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SUMMARY

The overall objective of SIDARUS is to develop and implement a set of sea ice downstream services in the area of Marine Safety, Marine and costal environment, and Climate and seasonal forecasting. The products to be developed are high-resolution sea ice and iceberg products from SAR, sea ice albedo, sea ice thickness, sea ice habitat conservation and ice forecasting.

A user questionnaire has been distributed to potential user within the selected areas and a first preliminary analysis based on the response has been assessed. This shows that the defined core users have requirements for a very wide range of ice, weather and oceanographic information. Users from the different segments have some specific requests but there are also many common needs.

Among the most important parameters are ice concentration, edge, type, drift, deformation and ice thickness. For near real time operators a demand of high spatial resolution is requested. The need for sea ice forecasts are especially highlighted by the Marine Safety segment where 2-3 days of forecast are most useful. Ice berg is only requested by this segment and occurrence, size and drift are all valuable information.

Discoveries made in SIDARUS survey is consistent with results from previous studies and shows that there is still an unmet need for sea ice data.

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1 Introduction

The overall objective of SIDARUS is to develop and implement a set of sea ice downstream services that will extend the present GMES services with new satellite-derived sea ice products. The scope of this document is to synthesise user requirements for each of the focused user segments addressed in SIDARUS which are:

1. Marine safety
2. Marine and coastal environment
3. Climate and seasonal forecasting

The assessment is based on information obtained through a questionnaire sent to potential users as well as requirements derived from previous EC projects and experience from the SIDARUS partners.

The questionnaire containing a sea ice section and a weather section and was sent out to relevant users in the mid-April 2011. The weather section was added to the questionnaire by a Task Team under the WMO's Executive Council Panel of Experts on Polar Observations, Research and Services. This group are gathering input to asses' user needs and perspectives on weather, water and climate products in the Polar Regions. A copy of the questionnaire can be found in the appendix.

A total number of 24 individual questionnaires have been provided to the defined set of SIDARUS users. Unfortunately not all have replied but the user review document is expected to evolve during the project period and new users will be added. The user group are divided into tree homogenized groups according to the key areas SIDARUS will provide services to. The objective of each key user group is to capture the essential requirements of users within one market area.

2 SIDARUS core user segments

In SIDARUS we have focused on three different user segments, Marine safety, Marine and costal environment and Climate and seasonal forecasting. Each of the user segments has unique requirements for parameters to be observed, accuracy of data, re-visit time etc. based on the products or services to be delivered. SIDARUS will address requirements for daily, near-real time monitoring and forecasting services and user's need for information about sea ice and icebergs in both Polar Regions. A user group with representatives from all segments has been established and has been provided with a user's questionnaire. The users who have provided feedback are listed in the Table 1 below.

#	Name of Organization	User category	Country
1	Norwegian Coast Guard, Squadron North, Sortland	Marine safety	Norway
2	Statoil ASA	Marine safety	Norway
3	Total E&P	Marine safety	France
4	Pole Position	Marine safety	Norway
5	Greenland Institute of Natural Resources	Marine and coastal environment	Denmark
6	University of Alberta, Dep. of Biological Sciences	Marine and coastal environment	Canada
7	The Royal Arctic Line	Marine safety	Danish
8	Tschudi Shipping	Marine safety	Norway
9	British Antarctic Survey	Marine safety	UK
10	Karl Angelsen	Marine safety	Norway
11	Université Louvain la Neuve	Climate and seasonal forecasting	Belgium
12	Fritz Johansen	Marine safety	Norway
13	Norwegian Coast Guard, KV Svalbard	Marine safety	Norway

14	Shell Internationals	Marine safety	Netherlands
15	A. N. Svertsov Inst. Of ecology and evolution (Niktia Platonov)	Marine and coastal environment	Russian
16	The Norwegian Coastal Administration, NOR VTS.	Marine Safety	Norway
17	Norwegian Meteorological Institute	Climate and seasonal forecasting	Norway
18	Arctica Offshore	Marine Safety	Finland

Table 1: User list (This is a preliminary list that will be extended during the project)

2.1 Maritime Safety

The Maritime Safety market area encompasses marine operations, resource developers (oil, gas, minerals, fish), ship routing and ship navigation, tourism, defence, and search & rescue operations. This segment contains most unique users in the Polar Regions. The users in this segment seek information about ice conditions and meteorological and oceanographic forecasts for the following reasons.

- Improved safety
- Optimised activities
- Reduced costs
- Quicker responses

Near real-time data on ice conditions, meteorological situation and sea-state are essential for safety and cost reduction. Forecasts provide a tool to plan and optimise activities, both in a tactical view and in operational planning.

Maritime defence activities include the performing of various tasks requiring detailed information about oceanographic and meteorological conditions in their operations areas, or along maritime routes. Typical activities are training, international manoeuvres, and patrolling.

For oil and gas exploration it is essential, to detect icebergs and to predicting the movement of objects. Information of ice parameters, wind, current and waves is therefore important.

The biological environment along the ice edge leads to fishing activities close to the ice. The fishing vessels normally don't have ice classes and prediction of ice development is therefore important in the tactical operation.

The reduction of Arctic ice extent, in particular during the summer months gives rise to new sailing routes which increase the needs for ice and weather information.

Many of the Maritime Safety core users operating maritime units in Polar Regions are commercial actors. They've got a commercial driving force where cost-reducing efforts are key figures, but they are also subject to national or international safety restrictions. Most core users are found within the oil/gas industry or shipping. These users are rather skilled in terms of assessing ice information and weather data from several sources, as it is a common task to issue this sort of information. However, the data comes from several sources and is of various resolutions and quality, and the gathering and interpretation of these data sets can be ineffective and often inadequate.

The geographic area of interest among these users is shown in Figure 1.

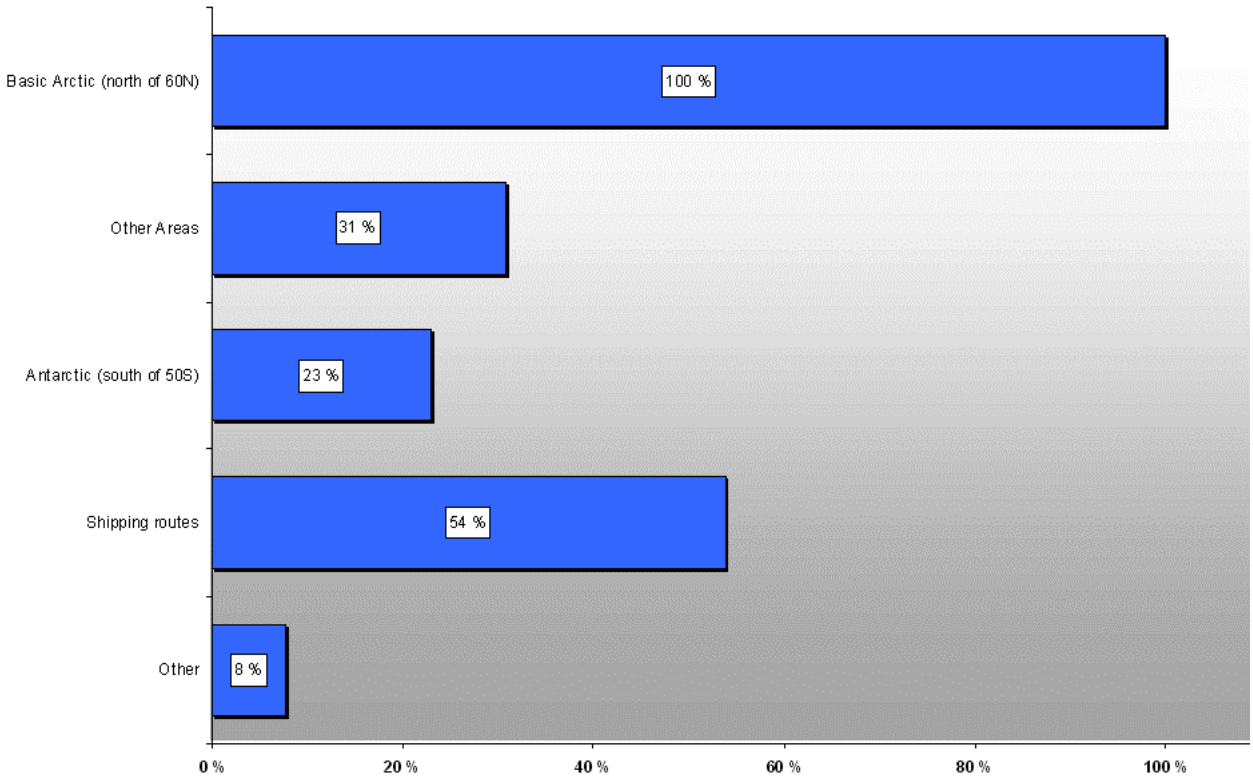

Figure 1: Geographical area of interest

In the Marine Safety segment a total number of 13 users have replied to the questionnaire. Their activities are spread among several categories and some users are involved in several of the categories. Table 2 shows how the different categories are represented.

What area is your organization involved in?	Nummer
Fisheries	1
Oil/Gas	6
Research	5
Shipping	5
Air Logistics	2
Government inspection	3
Insurance	0
Ferries	0
Government environmental	1
Tourism/Adventure	2
Other	1
Wildlife	0

Table 2: Marine Safety core user involvements

2.2 Marine and Costal environment

All SIDARUS core users represented in this segment are involved in the wildlife field. A selection of 2 Scientific & Biology Institutes and 1 University has expressed specific needs of new sea ice products and services to improve their in situ research. These Institutes are monitoring polar wildlife with satellite technology and have contributed to the questionnaire sent by the SIDARUS.

SIDARUS products and services will have an impact on the wildlife field in the Arctic area.

- **Arctic (North of 60) N)** shows to be of high interest for the following zones: European Arctic, Kara sea, Svalbard, Laptev Seza, Baltic Sea, Greenland Norwegian Sea, Denmark Starit, East Siberian Sea, Barents Sea, Fram Strait and White Sea.
- **Other areas:** Beaufort/Chukchi Seas, Caspian Sea, Baïkal Lake, Sea of Okhotsk, Bering Sea, Ladoga Lake.
- **The North West passage** is of interest for the shipping routes users.

Particular comment: one of the users is using sea ice data for polar bear habitat analysis. His research group focuses on a project which matches the bear location data to sea ice and they are planning a new project on the western end of the Northwest Passage. Hence, they are very keen on SIDARUS products.

The wildlife segmentation marked is separated as shown in Table 3 and how the users are expected to benefit from the SIDARUS is expressed in Table 4.

Area of study	Specie	Expected results
West, East Greenland	Bow-head whales, walruses, nawls	Presence and movements of ice, ice condition where animals are: amount? Is it moving fast?
Eastern part of Russia Caspian sea	Juvenile seals	Understand information about animal's habitat and the water/ice limit. Obtain information on water temperature
Northern part of Russia, Greenland	Polar bears	Match the bear location to sea ice data. Understanding of animal's habitat.

Table 3: Wildlife segmentation marked.

Activity	Task	Benefit
High-resolution sea ice and water ice delimitation by SAR	Improvement of SAR-based sea ice and water ice delimitation method to map details of the water coverage as well as ice detection methods.	Improved safety for juvenile seals populations in ice covered with waters. Cost reducing due to improved in situ observation in comparison with the cost of plane counting for colonies of seals. Improved planning tool for optimization of animal distribution.

Table 4: Wildlife user benefit from SIDARUS

NB: CLS is waiting for more feedback from the users.

2.3 Climate and Seasonal Forecasting

This segment is represented in SIDARUS by Université Louvain la Neuve and the Norwegian meteorological institute. Both institutes are running climatologically models for long term prediction of climate studies. Their interest in sea ice is on a global coverage.

In climate models, sea ice dynamics is yet represented in a very simplistic manner. More sophisticated models for simulating and forecasting sea ice dynamics are utilized on regional scales as information source for marine traffic and offshore operations in ice infested waters, and on hemispherical scales for hindcast and forecast simulations of sea ice cover variations in the Arctic and

Antarctic. Hindcast and forecast simulations are needed for investigations on climate variations. Such simulations contribute to the improvement of global models. Progress in understanding the role of different geophysical mechanisms that need to be considered in modelling sea ice dynamics, as well as modern computer technology make it possible to increase the spatial resolution of the numerical models. This requires more detailed parameterizations of relevant small-scale atmospheric and oceanographic processes, such as atmospheric boundary layer turbulences or local heat and salt exchange between atmosphere, ice and ocean, which have to be based on results of field measurements. Hence, satellite observations at different spatial scales need to be employed, i. e. coarse resolution products with the spatial and temporal coverage required for development and validation of or assimilation in numerical sea ice models of the whole Arctic and Antarctic, and high resolution imagery for local and regional observations in support of process studies. Still missing are, for example, systematic high-resolution long-term observations in key regions in support of field campaigns since the latter are often limited in time and/or in spatial coverage.

The data products to be provided by SIDARUS will provide sea ice data that can improve ice modelling, both on global/regional scales (ice thickness, albedo, snow cover characteristics, ice drift) and regional/local scales (ice edge morphology from high-resolution SAR products. The most important climate-related sea ice parameters that will be quantified in SIDARUS are ice thickness including thin ice areas, ice albedo, and leads/polynyas. Another important issue is the unexpected decrease of summer sea ice extent in the Arctic which triggered a stepping up of research efforts regarding the environmental changes in the Polar Regions. In this context, satellite and field data are needed that make it possible to assess the interaction mechanisms between ocean, sea ice and atmosphere in more detail than hitherto. Data on ice thickness on both large-scale, regional and local scale.

3 SIDARUS service portfolio

Presently there exist GMES services which meet some of the existing user's needs. SIDARUS will extend these services with new satellite-derived sea ice products, ice forecasting from regional models and validation of sea ice products using in-situ data.

The services to be developed in SIDARUS and how they will contribute to the different users segment are described in Table 5.

	Service line		
SIDARUS services	**Daily/regular products and services from satellite data**	**Seasonal and interannual products from satellite and non-satellite data**	**User groups**
High-resolution sea ice and iceberg products from SAR	Regional products showing ice types, concentration, deformed ice, icebergs Data from ENVISAT, TerraSAR-X, RSAT-2 Preparation for use of Sentinel-1 data	SAR data and derived products will be available year-round in Arctic and Antarctic Systematic SAR coverage will start with Sentinel-1 from ≈ 2013	Operators including marine traffic, offshore industry (design and operations), shipping, ice and weather forecasting, marine safety
Sea ice albedo	Regular products will be available during the project	Method development to derive seasonal products for spring, summer and autumn. Time series of albedo and meltpond fraction from 2003 to present	Sea ice and climate modellers
Sea ice thickness	Daily products according to SMOS data coverage	Time series of SMOS – derived ice thickness maps Archives of in situ data from submarines, HEM-flights, AUVs	Climate research, sea ice modellers, offshore industry shipping
Sea ice habitat conservation	Daily sea ice maps combined with marine mammal tracking data in selected areas in Arctic and Antarctic	Time series and maps for movement and migration analysis. Archives of products will be available for users	Environmental management, wildlife protection
Ice forecasting	Produced by highresolution ice-ocean model for the Barents Sea. Produced by circumpolar model for the Antarctic	Drift of icebergs in Antarctic circumpolar current and in Arctic combined with detection of individual icebergs within the sea ice zone	Marine Safety (shipping, sailing, offshore)

Table 5: Services delivered by SIDARUS

4 User Requirements

4.1 Need for sea ice, weather and oceanographic parameters

Some of the main points given by the responses from the questionnaire are summarized in the tables below. A complete list can be found in the appendix. Although the user segments have different request for sea ice data there seems also to be some common needs. In the following chapter we have tried to mach the needs to products delivered from SIDARUS.

Need for sea ice data and type of sea ice information most useful for the users are given in Table 6.

		Responce		
Parameter	**Product**	**Marine Safety Responce**	**Marine and Costal environment**	**Climate and seasonal forecasting**
Concentration	Percentage of cover	7	3	2
Concentration	Coverage in classes (e.g open Drift Ice (4/10-7/10). Very closed drift ice (9/10-10/10)	9	1	
Concentration	Ice or No Ice	6	1	
Edge	Detailed ice edge line	7	3	1
Edge	Simplified ice edge line (e.g 10-20 longitude/latitude coordinates)	2	0	
Type	WMO Ice Classes	7	2	2
Type	Simplified ice edge line (e.g 10-20 longitude/latitude coordinates)	7	1	
Drift	Low resolution (10 km)	5	1	2
Drift	High resolution (1 km)	11	2	
Deformation	Ridging	7	1	2
Deformation	Leads and Polynyas	8	2	2
Deformation	Floe Size	6	2	2
Thickness	Actual values	7	1	1
Thickness	Thickness in classes	6	0	
Thickness	Mean Average Thickness	6	1	1

Thickness	Modal Average Thickness	3	0	
Icebergs	Occurrence	10	0	
Icebergs	Size	6	0	
Icebergs	Drift	8	0	
Icebergs	Shape (Normal/Tabular)	4	0	
Other	Snow Cover	4	2	2
Other	Water Cover on ice	3	1	2
Other	Surface Temperature (Freezing/Melting)	7	1	1
	Number of respondents	13	3	2

Table 6: Need for sea ice parameters

It is worth noting that all segments need information of sea ice concentration, edge, type, deformation and thickness while ice berg is only important for the Marin Safety users.

Even though monitoring of polar wildlife is continuous in Polar areas, significant changes of patterns are being observed and require additional data. Biologists and Scientists agree to require the Percentage of Cover and detailed information in edge line as in depth information for their studies. WMO ice classes are also considered as useful, as well as high resolution drift data, leads and polynyas and floe size of ice deformation. Ice thickness is considered as useful.

It is interesting to notice that snow cover, water cover on ice and surface temperature are required as additional information among the wildlife users which will reinforce the studies of breeding behaviour changes due to climate change.

In addition to the need for ice information there are also expressed a need for other environmental parameters as shown in Table 7.

For the Marine Safety users' weather and oceanographic forecasts are important data to increase safety and optimize operations. Air pressure, wind strength and direction are the most important weather parameters. Ocean current and wave height and direction are required ocean parameters.

For both weather and ocean data high resolution is not critical as too much detail can be counterproductive and therefore confusing and hard to interpret. The time range required for weather and sea state information is somewhat longer than for ice information.

Today most users receive weather and ocean forecasts with a typical resolution of 10 km or more. The band width is a limiting factor for receiving data. When operating maritime units, these data are received through Navtex, ENCs or emails and in a planning phase mainly through downloads from websites.

Forecasts are perishable, and frequent updates are requested, often as frequently as possible. There are also users who find it useful to track low pressure systems to optimize the route and navigation in the area.

In the same way as for sea ice information, users rely on graphics rather than text-based products.

		Response		
Parameters	**Products**	**Marine Safety Responce**	**Marine and Costal environment**	**Climate and seasonal forecasting**
Meteocean information	Air pressure	7	2	
Meteocean information	Wind	13	2	1
Meteocean information	Others	2	1	1 (Air temp.)
Oceanographic information	SST	2	2	2
Oceanographic information	Current	10	1	2
Oceanographic information	Chlorophyll	1	1	1
Oceanographic information	Bathymetry	1	1	1
	Number of respondents	13	3	2

Table 7: Meteocean and oceanographic parameters requested

Other type of information required as Atmospheric and Oceanographic specificities are Air temperature, Surface fluxes, resolution higher than 2.5 lat/log degree, and Salinity and tide.

4.2 Requirements for updated information

The Marine Safety user requirement for ice information and weather, ice and oceanographic forecast follow from two aspects of time. The first aspect is during an ongoing activity, where safety and response time are in focus. In these cases requirements of near-real-time ice information is essential as well as meteorological and oceanographic forecast on a short term basis (nowcasting). The other aspect is as a tool for operational planning, where forecasts of sea ice and meteorological and oceanographic conditions in a wider time range is required, mainly as a tool to reduce costs and optimize activities.

For near real time data, frequently updated deliveries are critical and it seems to be important for Marine Safety segment to have updated information as often as possible. For weather forecasts the update frequency is not quite as critical, but still, updated data are important.

For the wildlife users it is also important to have historical data and this segment also emphasize the need of past studies.

How the frequent updated information is required is shown in Table 8.

	Response		
Update frequence	**Marine Safety**	**Marine and Costal environment**	**Climate and seasonal forecasting**
As often as possible	10		
Daily	7	2	1
Weekly	1	1	
Monthly	1	1	1
Annually			
On request for historical data	3	2	

Table 8: Required update frequency of sea ice information

During ongoing activities, as a description of real-time conditions, fine spatial resolution is important. The majority of these users need ice information with a horizontal resolution of 100 meters to 1 kilometre. Lower resolution is required for planning purpose and for climate studies.

	Response		
Spatial resolution	**Marine Safety**	**Marine and Costal environment**	**Climate and seasonal forecasting**
100m	8	2	
1 km	8	1	
10 km	4	1	2
25 km	1	1	1

Table 9: Required spatial resolution

The need for sea ice forecasts are especially highlighted by the Marine Safety users. For short time operational planning purpose a forecast of 2-3 days is most useful. Forecasts are also used as a tool for longer planning of the activities and this are mainly requested by the oil and gas industry. Forecasts do not require the same level of detail, but must still not be too rough.

	Response		
Time period for Ice forecasts	**Marine Safety Responce**	**Marine and Costal environment**	**Climate and seasonal forecasting**
Not applicable		3	1
2-3 days	11		
Week	6		
month	4		
3 months	6		1
1 year	1		1

Table 10: Required time period for sea ice forecasts

4.3 Product delivering

Different users are equipped with different communication systems and the required delivery method varies. During tactical operations near the poles the data band width is a limiting factor. In a planning phase or non real time studies the size limitation is almost negligible and data is downloaded from the web as shown in Table 11. The preferable data format is shown in Table 12.

	Response		
Delivery method	**Marine Safety Responce**	**Marine and Costal environment**	**Climate and seasonal forecasting**
Download from web	10	3	2
E-mail	8	2	
Electronic Navigation chart	9		
Navtex	2		
AIS	7		

Table 11: Preferred delivering mechanism

	Response		
Dataformat	**Marine Safety**	**Marine and Costal environment**	**Climate and seasonal forecasting**
JPEG/PNG/PDF	10		
GeoTiff	4	1	
JPEG2000	1		
GeoPDF	0		
NetCDF	1	1	2
Text (ASCII)	1		
Shapefile	4	3	
S-100	4		

Table 12: Preferred product dataformat

5 Experience from previous user surveys

5.1 ICEMON user survey

The ICEMON project was funded by ESA as one of 10 GMES Service Element (GSE) projects. It started in 2003, and by the end of 2005 ICEMON merged with another GEE project (Northern View) and became Polar View. The ICEMON project was based on existing ice service products, and made enhanced serviced made possible by ESA funding and in parallel national funding was explored.

ICEMON was driven by demands both from policies and regulations as well as users who had operational requirements for met-ice-ocean services. The main drivers were users of sea ice information. The ICEMON assessment was based on information obtained through a questionnaire sent to the ICEMON partners as well as feedback from the partners and other end users during the project development. The user-segments that were defined in ICEMON can broadly be divided into:

A. Ice navigation and sea transport

B. a) Design of ships and offshore constructions. b) Oil and gas industry

C. Port and maritime authorities

D. Environmental monitoring

E. Weather and ice services

F. Climate monitoring and research

Some of these users require low resolution, statistical data; operational users require high-resolution data in near real- time. Data need requirements show also need of NRT, offline or climate parameters, and organization/user requirement segments. High-resolution data in near real-time is required mainly by operational users (users-segments A, E and under operations B b), coarser resolution, off line data by scientific, research, designers and policy users (user-segments B a), B b), C, D and F).

In general the needs identified reflect high ambitions among the users in the various sectors. The most important parameters defined by the Core User Group are:

- Ice concentration
- Ice type
- Ice drift
- Deformation of ice
- Thickness of first-year ice and ridges
- Thickness of multi-year ice and ridges

Common characteristics

For ice navigation as well as research, the following parameters or processes can be described as common factors for the Arctic region as well as for the Baltic Sea.

- Ice limit, ice concentration and (implicitly) also ice type: derived from NOAA/AVHRR. Heavy restrictions in usefulness due to cloud cover and/or darkness most of the year, in the Baltic however mainly during the period November-February.

- Ice concentration, leads/polynyas, ice type, ice drift and ice deformation/ridging: derived from SAR. Although SAR is a cloud-independent source of information, its usefulness is somewhat limited in temperatures above 0°C due to reduced backscatter caused by melting snow.

- Ice edge, ice concentration, ice drift and polynya detection derived from SSM/I: Is mainly used in the Arctic due to coarse resolution.

- Additionally, there is a demand for affordable (low-cost) EO data from an increased number of satellites as well as from multiple sensors in order to improve the accuracy of ice charts and to develop new products e.g. with respect to ice thickness and ice resistance.

Concerning the present situation, physical limitations and needs for development we can define more clearly the difference in requirements for the Arctic compared to the Baltic Sea.

Arctic regions

The Arctic region is characterised by a year-round ice cover and partly very rough ice conditions including ice pressure and heavy, multi-year floes. The information about ice conditions in the Arctic is much more limited compared to the Baltic Sea. Due to the vast area, the inhospitable conditions and shipping restricted to the summer season, the ice mapping of the Arctic waters is even more depending on remote sensing as a source of information. Consequently, the traditional ice charts, basically from a combination of SSM/I and AVHRR data is of too coarse resolution to be useful for navigation.

There are some key areas with specific needs for improved operational monitoring using SAR products such as the Northern Sea Route, Svalbard and Greenland waters including the Fram Strait and the Canadian archipelagos. Climate research and climate modelling requirements are focused mainly on retrieving long reference data sets over periods typically of 10-100 years with coarse resolution compared to SAR.

Improved products are needed for.

- Ice concentration and ice edge, leads/polynyas, ice type, ice drift and ice deformation derived from SAR: In the European Arctic, SAR has so far mainly been used on an experimental basis assisting vessels in specific projects and in demonstrations.
- Distinction between first-year and multi-year ice, as well as ice thickness.
- SAR-based products for habitat studies (environmental monitoring and research)
- High resolution ice products based on SAR as well as ice thickness information from Cryosat gradually.

Baltic sea

The Baltic is characterised by a seasonal ice cover. It is a small area compared to the Arctic, surrounded by well-established ice services. The ice charts produced are of a comparatively good quality. However, due to wind and currents the ice conditions may change rapidly and the drift ice easily becomes compacted against the coasts, against the fast-ice edge or in narrow passages which obstructs the navigation.
Thus, the main problem is to keep the transportation routes through ice open to merchant vessels as there is a large number of port calls to the Baltic region during the winter. This ensures a demand of assistance from icebreakers (Sweden and Finland have about 15 icebreakers altogether, in addition to this there are some 5-8 based in Russia and Estonia) depending on the vessel's size and power. Consequently, detailed ice information based on best available remote sensing techniques is needed in order to maintain and further improve the safety of Baltic sea transportation.

Although the methods for SAR image processing in near-real time have been developed and used successfully at some ice services for several years, the number of SAR-equipped satellites is still too low to provide a temporal resolution suitable for operational purposes. For the same reason ice drift vector algorithms from SAR have so far not been applied here. There is a requirement from the users for more detailed ice charts or other products based on SAR data, especially depicting areas of deformed ice. Ice thickness data is presently obtained either from a small number of coastal stations or observed along the routes of an icebreaker or a ship. Ice thickness data derived from remote sensing would be highly appreciated by all users.

Over the next few years, a growing interest in high-resolution ice forecasts (including data assimilation from SAR and other high resolution instruments) can be foreseen e.g in order to optimize the transit route through the ice field.

6 Conclusion

The user review document aims to describe user requirements for sea ice information in the area of Maritime safety, Marin and costal environment and climate and forecasting. A questionnaire has been sent out to potential users in the respective users segments and analysis show that sea ice is an important parameter for all segments.

In the climate and forecasting segment and also to some extent in the Marine and costal environment segment the number of users is limited. The analyses must therefore be seen as a preliminary result and number of users is expected to increase during the project.

Among the most important parameters are ice concentration, edge, type, drift, deformation and ice thickness. For near real time operators a demand of high spatial resolution is requested. The need for sea ice forecasts are especially highlighted by the Marine Safety segment where 2-3 days of forecast are most useful. Ice berg is only requested by this segment and occurrence, size and drift are all valuable information.

Snow cover and water on ice are more important for the Marine and costal environment and climate and seasonal forecasting segments.

The most important weather and oceanographic parameter for the Maritime Safety segment seems to be wind and ocean current. The other segments have a more general need for weather and ocean parameters.

The preferable delivery mechanism for all users is web download but for operational units there is also a demand for other delivery methods such as data delivered directly in Electronic Navigation systems, e-mail, AIS and Navtex.

Discoveries made in SIDARUS survey is consistent with results from previous studies and shows that there is still an unmet need for sea ice data.

APPENDIX

Part I – Sea ice information

What area is your organisation involved in?

□ Fisheries	□ Oil/Gas	□ Research	□ Shipping
□ Air Logistics	□ Government inspection	□ Insurance	□ Ferries
□ Government environmental	□ Tourism/ Adventure	□ Other	□ Wildlife

How do you use sea ice information?

□ Tactical use (hours up to 2 weeks), e.g. navigation	□ Operational planning (30-day, seasonal to interannual), e.g. route planning	□ Strategic planning (years, decades), e.g. development of new logistics and investment	□ Historical information, eg, for data retrieval or for temporal integration	□ Information integrated with existing user data

What areas of sea ice information provision are you interested in?

□ New types of sea information products from satellite and models

□ Electronic delivery of sea ice information such as Electronic Navigation Charts (ENCs)

□ Information on long-term changes to sea ice (effect of climate change) for strategic planning

What geographical areas would you like to see covered? (Please tick all that apply)

Basic	Detailed		
□ Arctic (north of 60°N)	□ European Arctic	□ Baltic Sea	□ Barents Sea
	□ Kara Sea	□ Greenland/Norwegian Sea	□ Fram Strait
	□ Svalbard	□ Denmark Strait	□ Cape Farewell
	□ Laptev Sea	□ East Siberian Sea	
□ Other Areas	□ Caspian Sea	□ Sea of Okhotsk	□ Labrador Sea/Baffin Bay
	□ Beaufort/Chukchi Seas	□ Bering Sea	□ Ladoga Lake
	□ Baïkal Lake		
□ Antarctic (south of 50°S)	□ Weddell Sea	□ Ross Sea	□ Bellinghausen Sea
	□ Antarctic Peninsula	□ Eastern Weddell Sea	
□ Shipping Routes	□ Northern Sea Route	□ North West Passage	□ Cape Horn
Other areas not shown here:			

What types of sea ice information do you find most useful? (Please tick all that apply)

Basic	Detailed		
□ Concentration	□ Percentage cover	□ Coverage in classes (e.g. Open Drift Ice (4/10-7/10th), Very Close Drift Ice (9/10-10/10th)	□ Ice or No Ice
□ Edge	□ Detailed ice edge line	□ Simplified ice edge line (e.g. 10-20 longitude/latitude coordinates)	
□ Type	□ WMO Ice Classes	□ Simplified (Open Water, First-Year, Multi-Year)	
□ Drift	□ Low resolution (10 km)	□ High resolution (1 km)	
□ Deformation	□ Ridging	□ Leads and Polynyas	□ Floe Size
□ Thickness	□ Actual values □ Mean Average Thickness	□ Thickness in classes (e.g. WMO Ice Classes) □ Modal Average Thickness	
□ Icebergs	□ Occurrence □ Shape (Normal/Tabular)	□ Size	□ Drift
□ Other Parameters	□ Snow Cover □ Water Cover on ice	□ Surface Temperature (Freezing/Melting)	
Other types of information not shown here:			

What types of environmental parameters do you find most useful? (Please tick all that apply)

Basic	Detailed		
□ Meteocean information	□ Air Pressure	□ Wind	□ Others
□ Oceanographic information	□ SST	□ Current □Chlorophyll □Bathymetry	□ Others
Other types of information not shown here:			

How much detail in time, how often would you like to have information updated? (Please tick all that apply)

□ As often as □ Daily □ Monthly □ Annually □ On request for

possible historical data

□ Weekly

How spatially detailed should this information be?

□ 100 metres □ 1 kilometre □ 10 kilometres □ 25 kilometres

What time period of tactical and operational ice forecast (short-term) information is most useful? (Please tick all that apply)

□ Not applicable
□ 2-3 days □ week □ month □ 3 months (seasonal)
□ 1 year

Do you have a requirement for long-term predictions, i.e. on the effect of climate change on sea ice?

□ Not applicable
□ Years □ Decades

What time period of historical information would be useful?

□ Not applicable □ 1 year □ More than 1 year □ Less than 1 year

How would you like information delivered? (Please tick all that apply)

□ Download from web site □ E-mail □ Electronic Navigation Charts (ENCs) □ Navtex
□ AIS □ Other, please specify

Size of product information (I.e. dependent on your communication bandwidth, e.g. low for satellite)

□ Less than 256 characters □ E-mail text only < 10 Kb □ Iridium < 100 Kb □ E-mail with graphics < 1Mb
□ Unlimited (Full Internet access)

What electronic data formats do you prefer?

□ Images □ JPEG/PNG/PDF □ GeoTIFF □ JPEG2000 (streaming)
□ GeoPDF □ NetCDF □ Text (ASCII)

□ Vector □ Shapefile □ S-100 for ENCs □ Text (ASCII)

Other formats not shown here:

Part II – Weather and oceanographic information

A Task Team under the WMO's Executive Council Panel of Experts on Polar Observations, Research and Services, Services is gathering input to assess user/customer needs and perspectives on weather, water, and climate products in the Polar Regions in consideration of a Global Integrated Polar Prediction System. Thank you for providing your valuable input.

How do you use weather and Ocean information?

Please grade the impact of weather information on your business (1=imperative for reducing the costs and risks, 2= has a reducing effect on costs and risks, 3= useful but difficult to quantify, 4=insignificant. Please tick one per line.)

	1	2	3	4
Tactical use (hours up to 2 weeks), e.g. navigation	□	□	□	□
Operational planning (30-day, seasonal to interannual), e.g. route planning	□	□	□	□
Strategic planning (years, decades), e.g. development of new logistics and investment	□	□	□	□

Please grade the impact of ocean information (waves, currents, sea level, temperature etc) on your business (1=imperative for reducing the costs and risks, 2= has a reducing effect on costs and risks, 3= useful but difficult to quantify, 4=insignificant. Please tick one per line.)

	1	2	3	4
Tactical use (hours up to 2 weeks), e.g. navigation	☐	☐	☐	☐
Operational planning (30-day, seasonal to interannual), e.g. route planning	☐	☐	☐	☐
Strategic planning (years, decades), e.g. development of new logistics and investment	☐	☐	☐	☐

How do you currently receive weather and ocean information?

[open question]

What types of weather and ocean information do you find most useful

[open question]

How much detail in time, how often would you like to have weather information updated? (Please tick all that apply)

☐ As often as possible ☐ Daily ☐ Monthly ☐ Annually

How much detail in time, how often would you like to have ocean information updated? (Please tick all that apply)

☐ As often as possible ☐ Daily ☐ Monthly ☐ Annually

How spatially detailed should the weather information be? (1=imperative for reducing the costs and risks, 2= has a reducing effect on costs and risks, 3=useful but difficult to quantify, 4=insignificant. Please tick one per line.)

	1	2	3	4
100 m	☐	☐	☐	☐
1 kilometre	☐	☐	☐	☐
10 kilometres	☐	☐	☐	☐
25 kilometres	☐	☐	☐	☐

How spatially detailed should the ocean information be? (1=imperative for reducing the costs and risks, 2= has a reducing effect on costs and risks, 3=useful but difficult to quantify, 4=insignificant. Please tick one per line.)

	1	2	3	4
100 m	☐	☐	☐	☐
1 kilometre	☐	☐	☐	☐
10 kilometres	☐	☐	☐	☐
25 kilometres	☐	☐	☐	☐

What time period of tactical and operational weather forecast (short-term) information is most useful? (Please tick all that apply)

☐ Not applicable
☐ 0-6 hours ☐ 6-24 hours ☐ 2-3 days ☐ week
☐ month ☐ 3 months (seasonal) ☐ 1 year

What time period of tactical and operational oceanographic forecast (short-term) information is most useful? (Please tick all that apply)

☐ Not applicable
☐ 0-6 hours ☐ 6-24 hours ☐ 2-3 days ☐ week
☐ month ☐ 3 months (seasonal) ☐ 1 year

Medium-term forecasts often are associated with an estimate of the forecast uncertainty, or alternative development paths. Is the forecast uncertainty for your purpose (Please tick all that apply)

☐ essential ☐ useful ☐ difficult to use ☐ distractive

Further contact?

☐ Would you like to receive example products from SIDARUS and provide feedback to the project ?
☐ Would you like to be contacted by SIDARUS Project Team regarding becoming a member of the user group for SIDARUS and helping specify and review sea ice information product needs.
☐ May the WMO executive council panel for experts for polar services contact you for further information on your needs?

Other Comments?

SIDARUS contact for user interaction:

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