some discussions last year, I think there's been some confusion around the role of Polar View, and what service it provides. So I've been asked to give an update on that and hopefully resolve some of the confusion and then prompt a discussion about where Polar View fits in the range of ice services and information, and in the Southern Ocean and available to all the Antarctic operators. I'm going to give you an overview of our origins and aims and our strategy.

Primarily, we came at this because we're running this from the British Antarctic Survey and we operate ships ourselves. The top photograph you can see two previous vessels and we're about to take delivery of a new vessel as well. Sir David Attenborough will come into operation within the next year. So, we're an operator of ships and we've been addressing this since 2004. Way back then, there was a relative lack of good information about sea ice conditions in the Southern Ocean and the aim was to address that need. We did it through extending an existing European Space Agency program called Polar View, which was focused on the Arctic but extended it into the Southern Ocean to determine what information could be made available. So, at that time, there wasn't a great range of ice charting information, some but not a huge amount. As one of the previous panelists noted, the situation has improved considerably. We aimed to pull together as much timely, near real-time, high-quality ice information into a single point of delivery and make that available to ships that were operating in the Southern Ocean and sea ice region. The primary driver, of course, is to support their safe and efficient navigation in sea ice.


Sea ice information contributes to safe and efficient navigation

As I said, that's the main reason we're coming at this from our point of view, and from a large number of other operators. We sit within COMNAP with the other national operators. One of the biggest cost items for our operations each year is the cost of operating the ship so we need to make that as fuel efficient and safe and efficient as possible. So, providing the best information to them supports that. That's a primary purpose but it's used for many more purposes beyond that. We know we have a very large user base for Polar View. We don't track individual users but we do keep an eye on various key statistics of what the use is. We know that there are at least a few thousand unique users per month. That clearly is beyond just vessels navigating in sea ice.

Appendix H: Maritime Operations in the Southern Ocean



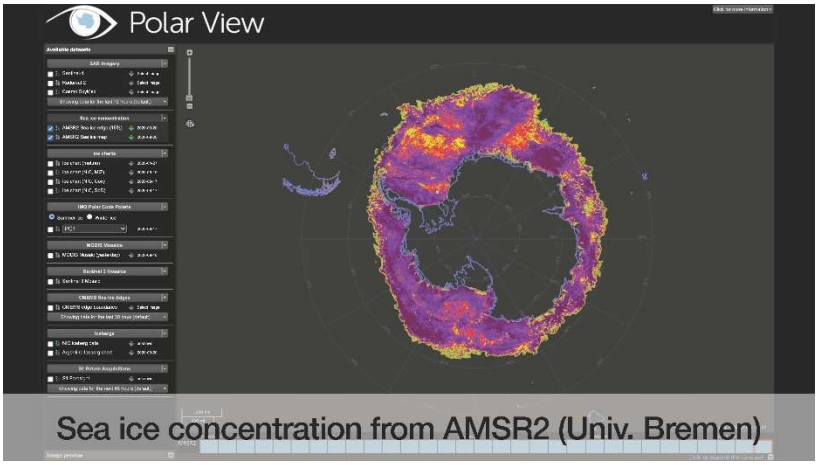
There is a wider community out there that's using the information that's being provided. I might point out one example that we use it for is monitoring ice shelves around the Antarctic and a lot of focus on large tabular icebergs that break off and drift into the Southern Ocean. We're very interested because we have a base that's sits on one of these floating ice shelves and, therefore, it's under quite a degree of monitoring. Information in a timely, near real-time basis helps with this. And we can then share that with others. And I know that Alvaro and I have been in conversation about this particular ice shelf because it might well affect both our station and the Argentine station. So, there is a wider user community well beyond just sea ice navigators.

Information access

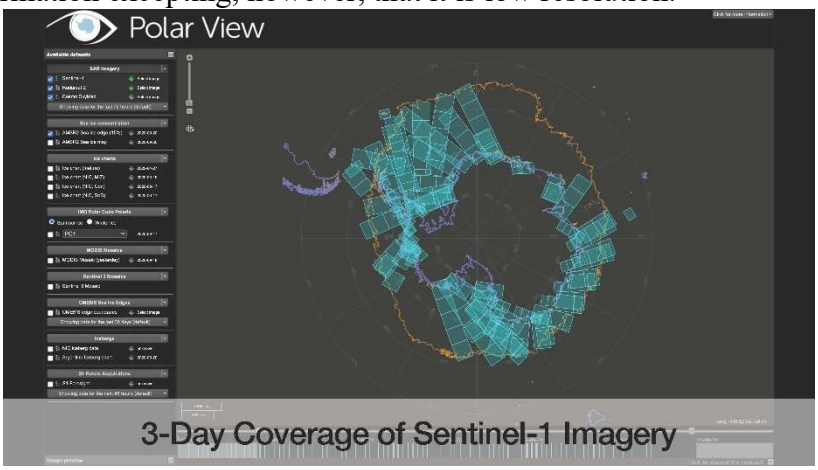
- Primary delivery via web portal at www.polarview.aq
- Arctic and Antarctic coverage
- High and low bandwidth interfaces available
- Also provide email notifications and delivery
- Maintain only recent information but archive is available
- OGC web services available

So, we provide the information that we collate primarily through a web portal and you can see the web address there Polar View.aq. For those of you that aren't aware, “aq” is the Antarctic domain, hence the weird extension. We provide this considering both high bandwidth that you might have access to, and also low bandwidth interfaces, which is the example shown here. This aims to address some of the limits in the communication. We all experience reduced bandwidth in large parts of the Southern Ocean where we have that available. Having an easy to use interface that doesn't require loading a heavy website is useful. But we also have routes to getting access to information such as email notifications that have been mentioned before. That means you don't have to sit around and refresh your website on a periodic basis. You just get a notification whenever a new bit of information is available covering your area of operation.

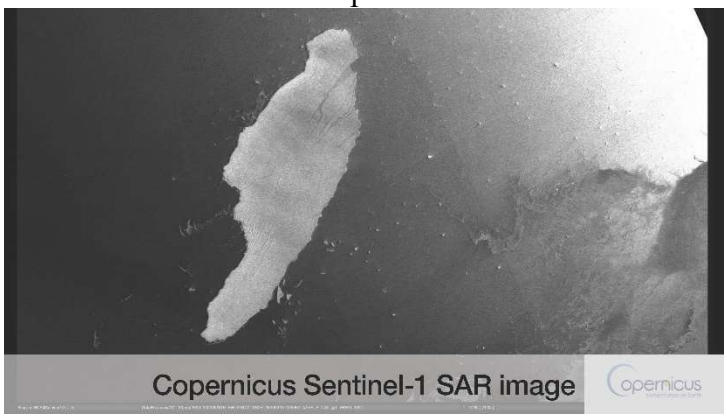
The main delivery is through this high bandwidth web portal, and it’s an interactive mapping portal. You'll be familiar with many examples like this. This one is focused on the Antarctic and with all the usual functionality of being able to zoom in and scale and pan around the map. It's through this that we provide a number of layers of information. I'll give you a quick walkthrough of what's currently available through the Polar View portal, starting off with one of the lower relatively lower resolution data sets that comes from passive microwave satellites. This provided by the University of Bremen and is the sea ice concentration data set. I know it's a slightly uncomfortable story for some in terms of the use of passive microwave for navigation but I've seen it used in quite a number of scenarios when nothing else is available. The captains have become incredibly adept at using whatever information is available to them and a large number of captains, ours included, are very used to using even low resolution information like this for planning routes through sea ice. So, this reliable, daily, complete Southern Ocean



coverage is a useful strand of information excepting, however, that it is low resolution.



But a key strand of what we process, and really the heavy lifting of the of the bulk of the data that we're processing on a near real-time basis, is the access to the Copernicus and European Sentinel-1 radar imagery. We do have the capability of delivering other strands of commercial SAR such as Radarsat etc. but the bulk of the routinely and openly available SAR imagery is the Copernicus Sentinel-1. This graphic shows you the individual frames that are acquired over the last two to three days. It doesn't cover the entire sea ice zone but we deliver everything that is collected in the extended wide and interferometric wide swath modes. The latency tends to be around four hours after acquisition, which makes it very usable by the ships in terms of an up-to-date picture. In terms of the coverage and where this imagery is acquired, that's not dictated by us. We don't have control over that. We're taking the imagery that's made available by the Copernicus program, as determined by the prioritization of the overall Copernicus high level operations plan. In total, we are turning around all of the imagery for the Antarctic and the Arctic as well, which amounts to about two and a half to three and a half thousand frames per month.



You need to look at this sort of imagery to see why it's so useful if you don't have very much information about the sea ice conditions. This sort of imagery is perfect for giving you a good understanding. Not only is it able to easily distinguish between areas of open water and sea ice, but it can also distinguish large bergs and smaller bergs. You can see the large A68 berg here that's just currently sitting off the edge of the sea ice zone. The ability to work in all weather conditions, regardless of cloud, and also during the polar night means that it has a huge range of capabilities in terms of giving a good up-to-date picture of the of the current sea ice conditions.

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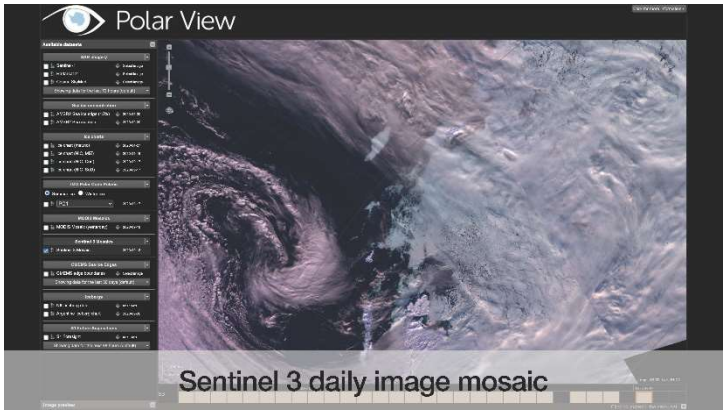
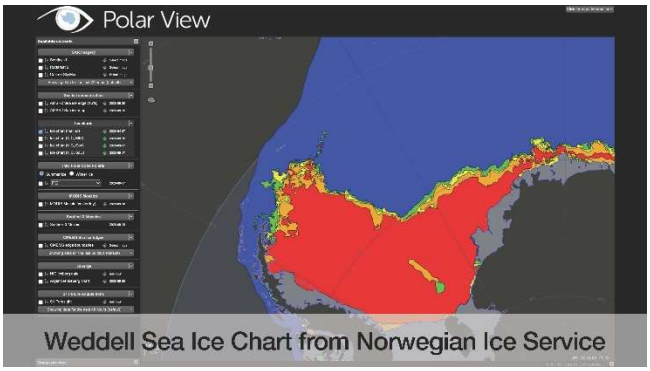
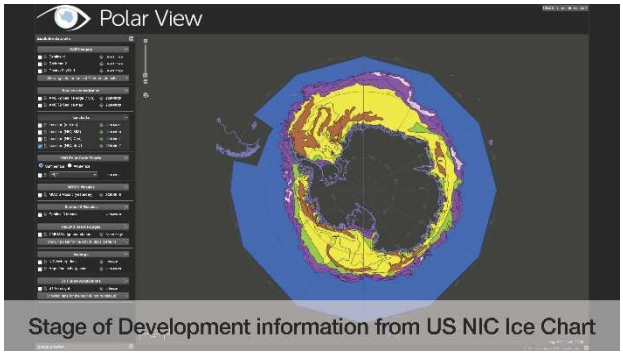
But, of course, even with clouds, optical satellite imagery is also highly useful. We produce a daily mosaic of Sentinel-3 imagery. An extract of this is shown here around the top end of the Antarctic Peninsula. You can probably make out the A68 berg again, just off to the left of the center of the of the frame there. These are produced on a routine basis and also made available through the portal.

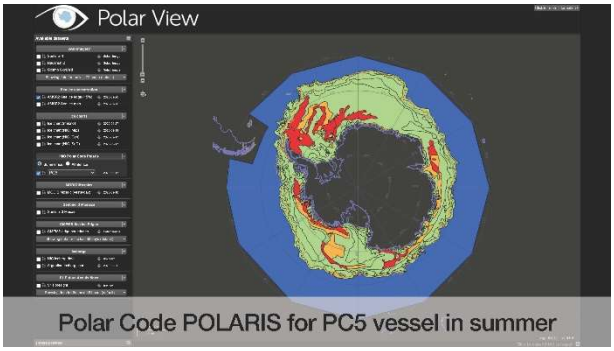


Satellite images that I have concentrated on so far are what we started off delivering because of the relative lack of other information. But the ice charts themselves are hugely useful and very important, especially since they provide the expert interpretation. Whilst Antarctic shipmasters become very adept at understanding the local conditions and have, in the main, large amounts of experience in understanding the sea ice conditions, and they're interpreting the satellite imagery and become very used to using satellite image sources such as passive microwave and radar imagery for making decisions, the expert interpretation that gets encapsulated in the sea ice charts is hugely important. So, we also make available through Polar View the charts where they're available. Starting off with the routine delivery from the Norwegian Ice Service of the Weddell Sea area, shown here. This is updated on a regular basis during the austral summer season primarily.





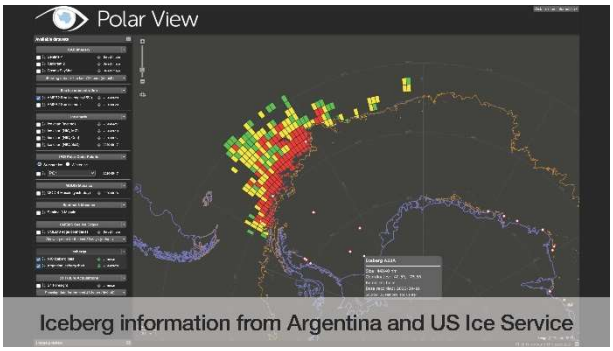
We also deliver the USNIC and Russian ice charts which provide both the sea ice concentration and shown here, the stage of development information that cover the entire Southern Ocean. For all of these ice charts, one of the major limitations is the frequency. They're produced on a weekly basis. As we heard during the preceding panel discussion some increase in the frequency of information is one requirement. Nonetheless, a combination of this expert interpretation plus, more timely satellite imagery is currently a powerful combination in terms of giving a picture to the ship captain.



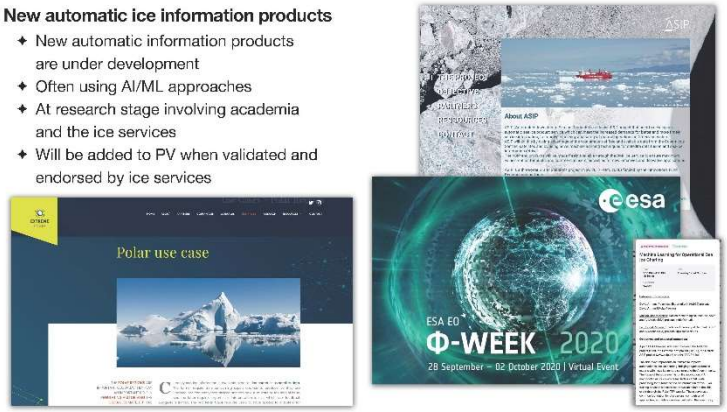
Appendix H: Maritime Operations in the Southern Ocean

One of the other strands of information that's been referred to previously is iceberg information. Previously, this was limited to the large tabular iceberg tracking information provided by USNIC but, more recently, we've incorporated the Argentine iceberg charts that Alvaro's team produces and they're now routinely updated and delivered. So, there is a good indication that where the information is available, and where we can incorporate it, we're really keen to make sure that as much of the ice service information is routinely and automatically provided through the Polar View portal so that we do move towards a place where there is as much information available at a single point of access.

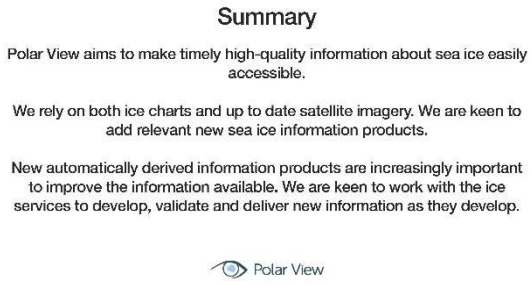
I should mention about the ice charts, and specifically the whole continent and Southern Ocean ice charts that provide both the ice concentration and stage development, is the ability to calculate the Polaris Risk Index. We now have this built into the Polar View site. So, in addition to having access to the ice charts themselves, a user is able to select the class of their vessel and also the choose whether they're operating in summer or winter conditions, which selects the Polaris risk indices, and get a colored risk output from the Polaris system for their vessel. We display here for a PC5 vessel from one of the most recent charts. It's probably worth mentioning, at this juncture, that there was mention of collecting information directly from ships. One of the most useful bits that's been ongoing the last few years is collection of observations and onboard Polaris observations such that they can be compared with the Polaris calculations that are derived from the ice charts, thus giving some input to any revisions to Polaris. Certainly, that's an active area of interest in making sure that any update or revision of the Polaris risk system is applicable to the Antarctic as well as to the Arctic where the primary focus is.



So, a quick comment on what I think is one of the areas where there's been some confusion and that relates to derivation of new automatic ice information products from the large volume of satellite imagery that's becoming available. Certainly, there's a huge scope for automatically deriving parameters from satellite imagery using a variety of novel techniques. A lot of the time options like machine learning and artificial intelligence can get bandied around. There's certainly a lot of development in that area and a lot of the time involving the ice services themselves, which is great. I've linked to two or three of them here with the Danish ASIP project. Norwegian colleagues are involved with us in the Extreme Earth project, bottom left, which is developing these sorts of methods, and the European Space Agency themselves are very focused on this. Their so-called Phi-week is coming up next week that provides an opportunity for bringing this sort of research together. There's a specific side event on machine learning for operational cis charting, during that event next week. But I think that the thing to stress from the Polar View side is that we recognize that these are all



in development, and rightly, in development by a range of experts from academia and the ice services. So, we're keen to use them. And we're keen to make sure that users get access to them, but only once the ice services are content that they are validated, properly QA'd, and endorsed by the ice services. At that point, we would start looking to make sure that they were routinely and easily accessible through a portal like Polar View.



So, with that, I'll conclude. But just to just to reinforce that our primary aim here is to be a single point of access for as much high quality and timely information about sea ice as possible. We're aligned both on the sea ice charts and on up-to-date satellite imagery in combination. That seems to fill the gap that there was. It's excellent to see such a large range of ice service products coming online and I absolutely reiterate comments from the previous discussion that it's excellent to see a coherency coming together from the Southern Ocean ice services and almost moving towards a Southern Ocean ice service that's rather coherent. And just to reiterate the point about any new novel automatically derived products, we want to work with the ice services to make sure that they are fit for purpose before they get any sort of primetime billing on services like Polar View and elsewhere. So, with that, I'll end. Thank you very much.

CHAT LINE

[8:22 AM] Alvaro Scardilli (SHN Argentina)
Thank you, Andrew,! Great presentation and hope you can continue adding data on the website

[8:22 AM] Bjørn Kay
TX Andrew Fleming - I use at least every polar code course one hour for presenting it as "one shop stop"! Like your comment according POLARIS! Do you have a youtube channel with tips and tricks...is also good for cloud sharing for preparing course participants in advanced?

[8:24 AM] Jamie Treleaven
Prime time viewing from polar view sounds pretty exciting and valuable. Make sure it is an ongoing operational service!

[8:26 AM] Alvaro Scardilli (SHN Argentina)
In our experience (Argentina) it was great to share our iceberg chart and the process was really smooth and PolarView people help a lot. And we can see that our product can be reach by many users. It is a great tool for ice ops

[8:27 AM] Alejandro de la Maza SERVIMET CL
is it possible that POLARVIEW covers the Patagonian Chanels with SENTINEL images for searching icebergs on commercial shipping routes?

[8:27 AM] Helen Beggs
Andrew Fleming - UKRI BAS Hi Andrew, great presentation. Would Polar View consider including sea ice model forecast images in future if they could be validated with in situ or satellite observations?

[8:29 AM] Jamie Treleaven
Task team is great idea for polar view

[8:29 AM] Richard Hall (RICHH)
John Falkingham it comes down to roles and responsibilities. What is the role of an ice agency, and what is the role of Polar View?

[8:34 AM] Alvaro Scardilli (SHN Argentina) (Invitado)
Richard, I guess that the difference is that for many many years PolarView worked, and continue, similar as an Ice Service, distributing ice charts and satellite imagery. It is great website developed for ops use, I think. Ice services have responsibility in the broadcast of the information, but one big difference with NH is that Antarctic waters have not sovereignty from a specific country and that allows this kind of excellent service

[8:37 AM] Richard Hall (RICHH)
Hi Alvaro, agree. Listening to the conversation there is confusion between the role of providing information, and providing access to ice information (tele-communications & satellite communications)

[8:38 AM] Greg Stuart
National Met Services still have some specific responsibilities for the Southern Ocean

[8:27 AM] Sean Helfrich
Do the other ice services see their missions as providing Level 1,2, or 3 imagery or products to customers as part of their mission? I think that Andrews talk suggests that having supplementary data along with traditional ice analyses helps to fill the time and spatial gaps that ice charts are challenged to provide.

Discussion

Marianne Thyrring

Thank you. That was a really nice presentation. One question has come up. Does Polar View serve data or only imagery?

Andrew Fleming

There's certainly a focus on imagery as being one of the main strands because, as I said, it fills a gap whenever there aren't frequent ice charts. The masters have become very adept to that. But in terms of data, I'm not quite sure what you're referring to when you're talking about the data. Is it data from, and the imagery itself or other sea ice data?

Greg Stuart

Imagery from the data and any uniquely Polar View produced products or services?

Andrew Fleming

In terms of the imagery, no, we don't. We produce portions of the imagery so you can download the geoTIFF images. That's easily accessible as one of the options but we don't link back to the original products and provide a backup. In terms of derived Polar View products, what we're driving are things like the daily Sentinel-3 mosaics and some other elements of the Copernicus Marine Service which are used for validation of the lower resolution products. The Polaris calculation is implemented on our side as well.

Appendix H: Maritime Operations in the Southern Ocean

Marianne Thyrring

Bjørn Kay is asking in the chat - do you have a YouTube channel with tips and tricks?

Andrew Fleming

I don't have a YouTube channel but that's a good idea. I'll rephrase it to reflect a conversation I had with John Falkingham at one point about better documentation of the strands of information that are available in Polar View. I think that's one thing that we could improve on, to provide better documentation about the limitations of the various types of information that are available through Polar View, such that it's not just one point access to the data and the imagery, but it's one point access to what information can I use for what and what are the limitations?

Klaus Strübing

I would like to thank Polar View for providing the SAR data because they allow me to present my paper for this meeting. Would it be possible to make smaller sections of the full SAR images to allow ships to get direct access and download the data for their area of interest?

Andrew Fleming

The short answer is, yes. We can set things up so that bits of imagery are being delivered. So, if you set up an area of interest that you're operating in and you request particular images, then there is an option for cropping the delivered product to the area of operations. So yes, that is possible. The other bit I would point you to is that one of the viewing options for the Sentinel-1 imagery effectively streams it online. So, if you've got an open connection to the Internet from the vessel, you can open this link. It doesn't download the full resolution image all in one go but it provides a cascading, scaling, lower resolution version of it allowing you to zoom in and only downloading the bits of imagery at the resolution that's required to display. We've used this extensively onboard a vessel even with a fairly poor bandwidth connection and it works rather well in terms of making a full resolution image available to a user on board. So that doesn't quite do what you're asking, but it's close to it.

John Falkingham

Andrew, you made it quite clear that Polar View wants to put new products, automated products on Polar View, but only after they've been validated or vetted by the ice services. Do we have a process set up to do that? How to how are you going to get validation from the ice services?

Andrew Fleming

That's a really easy one for me to answer because it's not for me to answer that. Surely, it's a question for the services to answer about how they're validating their products. Certainly, if there are requirements for it, we can help in terms collating local observations. Nick Hughes provided some excellent comments previously about plans for taking local observations and you mentioned an app to do that. We've certainly used local, onboard observations to help with the Polaris development. So, there are ways of doing that. But I'd love to hear from the ice services about how they would prefer to go about this.

John Falkingham

Sounds like a task team, or some kind of an action.

Andrew Fleming

Is there some investigation of periodic validation, using other sources of observation, whether they be shipborne, airborne, or some concerted airborne or drone campaign in localized areas to try and validate it? I don't know if the ice services already do that sort of thing routinely.

Penny Wagner

I know we're working on the Uncertainty Task Team and looking at this. We actually want to expand that to assess some of these automated products after this first session of the task team.

Andrew Fleming

Greg made a comment about the Global Ocean Observing System and the specific Southern Ocean Observing System initiative as well. There may be some role that can be played by them in this ground.

Neal Young

Andrew, given the community we have listening, and it's not just people that are active in Antarctica, or the polar regions for that matter, that there are limitations in the way we can get information. Basically, that is from the satellites, very, very severe limitations in some cases. We don't have geostationary satellites. So, we depend on the polar orbiting ones which go over at specific times of the day. Also, if you want SAR images, we're dependent on other ESA programming, or people paying. In terms of people asking for updated products more frequently, can you comment generally about the constraints that come into what you can provide through your site?

Andrew Fleming

You're referring specifically to limitations in Sentinel-1 coverage? Is that what you're driving at? Or more generally?

Neal Young

At two levels - one, the satellites typically go over at either,say, 10am in the morning, or 2, 3, 4 o'clock in the afternoon, or midnight; and two, the high resolution systems are heavily constrained by what's programmed to be acquired or paid for.

Andrew Fleming

You're very correct, of course, that there are orbital limitations. The way the satellites are set up so we only get observations at particular times a day. I cannot change the laws of physics and that's really the way it is, although it's interesting to see future plans for other constellations that might change the observation frequency. But we'll wait to see how that develops. In terms of the amount of imagery that those satellites can collect, then yes, they are not like other optical satellites that can be turned on all the time. They're very power hungry and, within each orbit, they can acquire for a total of 25 to 30 minutes. That's not all dedicated to the polar regions. We're competing with acquisitions around the rest of the planet. So, there is a very limited capacity and the Copernicus Program and the European Space Agency work very closelytogether to plan that capacity such that they get a maximum number of observations and satisfy a large number of competing voices. An increasing number of voices for "we want imagery here, please, we want imagery here". So, it's difficult and it's a hard sell sometimes for a relatively small, albeit important, community in the Southern Ocean. But with more satellites coming on board, hopefully we can maintain, if not

increase, the coverage we have at the moment. I think one of the best things that the Copernicus program has done in recent years was to say we can't deliver everything. That's not possible. At the very least we have an operational satellite that's not changing its acquisition plan all over the place. It's fairly stable and regular, and it's free and open access. Nobody has to pay anything or worry about any rights to use it. It's a great position to be in to make the most out of this sort of imagery. Of course, if the coverage doesn't suit everybody and people remain very frustrated by that, then they can either launch a satellite or go and buy something. Those are the only options available at the moment. Frustrating, but those are the facts.

Russ White

A question for you, Andrew. From the previous panel we heard some of the needs for information and the lack of satellite coverage. Obviously, we hope that satellite coverage improves and there's more observations but do you see the role of the ice services to bridge that gap by providing some kind of outlook or risk-based forecast – products to bridge the gap between satellite observations?

Andrew Fleming

That that would be a great scenario. In terms of information products that are currently not operational or are not routinely available, then forecasts certainly came out of the panel discussion - sea ice forecasts and iceberg forecasts and drift forecasts, as discussed yesterday as well. So that would be an excellent option if we had to limit, at least for the time being, to the range of observations that we've got. Certainly, there is scope for discussing optimizing coverage with the Copernicus operators, but bridging it with a forecast product. Yes, absolutely.

Russ White

Perhaps we could hear comment from some of the ice services heads on that issue in terms of the need to expand the availability of products from the services in the southern oceans. On bridging that gap between ice charts and satellite observations. Some comment from some of the some of the ice services of their view?

Nick Hughes

Yes, certainly, there's a role to increase the amount of information provision. At the moment the Antarctic and Southern Ocean is not really treated as a separate region here in Europe by things like Copernicus. So, there's a lot more scope for developing the provision new automatic products or better forecast models. From an ice service point of view, to use those we'd have to do some validation, either against observations from shipboard programs or inter-comparisons. I think there's a lot of scope for continuously generating automatic metrics between the different products available, including ice charts, so that we get a good idea as to how well automatic products are performing against human analysis.

Andrew Fleming

Can I make one quick comment in response to one of the points in the chat, which was made by Richard Hall originally and Alvaro replied, about being able to provide a service like Polar View in the Antarctic, which is not complicated by territorial issues and therefore an integrated view like this works. I would point out that there is an Arctic version of the website which operates just as routinely and provides everything else in the same place which is one of the huge advantages to open access data. That sort of initiative makes sharing and availability of information like this

significantly better and, therefore, much safer for vessels that need access to it because we're not trying to worry about access permissions.

Russ White

So perhaps I could actually pick on any representatives from BOM on the call. I see Jan's on the call, perhaps we could hear a perspective from bomb on where they see this issue.

Jan Lieser

Not entirely sure if I'll be able to respond. But I totally agree with everything that was said before. We are in a fledgling state of an organized service. There are some territorial and legal responsibilities for Southern Ocean safety of life at sea and METAREA provision of information. It's a great space to collaborate. I've actually been talking offline with Alvaro and we have some initiative trying to get the Southern Ocean limit of icebergs as well. SAOCOM Antarctic is up and running. Andrew Fleming as part of that as well and the Norwegian Ice Service. This is a spin-off of the IICWG if you wish - not an official IICWG task team. We've been looking at it as a collaborative effort. Going around circum-Antarctic to produce ice maps is certainly the way forward but it's a vast ocean. It's a big area and doing it one by one for the entire ocean is not feasible. I think collaboration is key.

Søren Olufsen

We occasionally do services for the for the Southern Ocean towards Antarctica. But there we have observation directly on the ship. So, I really don't feel comfortable commenting on the general problem for the whole Ocean.

Greg Stuart

There are responsibilities that we have, under the World Meteorological Organization for warnings, for advice, around high seas that do extend into the Southern Ocean. I think we're probably in a state similar to South Africa, in terms of our current status for ice services in particular. We are definitely on a trajectory to improve the quality of the services. We need to bring in people like Jan to increase our capacity to deliver those services and the numbers of people from the Bureau wanting to get involved in this particular group to be able to build those skills in understanding what's required is a sign that we want to grow our capability. We want to be able to do that in collaboration with all the services around the Southern Ocean. Antarctica is quite a unique environment to be able to do this in and to do it in collaboration with all of the countries that are active down there is the way that we want to be able to grow our capability in that space.

Marianne Thyrring

I think that the panel really gave us gave us good input on how to bring ourselves from where we are today to Buenos Aires next year. I think it was stated quite clearly that more information means more safety. It was also stated very clearly that we have situations where some days there are no data at all, which is obviously a problem. It was also stated, by the users of course, that they call for more and better - a better presented product is the wish list of our users. They also call for real-time information. Of course, this is a lot for us to cope with as the International Ice Charting Working Group. Apparently, and probably not surprisingly, what our uses today call for in the Southern Hemisphere is exactly the same as what they called for in the Northern Hemisphere. I think we should try to break some of these wishes down to something more concrete to see if we have people who would like to join the efforts to improve what could be presented for the users in

the Southern Hemisphere. I heard ice forecasts together with weather. Ice drift was mentioned a lot. The kind of ice conditions, bergy bits and growlers was mentioned as well. So, would anyone like to comment on how could we try and discuss something which we could develop in the next before we come to Buenos Aires?

Jurgen Holfort

What I see is that we should have daily products. If you look at the METAREAs in the North, there are daily products. The daily product is only the ice edge. It's would be a good idea to have it also in the Southern Hemisphere, which we ought to try. But also, in the discussion, it was much more than an ice edge. If the ships want to go into the ice, they need more than an ice edge. And clearly, if you have a METAREA coordinator, you have to deliver something each day – an ice chart or an ice edge. And you have to do it even if you don't have information. It is also like that for weather prediction – produce information even with missing data. But it's a really a big task. It would be nice if we, for next year, could have an ice edge for the Southern Ocean.

Marianne Thyrring

I think you are suggesting something which is interesting. I know that the way you eat an elephant is by small bits. You can't swallow a whole elephant and, of course, the Antarctic challenge is at least one elephant, probably more elephants. So, I think if we want to show that we can improve, we should be able to choose a few places. Maybe Alvaro could help us to prioritize where would it be most important to put our efforts?

Alvaro Scardilli

I agree with Jürgen that an ice edge daily product is achievable. For example, the USNIC does a daily product for the marginal ice zone. But I believe that it's achievable for collaborative products in this scenario for the entire Antarctica. As we were mentioning in the chat, maybe we can have a very frequent update of the products if we start collaborating better between ice services. We have some ideas, as Jan mentioned - the Southern Ocean limit of known icebergs that we started talking about among a few of us and there are some other ideas, of course. A.J. also mentioned that in the chat. So maybe we should focus on a better collaborative product but something that is realistic. I mean, if we want to start doing ice charts or any kind of product and we go with a very big objective, we are going to lose it. So, to be realistic, we want to have a very specific marginal ice zone like Chris Readinger mentioned in the chat. They use NC marginal ice zone daily products. We want to collaborate between other services to separate the task between us. Let's go to a very pointed objective and start working on that for example. We are going with these iceberg limits and trying to do a very specific task - not to go to a huge area.

The last thing is that Jürgen said, if the ship wants to go into the ice in the Antarctic Peninsula or East Antarctica or for the logistical operations of each country, we have to give them a specific products, not only concentration, but also stage of development. Very precise ice charts. We now have two more satellites we can use to cover Antarctica - SAOCOM. I had a meeting a couple of weeks ago with Constanza and the people of CONAE our space agency. They want to increase the amount of imagery in Antarctica and expand the broadcasting of this imagery. We also mentioned the chance to talk with Polar View to maybe add this kind of imagery on their website. Of course, a lot of coordination must be done. They space agency also said that they can create something similar in their own web page so you can link it to other websites. There are a lot of things we can

do to increase SAR imagery in Antarctica and this will allow us to have better products for all of the ice services. But we have to be very realistic on what we want to do - very specific.

CHAT LINE

[7:43 AM] Richard Hall (RICHH)
Hi, do you agree or disagree?
A weather forecaster has to deliver a regular forecast, regardless the quality of the input of the data.
It is the responsibility of the weather services to transmit the forecast to the user.
It is the responsibility of the user to have the communications equipment to receive the information
It is not the responsibility of the weather service to provide the communications link
[8:25 AM] jennifer
Folks - John Parker doesn't have chat - so I am going to add his thoughts on various topics - worth a look:
I have answers to Richard Hall's questions but I don't know I should take time over the meeting to answer them. Here they are:
1.A weather forecaster has to deliver a regular forecast, regardless the quality of the input of the data.
Weather Services are committed to issuing forecasts regardless of the data at hand. We are used to interpreting complementary and conflicting data and making approximations based on our science in those zones with reduced or no data. Through WMO publications Weather Services have committed to at least two regular issues per day for marine weather.
2) It is the responsibility of the weather services to transmit the forecast to the user.
Depending on where the weather service sits within its government this answer may differ. In the least it is our role to enable dissemination. Meaning we prepare our information to standards that can then be delivered through the maritime authorities and other through various channels. Some services do operate their own dissemination services (web, apps, VHF, phone, etc.). If a weather service is responsible for a METAREA, then ensuring dissemination through INMARSAT, HF or soon to be added Iridium is a requirement.
3) It is the responsibility of the user to have the communications equipment to receive the information
Under SOLAS (Safety of Life at Sea) there are requirements for ships of a certain size to be capable to receive weather and ice information in the marine environment. Any of our mariners joining is at this meeting could explain that better than I could.
4) It is not the responsibility of the weather service to provide the communications link
Not specifically in all cases. See my answer to 2).

John Parker

I wanted to comment on Jürgen's comment with regards to METAREA responsibility. Absolutely. I sit as a member of the Worldwide Met-Ocean Information Warning System. That group manages the METAREAs and our contributions from our weather and ice services. At a minimum, we are looking at ice edges in our threat areas where ice is present. Iceberg information can also be included such as an iceberg threat limit, as we see in the northwest Atlantic. Other information can be included. We include ice concentration within the marine zones that we've defined within the METAREA. But, if you wanted to pick a single task to move forward on, at least having that ice edge in all of the Southern Ocean METAREAs, would be a good objective to achieve within the coming year.

Marianne Thyrring

Thank you, John. We're not going to vote on this but I can hear that improving on ice edge would be something we could look for. That was one thing. And another thing that Alvaro and his colleagues in the Southern Hemisphere should deal with is a closer collaboration between local

and regional entities and agencies. But of course, if there's anything we can do to help, I'm sure everybody would like to do so.

Klaus Strübing

Yes, to some extent, we need to know about the ice edge. But, with respect to safe navigation, we need to know about the ice dynamics. That's a very critical factor for navigation in ice. We have the wind fields and perhaps from that, we could derive direct formation on the main areas of converging and diverging.

John Falkingham

Listening to this morning, Alvaro's presentation on the information that's available and then the very useful panel discussion from mariners on what they need and what the gaps are between the two, a couple of things came out to me. One was frequency. It's already been mentioned and maybe something the IICWG could facilitate is a kind of coordination group among those organizations that are producing information in the Southern Ocean with the objective of increasing the frequency and perhaps the number of areas that are produced. So instead of everybody producing a weekly chart on the same day, let's just coordinate and try to share the workload. That might be one area that we could work out over the next year. The second big thing that came out from the mariners is forecasts. They're pretty satisfied with the current information they have. Between what's available from the ice services, what's available from Polar View, they're pretty happy with the state of knowledge of the ice right now. But what they really are missing is what it's going to be like in 24 hours, or perhaps a little longer. That's what they want – forecasts. Tied in with that is ice drift. If they can get some knowledge of ice drift, they can make their own forecasts of where the ice is going to go. To me, that's a big gap that needs filling. That obviously involves much more than just product development. There are modelers needed. There's also been a chat going on in the last couple of days among the modeling community and what I'm hearing is from Australia and South Africa and elsewhere, is "hey, we want to work together". So maybe there's an opportunity where the IICWG could perhaps facilitate some kind of a collaboration group among the modelers. So that's something I look forward to. The last thing is the business of an ice edge. In the Southern Ocean, that's not just a sea ice edge, such as the marginal ice zone product that the NIC produces. What's really important is where are all those bergy bits and growlers? How far north are the small bits of dangerous ice drifting? And I think that's an area that that could really benefit from some coordinated efforts among the Southern Hemisphere ice services. The concept that we used to call the North Atlantic Limit of All Known Ice is, to me, the idea of national service. We want to provide the knowledge of where the ice is so you can avoid it, period. I don't want to go anywhere near ice so just tell me where it is so I can stay away. That's a basic public service. If you want to go into the ice, well, then you need more information and you better be prepared to do some work to get it.

Marianne Thyrring

Thank you, John. I think you are almost making a package and something which we will have to discuss a little bit in the coming days. Before we have our final meeting where we set up the tasks and task teams for preparing our meeting next year. So please, people, do think about what John just said a coordination group to focus on forecasts, ice drift, ice edge, bergy bits, and growlers. Is that a package? Or is it one, two, or whatever packages, and who would like to be part of a task team or coordination group which could deal with these things?

I think we have spent our time now and we are at a close of this day. I just want to thank everybody who's participated. I want to thank Alvaro for a fantastic presentation. This gave us a really good overview. Penny for running the panel so well and all the users - thank you so much for present to us the difficulties of using the information we deliver and telling us where to focus our work in the years to come. And thank you, Andrew, for presenting to us, the Polar View and your promise of further collaboration with all of us. Take care and see you tomorrow. Thank you.

Sidebar Discussion

Neal Young

If I can throw a comment out. I think there's at least three different threads in what you mentioned. The furthest north ice is a data collection activity. sea ice edge is a data interpretation activity and how to coordinate it, and modeling is a completely different community all together.

John Falkingham

I'm not sure but I think the furthest north ice is more than just data collection. It's also modeling.

Neal Young

Yes, but we need to collect data as well. There's no systematic collection of where ice is outside the sea ice edge.

John Falkingham

Right. And that brings a good point that Richard Hall, I think, first made a couple of days ago about the involvement of the operators out there in providing information back to the services in a systematic way. I know the services get all kinds of reports back, particularly about icebergs in unusual locations, but it tends to come in an email or a text message or something like that, that comes from a ship and it's not formatted and sometimes it's confusing. It doesn't come at the right time so it's very difficult for the services to gather that information together in a systematic way. Maybe one thing we could perhaps do is get the Volunteer Observing Ship program that WMO operates, to be more active in gathering ice reports in a systematic way,

Neal Young

Yes. I've struggled with that myself, even just simple iceberg observations from Australian ships. There was a Norwegian program run by the Polar Institute that worked moderately well. But it's flagged. It's now I think, defunct. There's there was Petra's thing with ASPeCT. And there's the northern hemisphere counter to that, which Nick referred to. We tried to do ASPeCT with some of the fisheries people and they really struggled with the way that worked. There needs to be a good look at it from people who are in the field to make it easy and tractable and practical. More than somebody sitting back here saying, here's the data we want and here's a system to record it in.

John Falkingham

I had a question in my head for the ship drivers on the panel but we ran out of time. My question would have been to them - How onerous is it on your bridge team to make systematic ice observations and send them back?

Neal Young

Well, I heard an offer from Alan and I sent a message to Alvaro saying, hey, we need to take this up.

John Falkingham

Yes, exactly. I wanted to expand that offer to the rest of the folks there. My feeling is the panelists we had are very engaged with ice information and they would be quite happy to do so. It's all of those other folks who are driving ships around, whether south or north but particularly south, and who basically don't go anywhere near the ice. They don't want to but every once in a while, they might see an iceberg or a bit of floating ice or something and it would be good if they reported that. It's also valuable if they report no ice, like there's no ice in sight because that can be factored into the products that the ice services put out.

Jan Lieser

I think we should look at smaller chunks. We've been looking for example, at SOLOKI, we call it the Southern Ocean limit of known icebergs. We have a lack of data collection and that, for example, ESA's Copernicus Program has us more or less at the sea ice edge and we know that icebergs drift much further than that. So that's the data collection problem to provide a trustworthy product to the maritime community. And that's something we, as small sub-team, would like to investigate further.

The other question was iceberg modeling. This was in a fledgling state within the bureau. We have a rather large community that is interested and curious about and wants to do some sea ice modeling. But, again, it is a product in development and nowhere near an operational service delivery yet. That said, I guess there's a huge scope for collaborative efforts between the South Africans, Argentines, Chileans, Kiwis and us.

Neal Young

Yes. I'm hoping Greg will take up the running now in contact.

Klaus Strübing

Iceberg or glacier ice limit in the Southern Ocean, I think it's very necessary to have the information. But I think it would be a very general limit because if you are looking for growlers or small pieces of glacier ice, there are hundreds of pieces of ice showing up in a SAR image. So, it must be more generalized limit. With respect to the modelers, I think, yes, we are talking on that problem since this group was founded to try to get people together and to get operational models involved. I made a comment yesterday that we should have forecasts for 12 for 24 hours. Our ice charts are, to some extent, historic ice charts. That should be one of our topic issues for the next year.

John Falkingham

I don't disagree at all. Obviously, to produce a forecast ice chart, I don't know that there any Arctic services that actually produce a forecast ice chart. They produce forecasts. Developing that in the Southern Ocean, maybe it's easier because you're starting from nothing. but you're also behind the eight ball because you don't have the experience of a lot of the Arctic services.

Appendix H: Maritime Operations in the Southern Ocean

Jan Lieser

But it was interesting to hear the mariner's perspective that kinematic fields are the most important ones. Where the ice is converging and diverging and I've been trying to hammer this message across within the bureau here for forever.

John Falkingham

Well, I think that's one of the things that the IICWG can do. With the report from this meeting, for instance, we can say, we had this panel of experienced people who drive ships in the in the Antarctic and here's what they say they need.

Neal Young

In the discussion there was mentioned of drift. But what is it that they're trying to learn from drift? There are two aspects, the one that Jan mentioned, which is often not referred to, and the other one is a lateral displacement of the icefield overall. So, if you're looking for a lead, it's moved. But if you've seen that wind field coming in, there's going to be convergence in your icefield then you don't want to go in.

Helen Beggs

I've been eavesdropping with great interest to take it back to my colleagues who are the ocean modelers and say this is what people say they want. But we are, as Jan said, in very, very early days. But don't underestimate us because we started the Blue Link project doing ocean modeling back in 2003. I've been involved right from the very beginning and we've made huge strides since then. This is going to be a version four. We're going fully global which means we have to include sea ice. And so, we have to predict sea ice. Whether it's going to be accurate or not, I don't know. The problem is going to be to get the validation data so that we can ground truth it. I am an observational scientist, so I'm most interested in getting data that is as accurate as possible that we can use to validate our model.

Appendix H1: Session 5 Background Paper

This session is intended to set the stage for a face-to-face meeting in Buenos Aires in 2021. The time is very tight and so we have streamlined it as much as possible.

The session opens with an overview of the Southern Ocean ice information currently available from the national ice services. Alvaro Scardilli will seek input from the other services to prepare this overview. Next, we will convene a panel of users of ice information to provide their views on what is needed and what is missing. At 40 minutes, it is recognized that the time allotted for the panel is extremely tight. Following the panel, we have allocated 40 minutes for Andrew Fleming to comment on the panel observations, to present Polar View and conduct a discussion on its role in providing ice information in the Southern Ocean. The Polar View portal is used extensively by Antarctic mariners and is an important piece of the whole. The session is wrapped up with a 20-minute plenary discussion led by the co-chairs to identify some tasks that can be undertaken to help maximize our productivity in Buenos Aires next year.

Panel Discussion

Panel member bios will be provided in advance to reduce the need for lengthy introductions. Each panelist should be given 2-3 minutes to introduce their views on what ice information is needed and what is missing. Following that, the moderator will direct prepared questions to the panel and

invite questions and comments from the audience. Experience with virtual meetings suggests that it is important to direct questions to individuals rather than making them open to all – while still allowing others to chime in. We will use the chat function of the videoconference software to field questions and comments from the audience. An assistant to the moderator will be charged with monitoring the chat and bringing them forward.

Moderator: Penny Wagner (Norwegian Ice Service)

Panelists:

- Mark van der Hulst (IAATO)
- Miguel Angel Ojeda (COMNAP)
- Capt. Karl Robert Røttingen of RV Kronprins Hakon
- Capt. Duke Snider (Martech / NI)
- Capt. Alan Gross of MV Ushuaia

Prepared Questions

Following are sample questions that could be addressed to the panel:

1. From your own experience and that of other ice navigators you know, what is the most widely used and reliable source of ice information in Antarctic waters? Why?
2. Are you confident that, when approaching icy waters, you will have reliable and accurate ice information available? Are there specific areas, where information providers should aim to have more frequent coverage?
3. Does the ice information currently available give you everything you need to know about the ice? Are there ice characteristics that you wish were better described? Is there sufficient information on the distribution of icebergs for your decision making?
4. Most ice information currently available publicly describes current or past conditions only. Would you like to have forecast ice conditions? What forecast period would be most important to you?
5. Are you confident that the majority of ice captains/navigators sailing in Antarctic waters are competent for polar operations? If there is a single group that could be targeted for better training, what would it be? Fishers? Cargo vessels? Yachts?
6. Can you identify one activity that the IICWG could undertake with its member ice services that would make a measurable improvement in the safety of maritime operations in the Southern Ocean?

Summary of Polar View service in the Antarctic (www.polarview.aq)

Polar View in the Antarctic was developed as part of the wider ESA funded Polar View activity in 2004. At this time there was very little up-to-date information available to ships about Southern Ocean sea ice conditions. Access to timely satellite imagery and passive microwave sea ice concentration data is very useful to ships operating in this region to augment the ice charts that are available. Polar View aims to make timely and high-quality ice information available to ships at a single point of delivery. BAS has continued to operate the Polar View service to support its own ships which operate in the Antarctic and to make useful information available to the wider Antarctic community.

It is the policy of Polar View to provide up to date imagery and information which is of known source and quality. We do not provide 'non-authorized maritime information' and all higher-level ice info provided through Polar View is from the ice services – e.g. Norwegian, US and Argentine

ice/berg charts. We are supportive of developments currently underway by the ice services and others to develop new ice information products, but would not make new ice information products (e.g. derived from novel AI/ML methods) accessible unless they were validated and endorsed by a recognised ice service.

Polar View is keen to work with the ice services and IICWG to ensure high quality ice information is made available to a wide audience of maritime users in the Southern Ocean.

Appendix H2: Session 5 Bios

Penelope Wagner

Penny is a researcher at the Norwegian Ice Service in the Division for Forecasting in Tromsø. She works on the validation, evaluation, and assists with assimilation of remote sensing data products for operational use and to aid in sea ice monitoring and forecasting. She has been involved in integrating stakeholder and end-user needs to improve the accuracy of sea ice products for navigational safety and for use in research as supplementary data products.

Alvaro Scardilli

As Lieutenant Commander in the Argentine Navy, Alvaro is Head of the Argentine ice service and Navy weather service, both units of the Naval Hydrographic Service. He has a degree in atmospheric sciences from the Buenos Aires University. His work is mostly focused on the development of products related to ice and weather for mariners in the South Atlantic Ocean and Antarctica. He is the representative for Region 3 (South America and the Caribbean) in the Global Ocean Observing System and the Joint WMO-IOC Collaborative Board. Alvaro has operational experience after several Antarctic cruises on board Navy ships during summer logistics operations. He also directs and co-directs research projects concerning ice and marine weather climatology and satellite imagery interpretation for sea ice and icebergs.

Miguel A. Ojeda

Miguel (Miki) (Gran Canaria 1966) has a degree in Marine Sciences from the University of Las Palmas de GC. In 1999 he joined the Marine Technology Unit in the Spanish National Research Council. Since 2005 he has been responsible for the coordination and logistical planning of the Spanish Antarctic campaign, designing and planning the schedule of the Spanish infrastructures (research ships and stations).

Appendix H: Maritime Operations in the Southern Ocean

For years, he has participated as Spanish representative in COMNAP (Council of Managers of National Antarctic Programs) where he is the Marine Platforms Expert Group leader.

Karl Robert Røttingen

Karl Robert has been a mariner since 2003 including Coast Guard patrols in the North Sea and Barents Sea. He captained the research vessel Dr. Fridtjof Nansen around Africa and Asia before becoming captain of the new Polar Class research vessel Kronprins Haakon following the vessel as on-site manager during construction. He has spent one season in Antarctica.

David (Duke) Snider

Duke is the CEO and Principal Consultant of Martech Polar Consulting Ltd, which provides global ice navigation services and support. He is a Master Mariner with 40 years at sea, operating many vessels in a broad variety of ice regimes in Arctic and Antarctic Polar Regions, the Baltic, Great Lakes and Eastern North American waters. Retired from Canadian Coast Guard service, he remains active at sea, holding the Polar Waters Advanced Certificate of Proficiency and The Nautical Institute Ice Navigator Level 2 Certification. Duke has authored numerous papers on ice navigation. The second edition of his authoritative book "Polar Ship Operations" was published in 2018. He is immediate Past President of The Nautical Institute and chairs the Ice Navigator Working Group tasked with administering The Nautical Institute's global standard for Ice Navigator Training and Certification Standard.

Andrew Fleming

Andrew Fleming is the remote sensing manager for the British Antarctic Survey, providing access to satellite data for a wide range of uses to support BAS science and operations. He established the Polar View Antarctic sea ice information service which has been operational since 2004, delivering timely sea ice information to maritime, science and other users. He leads BAS activities in related European Space Agency and European Union projects including the Copernicus Marine Environment Monitoring Service.

Mark van der Hulst

Mark has been actively involved for some years in IAATO, currently serving as chair of the Executive and Marine Committees. Mark spent most of his life working aboard ships or within the maritime industry. He served in the Royal Netherlands Navy for over 13 years and the Royal Netherlands Air Force prior to that until, by coincidence, he became involved in shipbuilding. Mark currently holds the position as COO of the Oceanwide Expeditions

group and works and lives in Vlissingen, The Netherlands. With his maritime background Mark is involved in the development of the Polar Code and related polar maritime issues and has participated in various sessions at The International Maritime Organization (IMO) Polar Code meetings in London.