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ARICE: Arctic Research Icebreaker Consortium:

**A strategy for meeting the needs for marine-based research
in the Arctic**

Deliverable 6.1.

**Survey on ship born environmental data collection in
the Arctic**

Submission of Deliverable

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Lead Beneficiary	FMI
Contributors	<input checked="" type="checkbox"/> 1 – AWI, <input type="checkbox"/> 2 – SPRS, <input type="checkbox"/> 3 - NPI, <input type="checkbox"/> 4 - ULAVAL, <input type="checkbox"/> 5 – UAF/CFOS, <input type="checkbox"/> 6 – AP, <input type="checkbox"/> 7 – CSIC-UTM, <input type="checkbox"/> 8 – CNR, <input checked="" type="checkbox"/> 9 - WOC, <input type="checkbox"/> 10 – IOPAN, <input type="checkbox"/> 11 – FMI, <input type="checkbox"/> 12 - CNRS, <input type="checkbox"/> 13 – NERC-BAS, <input checked="" type="checkbox"/> 14 – DTU-AQUA
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1. Abstract

We conducted an on-line survey on the environmental data collection on board vessels navigating in the Arctic. The survey was targeted to both the scientific community and the private sector. The results show that the basic meteorological, oceanic and sea ice observations are conducted on nearly all vessels. The basic meteorological and oceanic measurements are already automatic, while sea ice and snow observations are man made. In many cases, the data is stored but the storing and usage of the data vary largely.

Nearly all the respondents indicated an interest in some future collaboration with ARICE.

2. Introduction

The work in WP6 aims to enhance the environmental data collection in the Arctic by engaging private sector vessels to carry automatic instruments and by identifying key technologies that could lead to an improvement of ship-based and autonomous measurements in ice-covered seas. To best do this, we first need to have a clear picture of the current situation. The state of the art was studied with a survey identifying the parameters that are currently measured on board both research and commercial vessels navigating in the Arctic.

The survey was distributed to the private sector via World Ocean Council (WOC) newsletter that reaches over 35 000 people. The research community was approached by contacting directly all ARICE partners as well as other potential research institutes. The survey was opened mid June 2018 for two months. During this period we received only few responses and the deadline was extended by one month, to mid September 2018. Still, the number of responses may have been affected by the timing around the summer break.

The survey collected some key background information about the respondent and his/hers organization as well as about the vessels and types of operation they have in the Arctic. The information about measured variables were collected by providing a matrix including the parameters and options describing the type of the measurement, separately for meteorological, sea ice and snow, and oceanic variables. (Survey form is attached in the end.) The options describing the collection and storing of the data were: 1. Measured, 2. Not measured but data would be useful, 3. Automatic measurement, 4. For navigational purpose only, 5. Data stored and 6. Data transmitted real-time. At the end of the survey, we asked if the respondents if they were interested of being informed and/or collaborate with the ARICE project.

3. Results

In total, we received 25 responses. That number includes few responses from organizations not operating any vessels and some companies/institutes gave duplicate responses. The results cover 13 different ship users or operators, 6 from science and 7 from private sector. Responses from the private sector represent fields of cargo (2 responses), offshore oil and gas (2), tourism (1), fishing (1) and ice breaker owner and operator (1).

The main areas of operation are shown in Figure 1. Majority of the respondents are operating in several areas covering a large part of the Arctic Ocean. The majority of operations take place in the marginal seas, with a clear focus on the western part of the Arctic. Svalbard, Baffin Bay and Barents Sea are the areas with most operators. The eastern sector (Laptev Sea and East Siberian Sea) is the

main operation area for one responding organization only. Only research vessels are operating in the central Arctic. In the open answers, respondents mentioned few ice covered areas where they operate, but that were not included in our list: East and West coast of Greenland, Bering Sea, Bering Strait and Sea of Okhotsk (off Sakhalin).

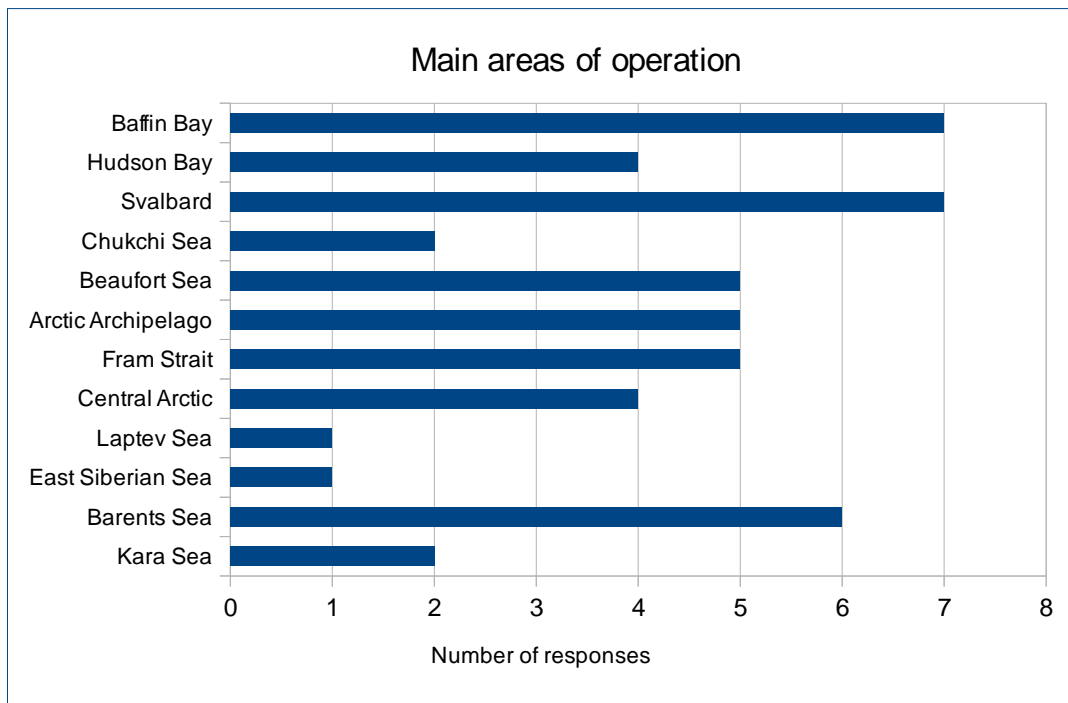


Figure 1. Main areas of operations.

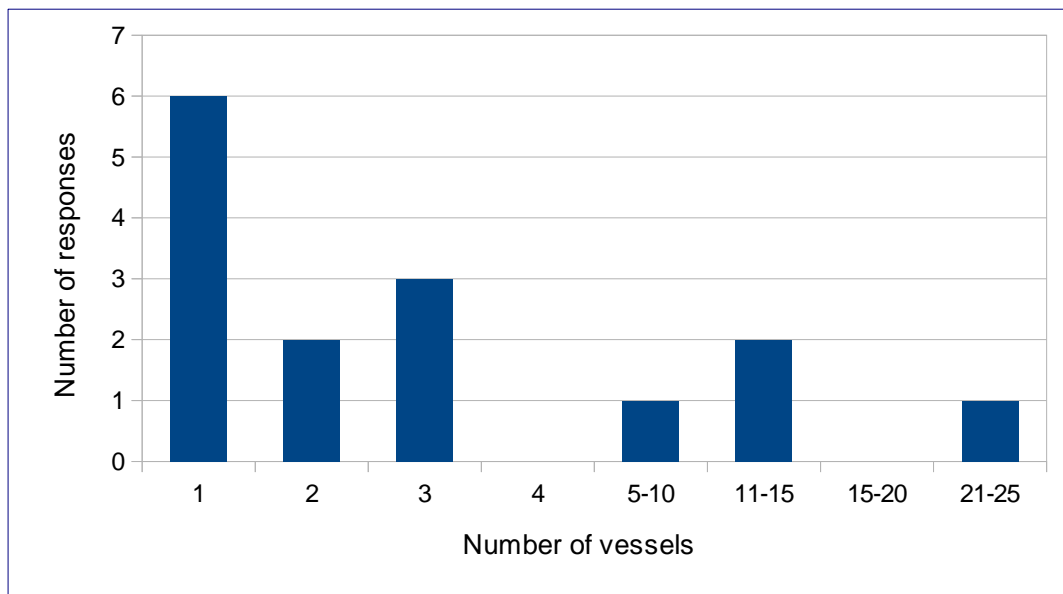


Figure 2. Number of vessels operated by the responding organization.

The frequency of operations varies a lot. Five respondents operate year round, two of them daily and three less frequently. The rest operate during the period from spring to autumn, either daily or by making expeditions of varying length. Majority of the respondents represented organization operating 1 to 3 vessels in the Arctic (Figure 2). All the responding organizations operate ice strengthened vessels, and three have additionally vessels without any ice class.

3.1 Environmental observations

The results about environmental observations conducted on board the vessels are summarized in Figures 3 to 5 for meteorological, sea ice/snow and oceanic variables, respectively.

The basic meteorological variables, air temperature and wind speed and direction, are recorded in all, and air pressure in nearly all vessels. These measurements are mainly automatic (9, 8 and 8 responses for air temperature, wind and air pressure, respectively) and the data is often stored (8, 8, and 7 responses). Almost half of the responding organizations even have a real time transmission of the basic meteorological data from their vessels (5, 6 and 6 responses). Also, water vapor/humidity and greenhouse gases are recorded automatically on the vessel(s) of 6 and 4 respondents, respectively.

Other meteorological parameters are clearly less commonly recorded and these observations are mostly conducted on the research vessels only.

The basic sea ice parameters, sea ice thickness and sea ice concentration, are observed in all the vessels. Also sea ice extent/ice edge and ice drift are commonly recorded (12 and 10 responses). Contrary to meteorological parameters, only one respondent reported any automatic measurements (ice thickness and ice load on the hull). Few respondents reported that the data is stored, but not any sea ice/snow data is transmitted real time.

In the oceanic observations, bathymetry, sea water temperature, currents and sea state are recorded on nearly all the vessels. Also, observations on fish abundance, marine mammals and birds are commonly made. Approximately half of the observations of bathymetry, water temperature, currents and salinity are automatic.

Overall, automatic measurements are still very rare. They are systematically in use for the basic meteorological variables only. However, also many other variables (meteorological, oceanic and sea ice/snow) are frequently observed and the data is stored. In some cases, this means that the data is stored in the ship logbooks only, while some other vessels transmit their data to a national meteorological office.

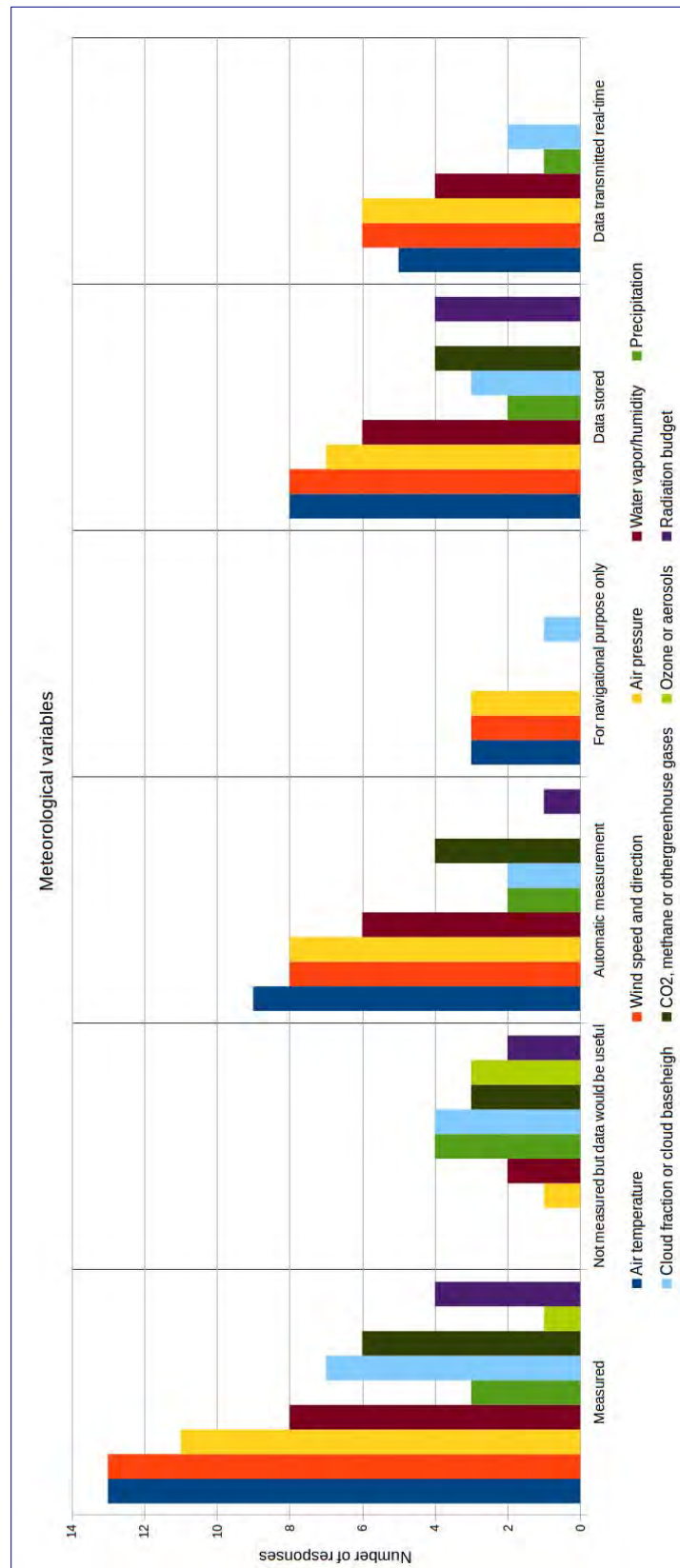


Figure 3. Collection of meteorological data.

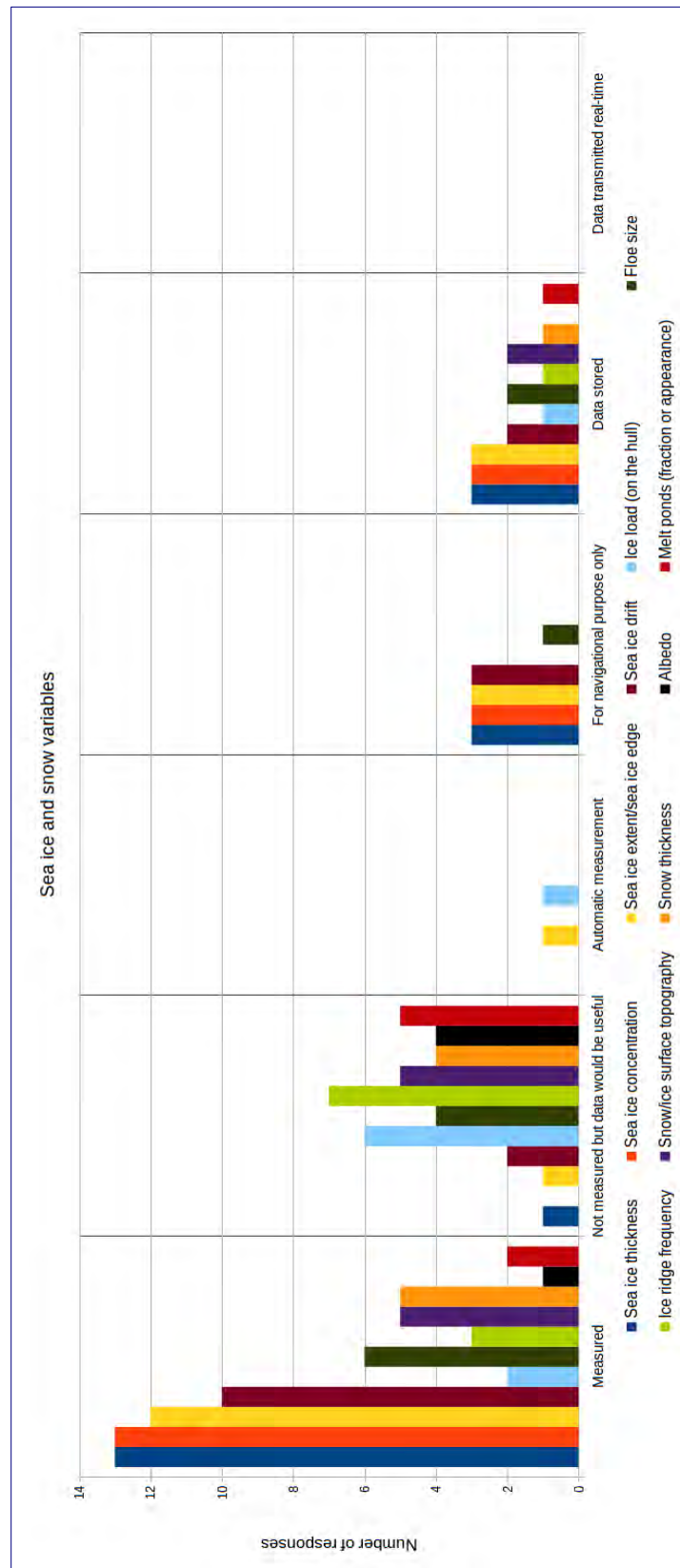


Figure 4. Collection of sea ice and snow data.

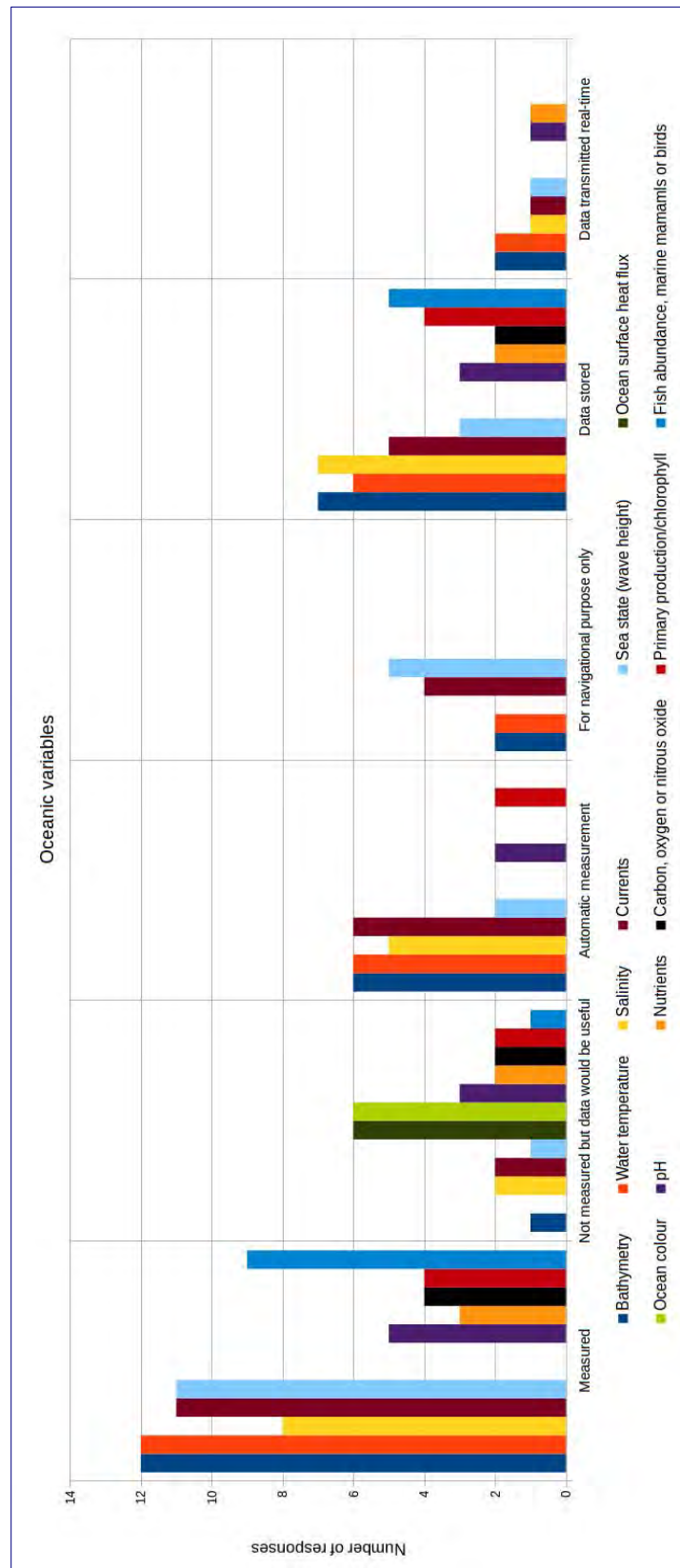


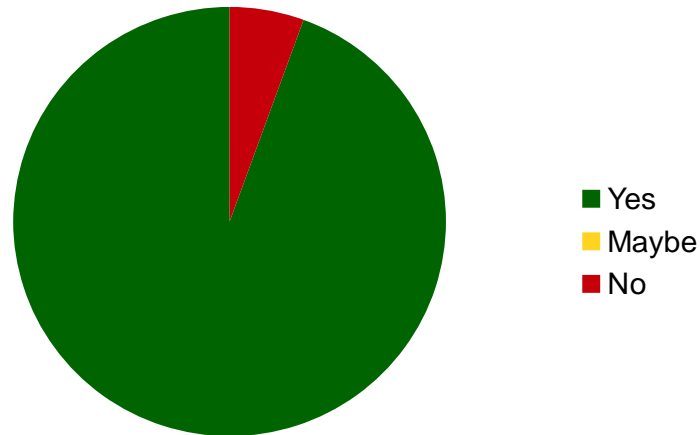
Figure 5. Collection of oceanic data.

3.2 Collaboration

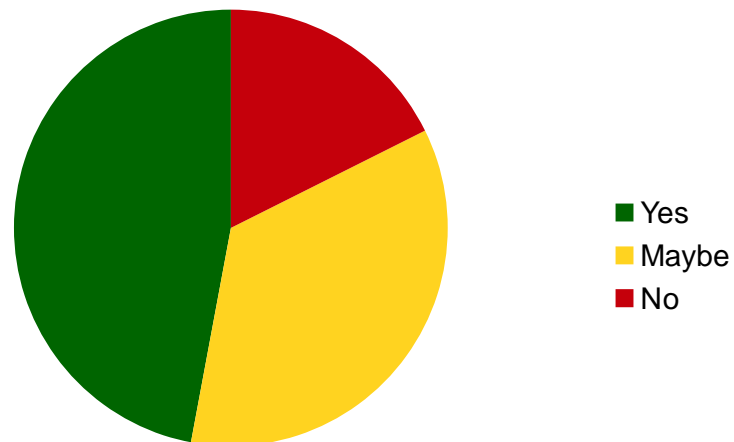
In the end of the survey, we inquired the respondents for their interest in future collaboration with the ARICE project. Overall, the responses were positive.

First two questions were about the exchange of information within the ARICE framework:

1. Would you like to be updated about the progress and news of our work in ARICE project?

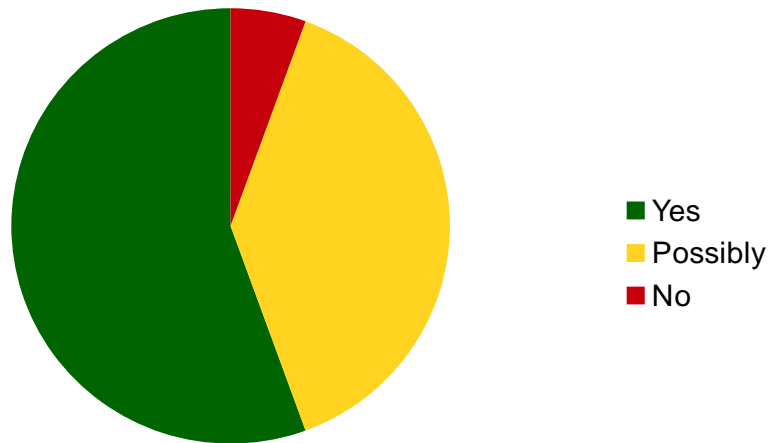


2. Would you be interested in a regular dialog with science community?



The third question was about the collaboration in the data collection. In the survey, we shortly introduced three potential ways of doing this: a) Sharing the data that vessels are currently collecting. b) Welcoming scientist to deploy autonomous instruments on board the vessels. c) Providing access for scientist to the Arctic on board the vessels.

3. Do you see collaboration in data collection possible in the future?



4. Conclusions

The results confirm that the collaboration with private sector is a potential way to increase the environmental data collection in the Arctic. Clear majority of the respondents showed a potential interest in co-operation with science community.

We see two clear aspects in which a development could significantly increase the amount of available Arctic environmental data. Commercial vessels are already now observing several environmental variables, but only few variables are currently recorded automatically. Developments of autonomous instruments would both enhance the data collection and harmonize the data. Another important area that requires development is the accessibility of the data. Majority of the observations are still stored only in the organization collecting the data, and in many cases even only in vessels log books. However, more than half of the respondents reported that they are already now transmitting some data in real-time, meaning that the needed technology exists in many vessels. Currently, the real-time data transmission is mostly limited to basic meteorological variables, while basic oceanic data is transmitted from a few and sea ice/snow data from none of the vessels covered in the survey. Especially for sea ice, this is connected to the lack of automatic measurements. However, also the man made and visual observations of ice conditions would be very useful for ice services, when reported in standardized format and transmitted in near real-time.

ARICE Survey - Ship based observations in the Arctic

In the Arctic, the collection of environmental observations is very limited due to difficult access. However, there is a need for more data. Enhanced data coverage would benefit both the science community and the Arctic marine industry. It would help to deepen the understanding of the wide range of processes behind the changes in the Arctic. This is needed for better forecasting models and risk assessment and thus a key to improved safety and sustainability of all the Arctic operations. In ARICE project, one of our goals is to enhance the environmental data collection in the Arctic by establishing a co-operation between science and marine industry and by identifying new technological solutions to improve ship-based and autonomous measurements.

This survey collects information about the environmental observations that are currently conducted on board vessels navigating in the Arctic, including those observations obtained for navigational purposes only.

It takes only a few minutes to fill this survey. We appreciate your help!

Description of the data protection: https://drive.google.com/open?id=1ektPj4_OEKCiqpY56ANuwzSox7-LnnwR

Name of the respondent:

Your answer _____

Email address of the respondent:

Your answer _____

Company/Institute:

Your answer _____

Job title of the respondent:

Your answer _____

Sector:

- Research
- Tourism/cruise
- Cargo
- Fishing
- Offshore oil and gas
- Governmental
- Military
- Other: _____



NEXT

Page 1 of 6

ARICE Survey - Ship based observations in the Arctic

Background information - vessels and operation

Ship operator:

Your answer

Number of the vessels operating in the Arctic:

Your answer

Number of the ice strengthened vessels:

Your answer

Frequency of operation in the Arctic (times/year):

Your answer

Main area(s) of operation in the Arctic:

- Kara Sea
- Barents Sea
- East Siberian Sea
- Laptev Sea
- Central Arctic
- Fram Strait
- Arctic Archipelago
- Beaufort Sea
- Chuckhi Sea
- Svalbard
- Hudson Bay
- Baffin Bay
- Other: _____



BACK

NEXT

Page 2 of 6

ARICE Survey - Ship based observations in the Arctic

Environmental observations - Atmosphere

From the list below, please select all the atmospheric parameters that are measured on-board while navigating in the Arctic. If the parameter is not measured but the data would be useful, you can note that. Additional information about each measured parameter can be given by choosing all the options (1-4) that describe the measurement or data.

	Measured	Not measured, but data would be useful	1. Automatic measurement	2. For navigational purpose only	3. Data stored	4. Data transmitted real-time
Air temperature	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Wind speed and direction	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Air pressure	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Water vapor or humidity	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Precipitation	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Cloud fraction or cloud base height	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
CO ₂ , methane or other greenhouse gases	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Ozone or aerosols	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Radiation budget	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Other parameters:

Your answer

Comments:

Your answer



BACK

NEXT

Page 3 of 6

ARICE Survey - Ship based observations in the Arctic

Environmental observations - Sea ice and snow

From the list below, please select all the sea ice/snow parameters that are measured on-board while navigating in the Arctic. If the parameter is not measured but the data would be useful, you can note that. Additional information about each measured parameter can be given by choosing all the options (1-4) that describe the measurement or data.

	Measured/Observed	Not measured, but data would be useful	1. Automatic measurement	2. For navigational purpose only	3. Data stored	4. Data transmitted real-time
Sea ice thickness	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Sea ice concentration	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Sea ice extent/sea ice edge	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Sea ice drift	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Ice load (on the hull)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Floe size	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Ice ridge frequency	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Snow/ice surface topography	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Snow thickness	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Albedo	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Melt ponds (fraction or appearance)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Other parameters:

Your answer

Comments:

Your answer



BACK

NEXT

Page 4 of 6

ARICE Survey - Ship based observations in the Arctic

Environmental observations - Ocean

From the list below, please select all the oceanic parameters that are measured on-board while navigating in the Arctic. If the parameter is not measured but the data would be useful, you can note that. Additional information about each measured parameter can be given by choosing all the options (1-4) that describe the measurement or data.

	Measured/Observed	Not measured, but data would be useful	1. Automatic measurement	2. For navigational purpose only	3. Data stored	4. Data transmitted real-time
Bathymetry	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Water temperature	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Salinity	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Currents	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Sea state (wave height)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Ocean surface heat flux	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Ocean colour	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
pH	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Nutrients	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Carbon (inorganic or organic), oxygen or nitrous oxide (N2O)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Primary production / Chlorophyll	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Fish abundance, marine mammals or birds	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Other parameters:

Your answer

Comments:

Your answer



ARICE Survey - Ship based observations in the Arctic

Interest in future collaboration

Collaboration between scientific community and private sector can be one solution for the lack of environmental observations in the Arctic. Better data coverage would benefit both sides. It would help to deepen the understanding of processes behind the changes in the Arctic. This is needed for better forecasting models and risk assessments and thus a key to improved safety and sustainability of all the Arctic operations.

One way towards better data coverage is a development of new technologies. In ARICE project we want to identify new key technologies that could lead to an improvement of ship-based and autonomous measurements in the Arctic. These new technologies could also provide important additional information of the current conditions and thus support the decision making and improve the safety of operating in ice covered waters.

Would you like to be updated about the progress and news of our work in ARICE project?

- Yes
 No

Would you be interested in a regular dialog with science community?

- Yes
 Maybe
 No

Name and email address of the contact person (if not the respondent):

Your answer

Science - industry collaboration in data collection could take place in various ways. Already now several environmental parameters are commonly measured on ships. Currently, this may be mostly for navigational purposes but these data could be very valuable for scientists and sharing these could be a first step to fill the gaps in data coverage. As another way of co-operation, private sector operators could allow scientists to deploy autonomous instruments on board their vessels. Also, providing an access for scientist to the Arctic would help expanding the data collection.

There are many possible ways for the collaboration and all of them are very valuable in our common objective to better understand the Arctic environment.

Do you see this types of collaboration in data collection possible in the future?

- Yes
 Possibly
 No

Comments:

Your answer

