

Report about the DMI/SalienSeas user-workshop: New ice products for Greenlandic waters 12. and 22. February 2021

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1 General overview about the user workshops

The Danish Meteorological Institute (DMI) and the SalienSeas project hosted two online workshops for Arctic maritime users in February 2021. The SalienSeas project aims at analyzing the needs of Arctic maritime users and at co-developing climate services and products tailored to such users. In this, the project partners from DMI focus on the geographical area of Greenlandic waters.

The aim of the workshops was two-fold: 1) to present newly developed prototype services and products for Greenlandic waters to interested maritime users and 2) to collect feedback from the users in order to further improve the products according to users' needs. This feedback is also valuable in respect to a possible operationalization of the products by the Greenland Ice Service.

The workshops took place on 12th and 22nd of February 2021 as online events with a limited number of participants in order to enable lively discussions. Invitations were sent to a diverse group including Greenlandic shipping operators, pilot service providers, an Arctic tourist cruise association and the Joint Arctic Command. In total 14 participants attended the two workshops.

The workshop started with a short introduction to the SalienSeas project and to the workshop setting. Thereafter, the Greenland Ice Service was presented, which gave the participants an overview of currently available ice services. In the following, five newly developed (prototype) products were presented by DMI where each presentation was followed by time for questions, feedback and discussions. The workshop closed after an additional round for open feedback.

2 Products presented at the workshops

During the workshops, the users were introduced to five newly developed products and services. Four of them were developed during the SalienSeas project (www.salienseas.com and <http://ocean.dmi.dk/salienseas>) and one during the SHIPcAPP project <http://ocean.dmi.dk/shipcapp/>. They are all targeting maritime users in Greenlandic waters. The products are described in the following subsections, and users' feedback is listed thereafter in chapter 3.

2.1 Iceberg atlas

The iceberg atlas (Fig. 1) depicts the typical number of icebergs in Greenlandic waters. It is based on a statistical analysis of icebergs detected in satellite data (Sentinel-1) during the years 2017–2019 and it includes icebergs larger than about 40 m. The maps on <http://ocean.dmi.dk/icebergatlas> are zoom-able so that users can get detailed information for their region of interest. The atlas offers maps for every week of the year (1-52) and for five levels of severity (extremely low, low, normal, high, and extremely high conditions) so that users get a good impression about how many icebergs they can typically expect.

2.2 Fast ice climatology from model simulations

The fast ice climatology maps (Fig. 2) shown on <http://ocean.dmi.dk/demonstrationservices/fasticeclim/> depict the likelihood of meeting fast ice in the Baffin Bay and Nares Strait area. They are based on a simulation with the high-resolution (3 km) ocean–sea-ice model NEMO–SI3 which is able to simulate fast ice. The product shows the occurrence rate of fast ice for each month of the year (Jan–Dec) during the years 2016–2019. The maps are intended for long-term planning e.g. to explore the possible time period for ice-based operations in certain regions.

2.3 Ice charts with highlighted fast ice area

Ice charts are issued by the Greenland Ice Service and show ice conditions from different satellite data sources as interpreted by a human. The product on <http://ocean.dmi.dk/demonstrationservices/fasticecharts/> (Fig. 3) employs these ice charts and presents them with a layout that highlights those areas which are covered by fast ice. The green hatch pattern is applied to make it easy for local inhabitants to identify the fast ice areas

even from black-white printouts. This product is updated daily and can be a valuable source of information for people who use fast ice for travelling or hunting.

2.4 High-resolution sea ice forecasts

The page <http://ocean.dmi.dk/demonstrationservices/iceforecast/> presents forecasts of the sea ice conditions around Greenland for the upcoming 5 days (Fig. 4). The forecasts are updated every day with a new simulation of the high-resolution (4 km) ocean–sea-ice model HYCOM–CICE. The model is able to simulate fast ice, and assimilation of ice concentration from satellites ensures a realistic ice cover at the beginning of each forecast. The users can explore the ice concentration, the ice thickness and the ice drift speed either directly on the webpage or on a zoom-able map.

2.5 Forecast for Cape Farewell

As an addition to the products developed in the SalienSeas project, a short introduction has also been given to the service developed in the SHIPcAPP project (<http://ocean.dmi.dk/shipcapp/>), which also targets maritime users around Greenland. An app for smartphones provides the users with high-resolution weather, sea ice and ocean forecasts for the area around Cape Farewell. The easy access and the intuitive layout makes this app a useful tool especially for planning of operations and adjusting plans onboard.



The SALIENSEAS project, part of the ERA4CS programme, is co-funded by the Innovation Fund Denmark and by the Horizon 2020 Framework Programme of the European Union (Grant 690462).

Iceberg Atlas

This atlas shows the seasonal distribution of the icebergs - observed from space - in the waters around Greenland; it is a service developed- and provided by the SALIENSEAS project. The atlas consists of a series of maps that displays iceberg statistics for each of the 52 weeks of the year. Note that the maps show statistics on icebergs detected in open-water only. This is due to the presence of rugged structures in the sea ice (such as ridges and rubble fields), that make iceberg-detection in sea-ice infested areas uncertain.

Further information about the atlas can be found here:

[Download the iceberg atlas \(pdf\)](#)

Number of icebergs: Maps displaying climatological conditions

Explore how many icebergs usually exist around Greenland under different conditions. Select a week number and then **hover** the mouse over the blue buttons. **Click** the buttons to open a zoomable map in a new window.

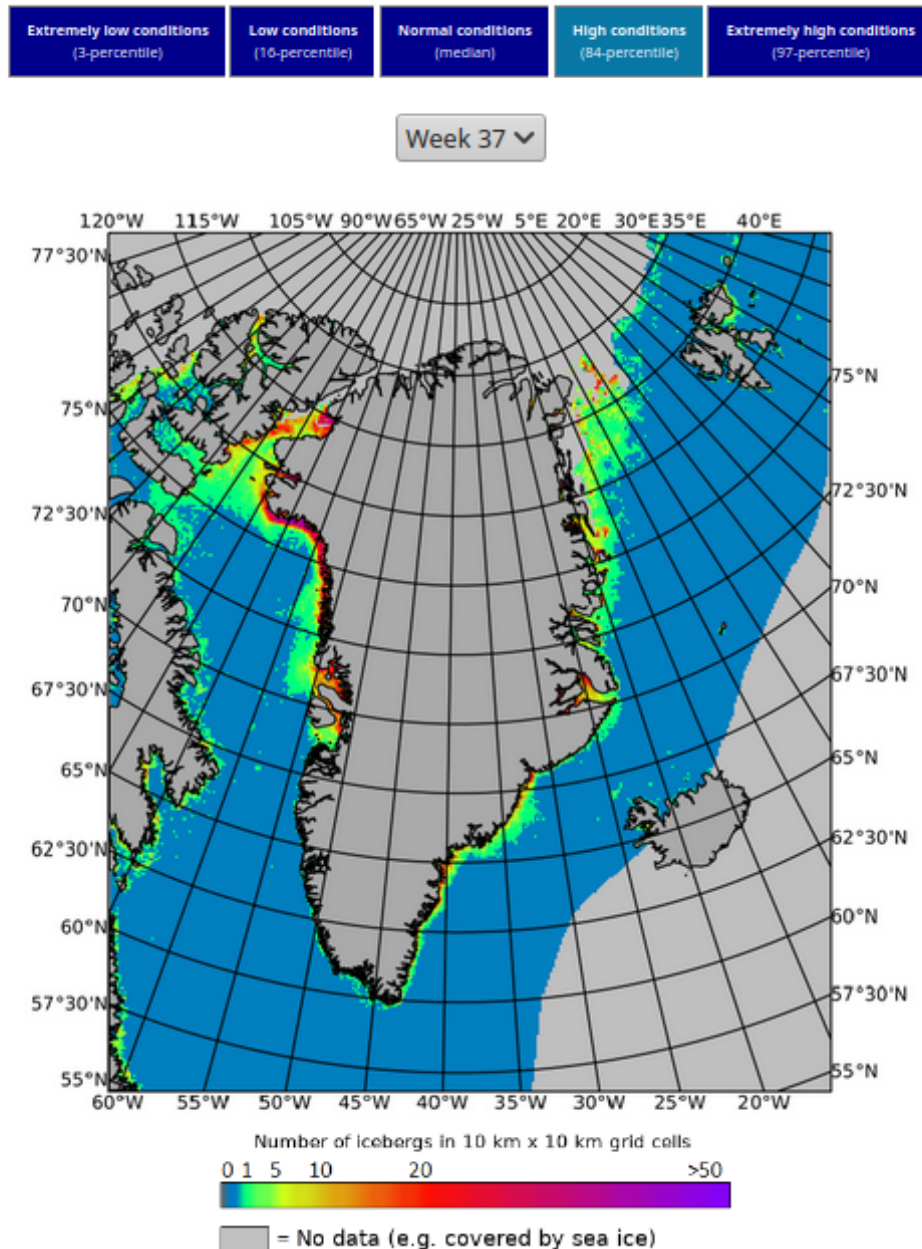
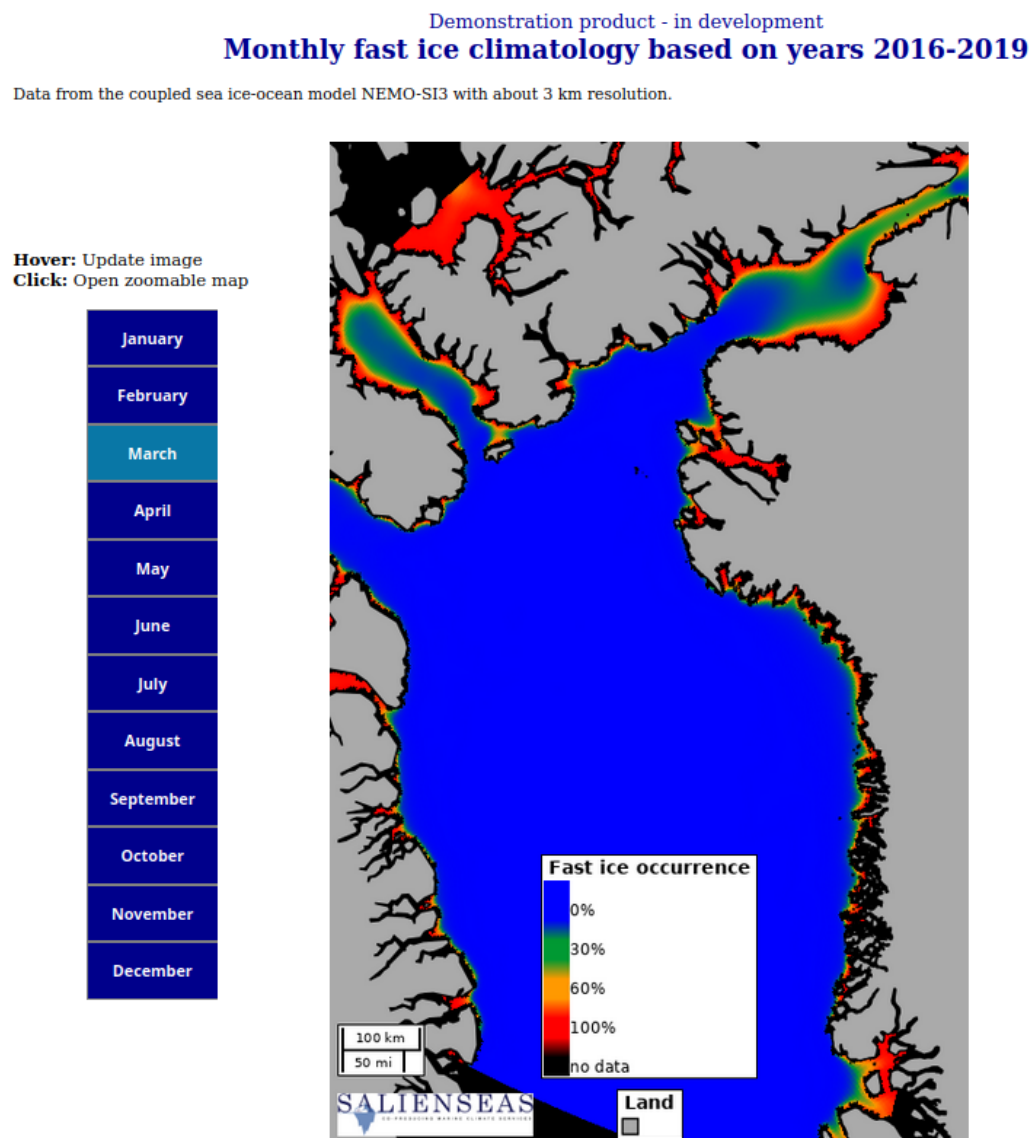


Figure 1: Screenshot of the webpage displaying an example of the iceberg atlas: Number of icebergs in week 37 if conditions are "high".



This demonstration product was developed in the project Salienseas, part of the ERA4CS programme.
Find other Salienseas products here: <http://ocean.dmi.dk/salienseas>

Figure 2: Screenshot of the webpage displaying an example map of typical fast ice conditions in the Baffin Bay in March.

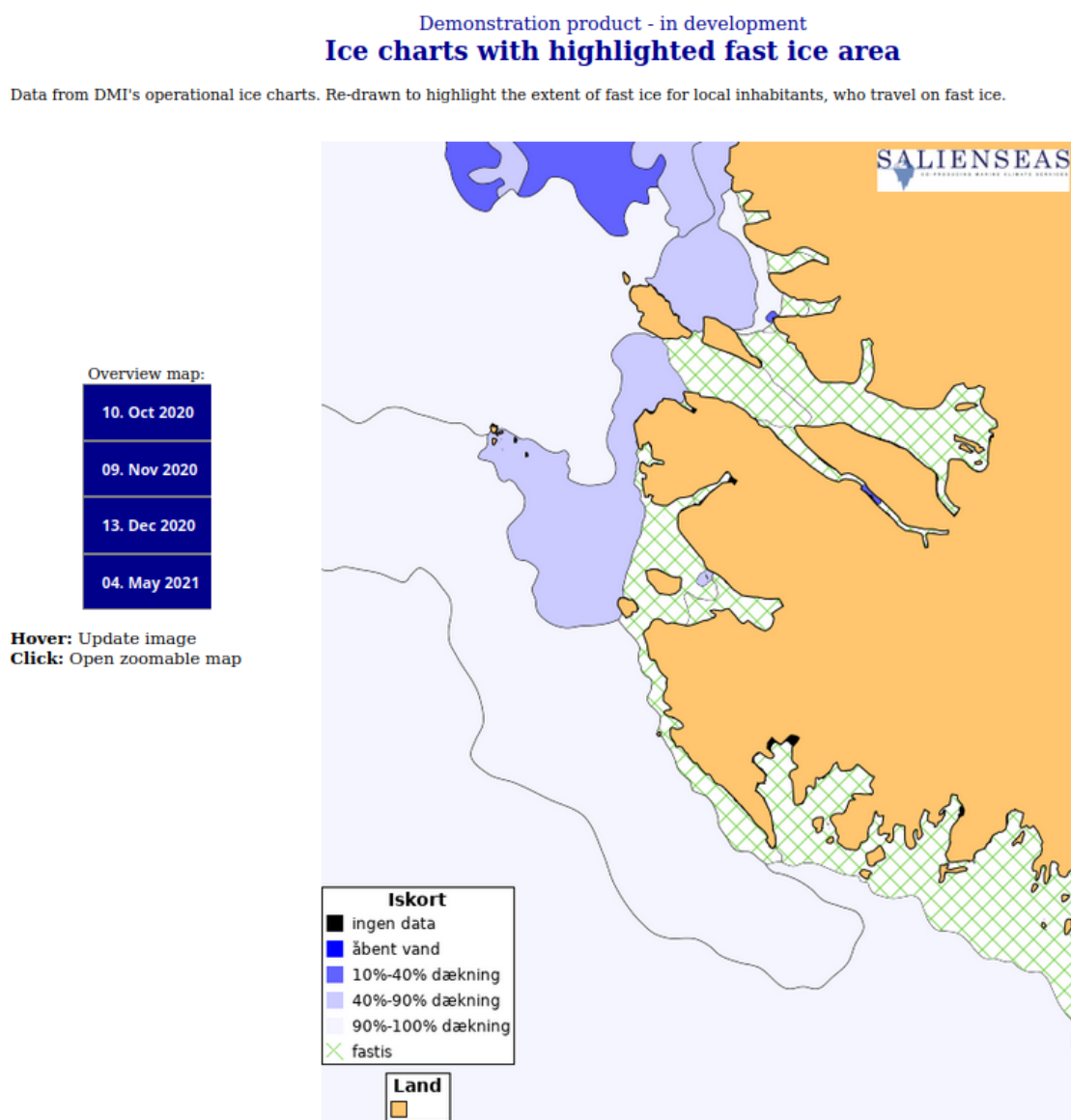
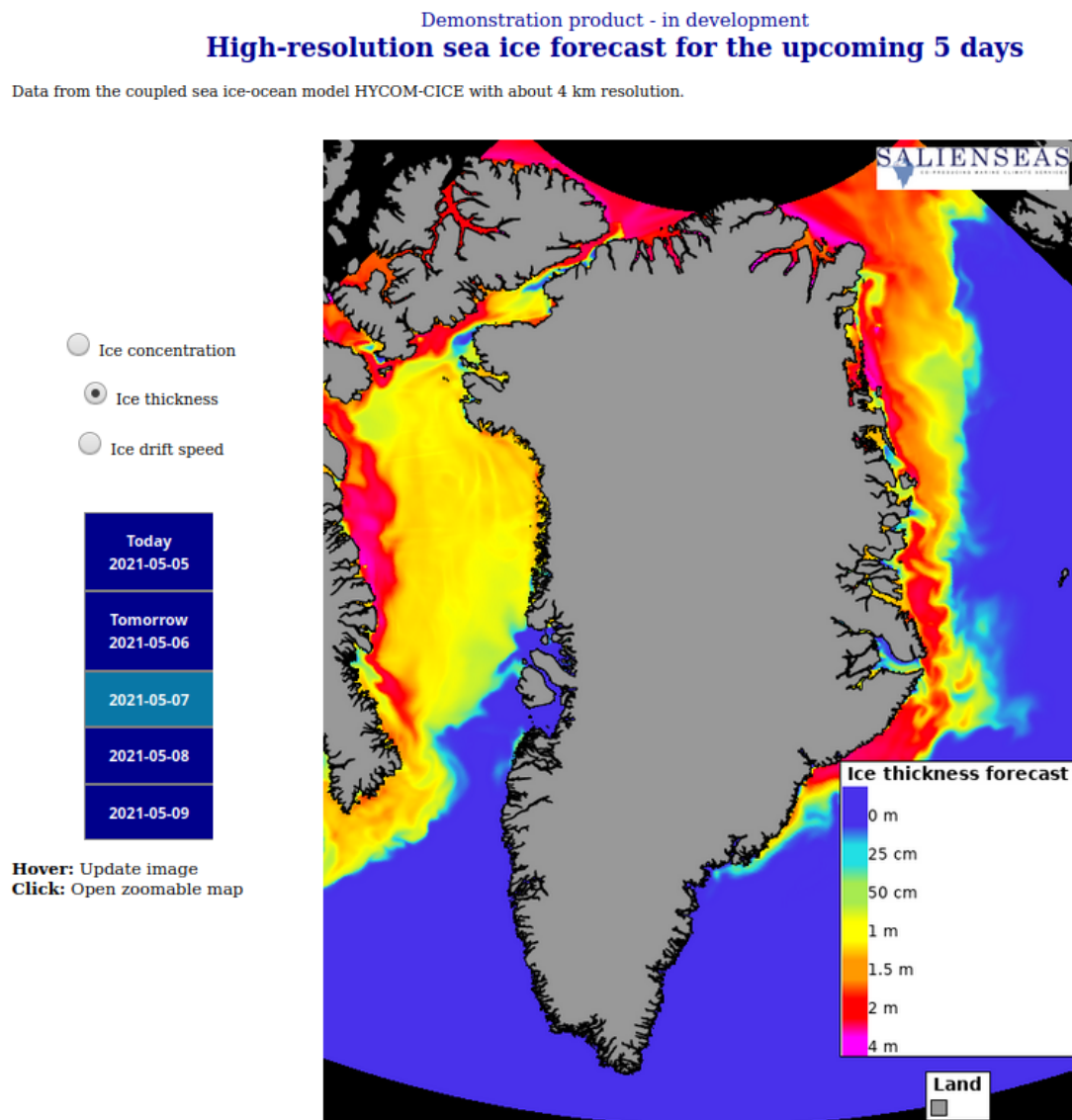


Figure 3: Screenshot of the webpage displaying an example ice chart with fast ice areas highlighted by a green hatch pattern.



This demonstration product was developed in the project SalienSeas, part of the ERA4CS programme.
Find other SalienSeas products here: <http://ocean.dmi.dk/salienseas>

Figure 4: Screenshot of the webpage displaying an example of forecasted ice thickness around Greenland.

3 Participants' feedback and comments about the products

After the presentation of each product, the workshop participants could ask questions and give feedback. The project team was especially interested to hear how useful the users see the product, either for themselves or for other actors in their field, and whether they could suggest specific improvements. All these points are important especially when considering if and how the newly developed products can be operationalized so that they become part of the product portfolio of the Greenland Ice Service. In the following subsections we list the comments from the workshop participants as received for each product.

3.1 Iceberg atlas

Feedback and comments from the workshop participants about the iceberg atlas:

- Clarify the definition of high/low “conditions”.
- Users need to be trained in order to know which severity-level they need to choose in order to display the appropriate level of risk for their operation.
- Clarify on the webpage what size of icebergs can be detected.
- Rather be conservative because an underestimation of the iceberg density can lead to safety issues.
- Make the link to the pdf-version of the iceberg atlas more visible on the webpage.
- Use the same colormap as in the product by the Greenland Ice Service. Reply: This suggestion cannot be accommodated because the Greenland Ice Service displays different quantities.
- It was suggested to add pictures showing examples of what a certain “number of icebergs per grid cell” means, i.e. how these conditions would look like in reality.
- The risk for navigation does not only depend on icebergs but also on many other factors (e.g. icing, wind, etc.). Military vessels sometimes have to take a higher risk if operations are very important.
- Expand the iceberg atlas into other regions outside of Greenland.
- The atlas has a high resolution/big file size. Is there a version for low-bandwidth use? Reply: As the atlas is not intended for operational navigation, no low-bandwidth version is planned.

3.2 Fast ice climatology from model simulations

Feedback and comments from the workshop participants about the fast ice climatology:

- This is a good tool for long term planning, access/scenario planning and consulting.
- It is good to show the months separately.

- How reliable is the product in the changing climate? Reply: This climatology is not based on a 30-year long time frame but only on 4 recent years. It therefore represents the conditions during last years.
- It would also be interesting to have a similar product for expected future condition. This could either be based on a model prediction or on an analysis of observed trends.
- An idea for creating simple predictions would be to find a past year that has similar conditions to the current year and use this as an indicator for the expected development of condition.
- Also useful would be a similar map that shows the ice-free region instead of the fast-ice region (ice avoidance line for ships).
- Make the same product from ice charts instead of model simulations. And/Or compare the two results.
- Make the same product for East Greenland.

3.3 Ice charts with highlighted fast ice area

Feedback and comments from the workshop participants about the ice charts with highlighted fast ice area:

- This is a useful product both for search&rescue operations and for locals.
- Add information about ice thickness and/or ice type/stage of development.
- Most interesting for users is the “save fast ice”, which is fast ice that is thick enough for travel (usually defined as 10/10 ice coverage and thicker than 15 cm). This information is routinely mapped by the Greenland Ice Service and is available as polygons. It could be visualized by using a traffic light system.
- Consider to produce a low-bandwidth version (file size below 300kB).

3.4 High-resolution sea ice forecasts

Feedback and comments from the workshop participants about the high-resolution sea ice forecasts:

- The forecast is very interesting.
- This is a good tool for planning in West and East Greenland. Around Cape Farewell, it is more a safety asset than a planning tool.
- Extend the product for the whole Arctic.
- The high resolution (4 km instead of 10 km as available until now) is a major improvement. It makes the product interesting for more users.
- It would be good to have an even higher resolution for specific areas, e.g. near the coast.
- Add more details to the webpage about the model specifications. For example explain

whether the effect of wind and currents is included.

- Add wind vectors on top of the ice maps.
- Add a plot of the surface pressure field and wind vectors on top of the ice plots. This would help to understand the full picture of the environmental conditions.
- Improve the colormap: Show more details of leads, which can be achieved by increasing the color resolution in the range of 75% to 100% ice concentration.
- Consider a low-bandwidth version.
- Use the S411 standard because this is what will be shown on navigation systems in future. Therefore it is good to get people to use these new color schemes.
- Show hourly instead of daily averages.
- Around Cape Farewell: It is important to depict multi-year ice even if the total ice concentration is small. This is important for the cruise ships and their safety.
- Suggestion: Derive a product for a "safe navigation window" for the next 2–5 days based on both ice charts and the forecast; Add a line of safe-travel (following the Polar Code) around Cape Farewell. Think in "worst case scenarios". This is especially important for less experienced users.
- There is a concern that assimilation of ice close to the coast (e.g. Cape Farewell) will cause problems.
- It is confusing to show the open water area in different colors (blue/green/black) for the different sea ice variables (ice concentration/thickness/speed).
- For mariners it would be good to be able to select different units for the ice drift value.
- Around Nordre Strømfjord the model seems to have a bit different coverage than the satellite photos/ice charts.

3.5 Other comments and feedback

At the end of the workshops, the users were invited to share any other thoughts, comments, feedback or questions they might have. This is a list of mentioned and discussed topics:

- A lot of interesting services!
- Our company uses on purpose different products from different information sources; we compare them with each other in order to get an impression about the accuracy. Therefore a "one stop shop" is not so necessary.
- One participant specifically mentions that they would like to follow up on the development of the products and that they can be contacted if updates are available.
- It is valuable when operators get involved in product development and testing. A recent trial activity for a new product on board of a vessel was received very well. This could be repeated if a new product needs testing.

- Regarding bandwidth:
 - Images sized of less than 300 kb are OK.
 - Low-bandwidth websites need an “empty”/simple entry page. It is not possible for users to load the interface on which they can choose e.g. product resolution/domain; they need direct access.
 - Station North could test low-bandwidth products.
 - It works well to have someone like the Greenland Ice Service sending e-mails with requested products. Therefore, a low-bandwidth website is only useful if it adds value on top of the e-mail sending service that is currently provided.
 - Low-bandwidth experience can be simulated in Chrome browser.
 - Conclusion: Do not spend time on a low-bandwidth webpage — it is not really needed.
 - In a current project, DMI works with a project partner on a satellite communication technology which can broadcast messages with a size of about 100 kb.
 - DMI has good experience with using Facebook to compress images.
- Use clear definitions of terms so that users know what is observed/displayed.
- A resolution of 4 km is valuable for planning; for tactical navigation there are other products.
- Are data files available as well? PNG files cannot be imported into other systems.
- Greenland Ice Service is working on a product for risk management that includes risk by sea ice and icebergs and it will be tested with marine users soon.
- Be careful what is presented for navigational use.
- Idea for a new product: Polaris maps for the 12 vessel types could be derived from ice charts.
- It is good to be able to give feedback, so that product development does not go into dead ends.
- The area around Cape Farewell is so important that it would be good to have a dedicated plot for this region on the webpage.
- One participant offers to reach out to them and their network to discuss which regions could be relevant as focus areas in terms of increased model resolution. A broad group of users might yield a quite diverse field of answers.
- I would like to participate in a second meeting on a later stage.
- There could be some opportunities for sharing data over “VDES” for presentation in onboard ECDIS. If a special satellite with 15-16 daily visits and equipped with selected sensors is needed, get in contact with us.
- Transferring demonstration products from Research&Development into operations at the Greenland Ice Service requires funding.

4 Conclusions and Outlook

The two user workshops in which the SalienSeas project and DMI presented newly developed products and services for Greenlandic waters to selected maritime users were a success and well-received by the participants. The events stimulated good discussions, which could easily have continued longer than the scheduled time slot. The users were in general very willing to give feedback about the new products and they also contributed with a bunch of new ideas which can help to improve the products and tailor them better to their specific needs. Therefore, such workshops are beneficial for both sides: The users get informed about the newest product developments, and the service providers receive valuable feedback which can help them to direct resources for product development better to where they are most needed. Additionally, this feedback can also guide the decision about operationalizing promising products and bringing them from Research&Development into operational production in the Greenland Ice Service.

Many users were interested in receiving a follow-up e-mail with the material that was presented during the workshop. Such an e-mail was sent a few days after the second workshop to all participants. It included the presentation slides as well as links to the webpages of all presented products. Additionally, it was announced that a report will be written about the workshops and the participants were asked for their statement of agreement to publish their names and affiliations in the report.

Considerations for future workshops

Some users indicated that they would like to participate in future workshops again. If a similar workshop is to be organized, following points and experiences are good to consider:

- Registrations for the workshop tend to arrive quite shortly before the event. The host could keep some spare spots for late-comers.
- Links to the product webpages could be sent to the participants in advance.
- Hosting the workshop as online event showed to have an advantage not only because users could participate both from Denmark and from Greenland without having to travel but also because it enabled ship crews to attend directly from their vessels.
- It can be recommended to keep the participant group small in order to enable lively discussions. A number of 6–8 users turned out to be a good size.
- The chat system is useful both to help moderating the discussions and to keep a record for later.
- The workshops were planned to last for 2 hours and this time was easily spent. Presentations can be kept short in order to leave more time for discussions. It is advisable to include a break.

5 Appendix

5.1 List of workshop participants

Project members and presenters

- Machiel Lamers, WUR
- Steffen M. Olsen, DMI
- Keld Quistgaard, DMI
- Jørgen Buus-Hinkler, DMI
- Andrea M. U. Gierisch, DMI
- Till A. S. Rasmussen, DMI
- Matilde Brandt-Kreiner, DMI
- Berill Blair, WUR

Users

- Trygve Erthmann, AKO
- Troels Jacobsen, AECO
- Lars Moltsen, MARIOT project
- Bo Junker Albertsen, FCOO
- Johan Söderkvist, FCOO
- Vilhelm Petersen, RAL
- Bettina Ovgård, AKO
- Jeppe Schloss-Pedersen and his crew on HDMS Hvidbjørnen, AKO
- Thomas Bøggild, GPS
- Peer Brandenburg, GPS
- Gorm Nørgaard, RAL
- Kasper Riis, RAL
- Søren Laursen, FMI/GEOMETOC
- Carsten Hansen, FMI/GEOMETOC

5.2 List of abbreviations

AECO Association of Arctic Expedition Cruise operators

AKO Joint Arctic Command

DMI Danish Meteorological Institute

FCOO Forsvarets Center for Operativ Oceanografi

FMI/GEOMETOC Forsvarsministeriet Materiel- og Indkøbsstyrelse, Joint GEOMETOC
Support Centre

GPS Greenland Pilot Service

RAL Royal Arctic Line

WUR Wageningen University