

Summary from the Automated Products Discussion Session

INTRODUCTION

This panel discussion was moderated by Marianne Thyrring. The panelists were:

- Dominique Obaton (Mercator Ocean)
- Jørgen Buus-Hinkler (DMI)
- Juha Karvonen (FMI)
- Frode Dinessen (Met Norway)
- Andrew Fleming (BAS)
- Keld Qvistgaard (DMI)
- Nick Hughes (Met Norway)
- Mike Hicks (IIP)
- Sean Helfrich (NOAA)

Additionally, Pierre Bahurel, Director-General of Mercator Ocean, gave opening and closing remarks.

BACKGROUND

As the impacts of climate change have become evident over the past two decades, many organizations have invested deeply in the development of automated processes for monitoring ocean phenomena, including sea ice and icebergs. Excellent scientific work has been done demonstrating promising results for automated monitoring of ice parameters. To publicize and help derive commercial and/or societal benefits from their achievements, many of these organizations are making their automated ice information products available on the Internet. Some products are generated on an operational basis and are available freely to users. For example, see:

1. Arctic Ocean Sea and Ice temperature and sea-ice-concentration available at http://marine.copernicus.eu/services-portfolio/access-to-products/?option=com_csw&view=details&product_id=SEAICE_ARC_SEAICE_L4_NRT_OBSERVATIONS_011_008
2. Polar View Arctic sea ice concentration browser at <https://www.polarview.aq/sic/arctic/>

At the same time, Ice Services around the globe are striving to stretch their finite resources to meet ever-growing user demands driven by the same climate change impacts. To do so, they have been turning to automated products in various ways and with varying degrees of success. Although they are all working on methodologies to bring automation into their workflows, no national Ice Service has yet found a fully automated solution sufficient for the safety of maritime operations in ice-infested waters. All ice analysis and charting products are subject to some level of human ice specialist scrutiny and validation. Ice Services are actively working on

understanding the appropriate level of human-machine mix in the production workflow to ensure maritime safety.

While many of the automated products that have been developed have demonstrated quality and utility for specific purposes, Ice Services have so far found them generally inadequate to support maritime operations. For example, automated ice concentration charts may be perfectly suited to climate monitoring or numerical weather prediction applications, but are lacking in resolution for maritime operations.

This has led to two issues of concern to the International Ice Charting Working Group:

1. Despite the significant investment in the science and technology of automation in ice monitoring, the benefits have yet to be realized by the operational Ice Services. There appear to be systemic barriers to the uptake of the advancements into the operational production chains of the Ice Services.
2. The free availability of automated products may lead to their inappropriate use by ship-routing companies or by mariners themselves without a complete understanding of the product limitations. If the limitations of a particular product are not understood by the mariner, it could lead to hazardous, potentially catastrophic encounters with floating ice. Ice charts and other ice information products provided by the national Ice Services are validated by trained ice specialists and follow international standards. Users can obtain expert assistance with these ice charts on a 24/7 basis through dedicated maritime authorities familiar with them.

The purpose of this panel discussion was to explore ways that organizations developing automated products, such as the Copernicus Marine Environmental Monitoring Services (CMEMS), can work more closely together with the national Ice Services on improving automated results for their mutual benefit and that of the maritime public.

INTRODUCTION BY MARIANNE THYRRING

Director-General, Danish Meteorological Institute / IICWG Co-Chair

We have learned a lot of lessons in the sessions of the past couple days. We know more about what users want and what automated products are about. The time has come to put it all together and see if we, in common, can make it better. We are not always speaking in the same terms. An ice analyst is like an extreme sport athlete – every day, only the best is good enough, only the top result counts. It is a tough challenge for them. So far, the Ice Services and these “extreme athletes” are not happy with automated products. They are afraid that they will not be good enough or reliable enough. It is not that we don’t like the development but that we are thinking of our users. It is an eternal challenge to be bigger and better every day. The new IPCC report on what climate change means for the oceans shows that we are going to have lot to do. The job will become even more complex and difficult. Demands are growing, technology is growing and the amount of data is growing. Human production is too slow to cope but human judgement is needed to understand what automation can do for us.

INTRODUCTION BY PIERRE BAHUREL

Director-General, Mercator Océan International

Copernicus Marine Environment Monitoring Service budget is \$4B over 7 years to launch satellites and improve services. We are examining priorities for investment and have 3 implementation principles:

1. Upstream coordination and Core Products production - Copernicus looks after upstream and midstream. We set priorities for research and development, run models and process data, deliver basic products and simplify access to them so downstream service providers can add value.
2. We are the ocean experts but market generalists - we serve expert service providers and are committed to their development.
3. We are completely driven by cooperation - with a service that is open to all with a pan-European network. We have 300 partners in Europe contributing to the upstream components and the core products.

The Arctic is very important and we are interested in improving the Ice Services. Maybe the case can be made for the next satellite to be Arctic and ice focused. The timing is critical because there is a new parliament and new budget discussions to decide the priorities. We want to work together to explain in simple terms to impress the priorities upon our panels.

INTRODUCTORY STATEMENTS BY THE PANELISTS

Dominique Obaton

Head of Mercator Océan's Operations & Services Department

We have a catalogue of 174 products including modelling, satellite and in situ products. – Satellite ice products number only 12 and there are only 5 at high resolution. Products are made by DMI, FMI, and Met Norway. We are here to discuss how to better integrate with the Ice Services. Every time we integrate and interact we improve.

Jørgen Buus-Hinckler

Research scientist at Danish Meteorological Institute

We produce automated iceberg concentration products for CMEMS. Icebergs are detected automatically in Sentinel-1 imagery. We then simply count the number of icebergs in a 10 km grid and make this available to users easily. We want to introduce new products and are asking how we should go about that. Originally, the main idea was to provide gridded information in NetCDF format to models. Now we should involve the users – both intermediate users and end users. This meeting allows us to ask the end users what they want.

Juha Karvonen

Research scientist at Finnish Meteorological Institute

We produce automated products for sea ice thickness, sea ice drift, sea ice concentration, land fast ice and SAR image mosaics over the Baltic Sea automatically on an operational basis. In addition to improving these products, we have degree of deformation and risk

index outcome products in development. To best serve users, we need to simplify products by fusing them together and use automation to deliver products better and faster. Automated ice charting will go together with automated navigation and autonomous ships in the future.

Frode Dinessen

Research scientist at Norwegian Meteorological Institute

Met Norway is producing automated products for sea ice edge, type and concentration globally based on passive microwave data. These are used for data assimilation into models and climate studies. The focus is toward high resolution products. We are currently working on ocean ice atmospheric models going to 2.5 km resolution. We need to use spatial resolution ice products to support this modelling effort. For high resolution, there is a Sentinel-1 product at 1 km resolution and an AMSR2 product at 5 km that can be used in combination. We are proposing an ice type product from Sentinel-1. These products are to be provided in NetCDF format and made available to CMEMS. It is aimed to data assimilation. However, even if a product is meant for models, it could also be used by operational Ice Services. They could look at products and give feedback to developers.

Andrew Fleming

Remote sensing manager for the British Antarctic Survey

BAS set up the Polar View service over a decade ago to provide support to ships in the Southern Ocean. It now has a wide range of users. They make products available to the ship masters in the Antarctic. The site provides a mixture of charts from Ice Services, a range of satellite imagery and also derived information products. The Antarctic has been a vacuum of information but ship masters have used Polar View extensively to best advantage. Operators in the Southern Ocean are masters at using whatever information is available.

Keld Qvistgaard

Senior ice advisor at the DMI Greenland Ice Service

Yesterday, we had the marine community who were the users. Today, the value chain has changed and Ice Services are the users receiving products from the science community. We need automated products but have to use them intelligently. DMI has seen the CMEMS iceberg product but has not figured out how to use it. It is not in a format that can be edited manually. Automated target detection detects everything, including ships and false targets while missing the most hazardous bergy-bits and growlers. Even if the target can be spotted by the eye in the satellite image, the algorithm might still miss it. WE can't just concentrate on Sentinel-1. We need all the satellites. Whatever product is given to mariners has to be timely and accurate. Science, please help us.

Nick Hughes

Leader of the Norwegian Ice Service of Met Norway

The Norwegian Ice Service is small and, with increasing pressure on resources, we have been relying on automation to reduce work load without degrading quality and losing the trust of users – but this is difficult. User comments show the need for more detail and more frequent updates but the want to keep the same formats. The size of the products must be

kept small to handle the bandwidth limitation in the high north. Often we see a “hype” cycle in projects. Initially ambitious plans to fully automate get reduced when difficulties are encountered.

Mike Hicks

Chief Scientist for the International Ice Patrol

IIP’s mandate is to guard the iceberg limits of in the North Atlantic. Ships are mandated to use the product and it can have a significant impact on their routing. Although they don’t have to stay outside the iceberg limits, they usually do. In May, an iceberg that set the eastern iceberg limit far offshore came from satellite detection. IIP had to make a decision as to whether the target was real and whether it was necessary to send an airplane to verify it so far offshore. We decided to send the plane since we had additional information showing a cold core that made the target a plausible iceberg. Automated algorithms do not see all icebergs so modeling of drift and deterioration is essential. We are exploring the use of SAR to reduce the time required to do the analysis and reduce the bias in charting – not to replace analysts but to help them do better.

Sean Helfrich

Research Scientist at the NOAA Center for Satellite Applications and Research (STAR)

At NOAA STAR, we develop new products and innovations to go into products for operational use. We work on many products including waves, winds and ice using mostly SAR data for a wide range of users including modellers, scientists, and the public. The objectives are to apply SAR data to reduce the time to generate ice analyses, increase accuracy and reduce human biases.

SUMMARY COMMENTS FROM THE PANEL AND AUDIENCE

1. Define channels of user interactions and sharing and how to do it (interact).
 - a. More meetings like this one that bring mariners, service providers and scientists together.
 - b. Continue to conduct user surveys – but not to exclusion of face to face talks.
 - c. Ice Services should be integrated into the development of research proposals – but the practical problem is that analysts are busy in their daily work and it is difficult to get their time.
2. There are multiple types of users but they all need forecasts and prognoses. The people in the backroom are trying to provide the best products for modellers to use or to make other products. That is what Ice Services need too. CMEMS have been providing high resolution ice charts for the modellers. Now, we should be doing automation and standardize the products. Make these satellite based products available. Ice Services should tap more into the Copernicus system.
 - a. Probably the products CMEMS provides for the Ice Services are not suitable – should provide shape files.

- b. Are we talking about products or processes? We foresee a future when ice analysts concentrate on heavy traffic or difficult areas and routine areas are automated.
 - c. We are talking about a future time. We are only at an intermediate step. Science needs feedback from Ice Services to improve.
 - d. Analysts can use the automated products to spend more time on (end) users' needs. They should be backed up by good products.
- 3. Ice Services should challenge the science community to help with the work flow. Don't make the end product – help the analysts make the end product e.g. with uncertainty measures. Make a system that is automated more and more as it matures so that analysts can eventually be extracted. Concentrate on the transition and not the end.
 - a. We need to find a way to determine what is good enough. What is the 80% solution? How do we know when to stop? Need Close Collaboration.
 - b. Cannot just rely on Ice Services asking for solutions. The science community develops ideas that go beyond what Ice Services are doing now. Before cell phones became available, users would never have thought to ask for the capabilities of modern smart phones. Now they are ubiquitous.
- 4. What kind of uncertainty can end users live with? Ice Services don't know because we don't know what the uncertainty is currently.
- 5. To get funding, scientists must present proposals and results as 100% solutions. Are Ice Services aware that they can't get everything they want all the time?
 - a. Applications may work well in some areas but poorly in other areas. Uncertainty needs to be assessed in difficult situations.
 - b. The end goals of some research projects could be set higher. It happens that at proposal stage, the goals are lofty but later get diminished as difficulties are encountered.

TOWARDS A ROADMAP TO THE FUTURE

From the previous discussion, it is clear that, while the operational Ice Services and the science community have these same high level goals, they have different drivers and face differing constraints in the details of practice. Communication between and among groups is always noted as essential but is always difficult to achieve.

What can we do to bring scientists, Ice Services and users together?

1. Validation – if Ice Services really use automatic products, there must be feedback to science on good and bad areas. E.g. comments on how each product is performing should be shared with the scientists. Ice Services have to translate what end users need into the Ice Service's needs that go to the scientists.
2. Common goal – consider a common global ice edge that we all agree on as an example. We need to understand the roles and responsibilities in attaining this goal. Who should be doing the measuring, integrating, modelling and delivering? There will always be uncertainty in the forecast of this ice edge so we should have a common way to illustrate this uncertainty (a red-yellow-green stoplight model?).

Everyone must know their role in the processing chain and how to connect with others in the chain.

3. Communication - each ice service should set up rules for communication between scientists and analysts so they can meet on a timely basis (weekly?). It must be formalized. Communications must be between the organizational layers. The analysts communicate with their end users and provide that information up the chain.
4. Roadmap of confidence - communicate uncertainty and confidence. Analysts will transition into a decision support role to communicate confidence levels to end users.
5. Requirements - IICWG should create a list of requirements or hold a workshop where we walk through the workflows to understand where processes can be assisted with automation.
6. Database of data – create a database of data that the Ice Services think are important and get scientists to work on these data. Undertake inter-comparisons of different processing methods. IICWG can judge how to communicate these methods to end users.
7. Workshops/Meetings - for Ice Services, mariners, and researchers to connect with each other and hash out their requirements. There should be iteration between scientists and analysts. There must be commitment to communication, engagement and feedback towards getting the results that end-users want. Review a list of potential value added products. Understand the usability of automated products.
8. Start small - stop trying to force all the requirements into one big box. Look at synergies and take advantage of the relationships developed here. There must be small projects that can be done within the different groups to break down the aversion to automated products.
9. Don't forget the small Ice Services - their challenges continue to be data access, processing, and dissemination. The scale of the small Ice Services and their users is different from the larger Ice Services.

CONCLUSIONS FROM THE DISCUSSION

BASIC AGREEMENTS

1. The user is important – we must make products and provide services that meet the users' needs.
2. Ice Services are already inundated with more data than can be handled by humans – and the data quantities are going to explode beyond comprehension. Ice Services want and need to use automated tools to deal with the flood of data.
3. Validation is a critical component of user acceptance – it is necessary to give users a sense of the uncertainty that is associated with every product.

4. Ice Services are both users of CMEMS and service providers (to end users in the marine environment).
5. Effective communication between and among different groups and different levels is essential to success.

MISUNDERSTANDINGS

1. There is not a common understanding of who the user is. The term is used indiscriminately and often refers to communities with vastly different needs e.g. mariners v. modellers v. climate scientists.
2. Generic use of the term “high resolution” without quantification causes misunderstanding. To those speaking about passive microwave radiometer data, it means a few kilometres; to mariners and Ice Services it means a few metres.
3. “Ice edge” to mariners and Ice Services means the boundary between the open sea and any amount of sea ice (Ref: WMO Sea Ice Nomenclature). To the science community, it means the 15% concentration line. This is important because the largest group of mariners who use ice information products are those who travel near the ice but don’t want to encounter it.

CONFUSION ABOUT “USERS”

Who are the CMEMS “users“?

- “The operational maritime community, Ice Services, and modellers are the CMEMS users of record”. (Dominique Obaton)
- “CMEMS does not have end users – only intermediate users. We are working with European Ice Services to increase user interaction” (Dominique Obaton)
- “To be clear, for CMEMS, users are the Ice Services” (Jørgen Buus-Hinkler)
- “(CMEMS) was originally focused on modellers and has expanded to ice charts” (Matilde Brandt)
- “The Copernicus Marine Service sea ice satellite products also help maritime shipping companies find the safest navigation routes through ice-covered areas.” (CMEMS website <http://marine.copernicus.eu/markets/#marine-navigation>)

WAYS FORWARD

- We have the makings of a new task to work on this topic. Perhaps we try for a common pilot project such as the global ice edge mentioned above. A task group could flesh this out. A workshop could be organized to help with this as well.
- Find gaps in the production chain to know what will make the largest improvement in the work of the ice analyst instead of on the end product. Formalize communications and have one group that works on this on a continuous basis (or maybe have multiple groups to reflect the varying size of Ice Services so more gaps can be found).

- Improve communications. Do better validation of products – both scientific validation (accuracy) and operational validation (usefulness). Address the questions about uncertainty.
- Validate with a loop that includes the Ice Services so we can see what kind of improvements are needed. Must get some agreement on how to validate - what is the reference?
- Develop better user interactions. Have well-defined roles in the value chain. The environment is changing with sea ice melting and new users coming into the picture. Things are always changing, so we need to think about how Ice Services will look in years ahead.
- Communication can be restricted by funding. Ice Services are often not involved in proposals for development funding even though proponents identify Ice Services as a target user in order to boost their chances of funding.
- Develop common goals. Even if products have uncertainties, we should still give these products to the users with a formalized way to communicate the uncertainties. We need to find ways to determine the uncertainties in the products. Ice eggs are a formal way to communicate ice information.
- Keep the Southern Ocean in mind. The Ice Services there are not as big and they usually trail in development. We need a better common voice for the whole Southern Ocean.

PANELISTS' TAKE AWAY FROM THIS SESSION

The moderator asked the panelists to state one thing that they didn't know before this session.

- It is encouraging that there is a strong line of R&D and others working in the Southern Ocean that can be used.
- There is less disagreement between the researchers and the Ice Services community than expected.
- There is scope for better communication towards common goals.
- We need better communication between the groups.
- We need to find ways to communicate better.
- You cannot overestimate how valuable user engagement is. We really need to understand the users. Know our user base and interact with it.
- CMEMS needs some specific expertise in ice and we have to be more clear about who our users are – at least on our website.
- The need to identify bottlenecks in the production chain to determine the breakdowns in timelines and accuracy in the products. We need to address automation techniques that will have the greatest impact in production chains.
- The need to understand our limitations and the need to communicate the uncertainty in our products.

CHALLENGE FROM PIERRE BAHUREL, DIRECTOR-GENERAL OF MERCATOR OCÉAN

We should not wait for Copernicus to be excellent before it is good enough for the Ice Services. So, to the Ice Services:

1. Are you registered as a CMEMS user?
2. Will you come to workshops to help us improve our products? There is one for the Baltic (on 5-6 November) and others in the next few months. Will you go?
3. When we are ready to progress, we ask our users. Are you communicating well enough within your own organizations to ensure the correct response?
4. If we have small calls for science upgrades to put into services, will you support them?
5. Are you connected to the Copernicus User Forum? Do your representatives there know what you want?

CONCLUSIONS AND RECOMMENDATIONS

1. Everyone agrees that Ice Services need to adopt more automation in their production chains to cope with increasing data volumes and user demands.
2. Both the science community and the Ice Service community agree that the high level goal is help mariners operate more safely in a changing environment.
3. Everyone agrees that better communication is essential to the successful implementation and use of automated ice information products. However, there are practical and systemic barriers that must be overcome.
4. Misunderstanding and misuse of some important terminology contributes to misinterpretation and false impressions.
5. It is important to define who the “users” of a particular activity or project are, get to know them, and maintain continuing dialogue with them to adapt to changing needs. Mariners are users of the Ice Services. The Ice Services are users of CMEMS and other science organizations developing automated products.
6. Scientists should involve the operational community earlier in the proposal cycle to help ensure that projects are defined that will deliver useful results.
7. Ice Services need to be more proactive in learning about new automated products and processes and in providing feedback to developers. They should be in close connection with their representatives to the Copernicus User Forum so that needs are articulated early in the development cycle.
8. Validation, for both scientific quality and operational utility, is essential for the successful implementation of automation.
9. Rather than working on end-user products, the science community could have more impact by working in synergy with Ice Services on processes to add value to the

existing production chain (e.g. more accurate, timely, relevant information). The Ice Services already have strong connections with the marine community that should be utilised.

10. It would be useful to define a small scale pilot project to develop a new product for mariners based on automated processes and to involve the scientists, Ice Services, and mariners in the project from the outset. It should be a new product addressing an identified need by the marine community. The primary purpose of this project is to demonstrate how the development cycle could work if all the stakeholders are involved.

End
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