EC PORS Services Task Team

White Paper (First Draft)

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Table of Contents

Introduction

The World Meteorological Organization (WMO) at its 16th Congress (2011), adopted a resolution (Resolution 11.9/3 (Cg-XVI))[1] regarding an initiative to develop a **Global Integrated Polar Prediction System (GIPPS)**, capable of providing information to meet user needs for decision making on timescales from hours to centuries. The global benefits of such a system are envisioned in terms of enabling service delivery and developing observing strategies in polar regions, and in addressing key uncertainties in weather, climate, water and related environmental variability and change, thereby improving global prediction. This initiative would contribute to all WMO high priorities, in particular Disaster Risk Reduction, and the Global Framework for Climate Services (GFCS)[2]. The Congress agreed to embark on a multi-year endeavor towards GIPPS, as a legacy of the International Polar Year (IPY), to benefit the global community.

The word 'Global' in GIPPS reflects that it would be an international effort and that the poles, including the *Third Pole*[3], affect systems (weather, climate, hydrological, oceanographic, biological, chemical, etc) globally; 'Integrated' reflects the interconnections between all these systems, and also because the System itself will be based on the principles of operational services, observations, and research related to this that are integrated and aligned[4]. For polar areas, GIPPS is seen as becoming a foundation of delivering the WMO's substantial contribution to, "*...the protection of life and property against natural disasters, to safeguarding the environment and to enhancing the economic and social well-being of all sectors of society in areas such as food security, water resources and transport*[5]."

The WMO Executive Council Panel of Experts on Polar Observations, Research and Services (EC PORS) formulated the vision of the GIPPS through its first two meetings in Ottawa, Canada in 2009 and Hobart, Australia in 2010. A Concept Paper[6] was developed by EC PORS members to articulate the scope and objectives of the GIPPS for the consideration of the

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1 WMO Congress XVI Draft Resolutions: http://www.wmo.int/pages/prog/sat/meetings/documents/PSTG-1_Inf_04_CG-16-PINK11-9-POLAR-ACTIVITIES.pdf

2 Paragraph 11.9.5, Annex to Paragraph 11.9.5, and Resolution 11.9/3 from General Summary of Congress XVI, Agenda Item 11.9, "Other Cross-Cutting Matters – WMO Polar Activities"

3 Himalaya and Tibetan Plateau region

4 See Section 6.4 at http://www.wmo.int/pages/prog/www/WIGOS_6_EC_PORS/Final_Report2010.pdf

5 http://www.wmo.int/pages/about/index_en.html

6 http://www.wmo.int/pages/prog/arep/wwrp/new/documents/Doc3_3.pdf

WMO Congress. It was determined the development of a GIPPS must be service-driven and meet the vision and objectives of the WMO Strategic Plan. The objectives of the GIPPS are to:

- meet 'user requirements' for high northern and southern latitudes, as well as for the Third Pole;
- accurately predict the future state of the atmosphere; sea ice; (upper) ocean; and hydrosphere/cryosphere, particularly where prediction systems that are tuned for lower latitudes are less robust; and
- be supported by appropriate observational systems and enabling scientific research and development.

The purpose of this paper, as a continuation of EC PORS work on the GIPPS, is to define and validate the needs and opportunities for improving weather, ice, water, and climate services in the polar regions; relate these to the GIPPS concept; and ensure the concept of a GIPPS would be responsive to user requirements.

Background

Weather, snow and ice play a central role in operations and daily life in the polar regions, and the climate is an ever-present influence. To appreciate the perspectives of users of weather, water, and climate services in the polar regions, it is important to gain an understanding of the polar environment and its relative challenges.

There are many settlements in the northern polar region, including within the United States (Alaska), Canada, Denmark (Greenland), Iceland, Norway, Sweden, Finland and the Russian Federation. Arctic circumpolar populations share common challenges and influences but are extremely diverse communities with unique cultural interests. The Arctic region is home to almost four million people[7], including an increasing majority of non-indigenous settlers. Economically, the region depends largely on natural resources, ranging from oil, gas, and metal ores to fish, reindeer and birds. Recently, the tourism sector has also grown in many parts of the Arctic.

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[7] AMAP, 1997. Arctic Pollution Issues: A State of the Arctic Environment Report. Arctic monitoring and Assessment Programme (AMAP), Oslo, Norway. xii+188 pp.

Populations are commonly distributed along or are dependent on coastal waterways and river systems for transportation, access to goods and services, and subsistence activities such as fishing and hunting. River communities depend on accurate hydrology, river, and ice forecasts to assess flood vulnerability and freeze/thaw impacts. These river systems also provide critical habitats for species important to indigenous populations and commercial interests. Coastal communities depend on accurate knowledge of ice edge e.g., for hunting of marine mammals or fish. Coastal freshwater discharge and upwelling play an extremely important role in marine ecosystems, as they affect fish and wildlife, glacial retreat, and ultimately sea level rise. Ocean storms pose complex weather and oceanographic hazards that threaten ships and infrastructure offshore as well as coastal communities. Frequent ocean storms over ice-free areas have a compounding effect on coastal erosion problems and can disrupt traditional subsistence activities for indigenous peoples.

The southern polar region has no permanent human habitation. There are a number of permanent research stations: McMurdo Station, Palmer Station and Amundsen-Scott South Pole Station (United States), Troll Research Station (Norway), Esperanza Base and Marambio Base (Argentina), Scott Base (New Zealand), and Vostok Station (Russia). While there are no indigenous human cultures, there is a complex ecosystem, especially along Antarctica's coastal zones. Moreover, the South Pole is governed by an international treaty, a very specific governance arrangement and different from the governance of the North Pole.

The polar regions experience daily incremental changes in daylight hours leading to the extremes of twenty-four hours of daylight in summer and complete darkness at mid-winter. These are the coldest parts of the earth, covered most or all of the year by ice and snow. The large amount of ice and snow also reflects a large part of what little sunlight the polar regions receive, contributing to extremely cold temperatures in winter. Glaciers are present wherever there is sufficient precipitation to form permanent ice. The polar ice packs significantly change their size during seasonal changes of the year. Sea ice cover (extent and character) in the Arctic has major implications for industry (shipping, commercial fishing, resource extraction), the lives and livelihoods of the residents, and the culture and infrastructure of the communities. The winter freeze-up and spring melt cycles are important drivers of transportation, subsistence, and even recreational activities.

The weather and climate of the polar regions are influenced by the polar ice caps and adjacent oceans. The Arctic Ocean and the Southern Ocean (the ocean around Antarctica) have different characteristics than the rest of the world's oceans. These differences, particularly with regard to circulation, ice cover, productivity, and biologic diversity have a profound impact on the people and other living things inhabiting the polar regions.

The International Convention for the Safety of Life at Sea (SOLAS) is an international maritime safety treaty. The first version of the treaty was passed in 1914 in response to the sinking of the *RMS Titanic*. The Convention was updated and amended several times over the years. The Convention in force today is sometimes referred as SOLAS, 1974[8]. In part, it places requirements on all vessels regarding voyage and passage planning, expecting a careful assessment of any proposed voyages by all who put to sea. Every mariner must take account of all potential dangers to navigation, weather forecasts, tidal predictions, the competence of the crew, and all other relevant factors. These requirements apply to all vessels and their crews, including yachts and private craft, on all voyages and trips including local ones. SOLAS, 1974, effectively provides the mandate for the government provision of marine weather and sea ice services.

The Services Task Team would appreciate the help of EC PORS members in the Himalayan-Tibetan Plateau area to provide relevant background for this section.

Existing Services

National Meteorological and Hydrological Services observe weather, ice and water conditions around the world, providing a steady flow of data which are then transmitted worldwide for forecasts and planning purposes (WMO World Weather Watch). Forecasts and warnings are generally provided for surface, marine, and aviation weather interests, with emphasis when possible on high-impact events such as extra-tropical storms and polar lows, storm surge and other coastal hazards, heavy precipitation, floods, droughts, volcanic ash, and space weather. Services are delivered through a number of media from the Internet to high frequency (HF) radio broadcasts.

[8] http://www.imo.org/About/Conventions/ListOfConventions/Pages/International-Convention-for-the-Safety-of-Life-at-Sea-%28SOLAS%29,-1974.aspx

Meteorological and oceanographic services provided by various governments across the world, and indeed within the polar regions, vary in terms of content, presentation, and time scales covered. General forecast services, designed for land areas with permanent populations, are typically more robust than those for the coastal marine and offshore/high seas environments. "Public" weather forecast information is generally available on an hourly to daily basis for five to ten days in advance, containing routine information about temperatures, winds, and precipitation and warnings or alerts for extreme weather. Marine forecasts are generally less detailed – provided for broad areas – and do not extend as far into the future. Forecasts of wind, sea, and weather conditions are generally provided for 24 hours up to 72 hours in some locations with more general outlooks out through five days. In marine forecasts, hazards such as strong winds, freezing spray (ice accretion), fog, and heavy seas are emphasized. Marine and oceanographic services are also provided by the private (commercial) sector, primarily to provide greater detail in forecasts and analysis to support commercial ship routing, oil and gas development, etc.

Sea ice services are handled and distributed both by various national institutes and commercial companies. The provision of ice charts and basic forecasts are usually governmental responsibility for the safety at sea. Current sea ice services are largely concentrated on the production of near-real-time ice information (analyses). Ice products are created by combining data from satellites, limited aerial and shipboard observations, and in-situ sensors, using models and expert analysis. Detailed ice information is required by a wide spectrum of users operating in ice-affected regions e.g. native hunters, cruise ships, commercial ships, supply ship, ice breakers.

The IPY Ice Logistics Portal is a joint initiative of the Joint WMO-Intergovernmental Oceanographic Commission (IOC) Technical Commission for Oceanography and Marine Meteorology/Expert Team on Sea Ice (JCOMM/ETSI) and Polar View, aimed at creating a convenient point of access to operational sea-ice information produced by the world's ice services. The Polar View team consists of companies and research organizations from across Canada and Europe, committed to establishing a dedicated service center for addressing polar issues using earth observation technologies.

National hydrological services measure and monitor hydrologic variables and issue predictions for effective water resources management and flood management. The WMO promotes water-resources assessment and provides the forecasts needed to plan water storage, agricultural activities and urban development (Hydrology and Water Resources Programme). Like meteorological information, hydrologic services vary in terms of content, presentation, and time scales covered. Services are generally designed to ensure forecasts and warnings of hazardous events such as floods and droughts, as well as provide information necessary for important resource management activities. In many countries, the hydrological services are a separate entity from the meteorological services and, often, belong to different ministries with very different missions. As with meteorological and oceanographic products and services, the private (commercial) sector provides more focused hydrological information to meet the needs of their customer base, i.e., dam operators, reservoirs, etc..

Climate services take several forms, from statistical information based upon historical records to predictions based upon computerized general circulation models to consensus-driven outlooks developed through regional forums (Regional Climate Outlook Forums). Like weather and oceanographic services, climate services are delivered both by government organizations and private companies. The WMO Climate Information and Prediction Service (CLIPS) project focuses on the promotion of operational climate prediction services, particularly on seasonal to inter-annual scales in a user-targeted manner.

The Services Task Team would appreciate the help of EC PORS members in the Himalayan-Tibetan Plateau area (i.e., "Third Pole") in order to represent current services in that region.

Arctic and Antarctic Drivers

While the provision of weather and oceanographic services is inherently challenging in the polar regions where observational data is sparse and the climate is particularly harsh, this work is further complicated by climate change. Numerous reports have highlighted the extent and rapidity of climate changes at high latitudes. There is now widespread evidence of overall change in the Arctic region.

- Atmosphere – Recent Arctic temperature increases are more than double those found at more southerly latitudes. The Arctic's 2008 annual mean air temperature over land was the fourth warmest on record, which continues a long-term upward trend.
- Sea Ice – Four of the last five years represent the lowest sea ice extents on record, with open water extending later into the fall prior to freeze-up. Thick multi-year sea ice has decreased 35 percent in the last five years.
- Ocean – Ocean ecosystems are shifting due to a combination of Arctic warming, large natural variability, and sensitivity to changing sea ice conditions.[9]

Led by a team of 121 international scientists from 14 countries, the 2011 Arctic Report Card[10] shows that record-setting changes are occurring throughout the Arctic environmental system. Higher temperatures in the Arctic and unusually lower temperatures in some low latitude regions are linked to global shifts in atmospheric wind patterns. A shift in the Arctic Ocean system since 2007 is indicated by the decline in ice age and summer extent, and the warmer, fresher upper ocean. Continued dramatic loss of ice sheet and glacier mass, reduced snow extent and duration, and increasing permafrost temperatures are linked to higher Arctic air temperatures. Since 1998, biological productivity at the base of the food chain has increased by 20%. Polar bears and walrus continue to lose habitat in Alaskan waters. Increased "greenness" of tundra vegetation in Eurasia and North America are linked to an increase in open water and warmer land temperatures in coastal regions. All have repercussions and consequences to those who work, live, and play in the Arctic region.

The Arctic ecosystem is changing in terms of permafrost degradation, increasing winter runoff, coastal erosion, and reduced ice thickness, and there is increasing concern about how people and industries will adapt. Changes in water regimes, their intensity and flood frequency have direct consequences for the transfer of pollutants into the Arctic Ocean. Sea ice cover (extent, thickness, and character) in the Arctic has major implications for industry, the lives and livelihoods of the residents, and the culture and infrastructure of the communities. Polar sea ice

[9] http://www.arctic.noaa.gov/docs/NOAAArctic_V_S_2011.pdf
[10] Richter-Menge, J., M. O. Jeffries and J. E. Overland, Eds., 2011: Arctic Report Card 2011, http://www.arctic.noaa.gov/reportcard

has been diminishing in recent years and economic sectors such as shipping, tourism, fishing, mining, and energy development stand to gain from increased access to the regions.

Changes in Arctic climate have local to global implications. The following is an excerpt taken from NOAA's Arctic Vision and Strategy[11]. "The polar regions, though physically remote from the population centers of the globe, have profound significance for the planet as a thermostat to stabilize the Earth's climate. They act not only as regulators of global temperature, but also as barometers of change. Environmental concerns are increasing as reductions in sea ice and other climate-induced changes bring increased opportunities for economic development and increased access to Arctic resources. These economic drivers, in turn, can further threaten ecosystems and Arctic inhabitants already impacted by the rapidly changing climate. The risks to sound Arctic policy and stewardship are further intensified because the science that underpins many of the decision-making processes and support services is largely inadequate."

The Services Task Team would appreciate the help of EC PORS members in the southern polar region as well as for the "Third Pole" in order to better understand the service drivers in those regions.

User requirements

As an outcome of the Second Session of EC PORS in Hobart, Australia, October, 2010, a small team of EC PORS members agreed to facilitate the conducting of a survey to capture the service requirements of the marine community in the polar regions. To get the most out of a survey, the team made use of already existing projects with similar tasks of ascertaining user requirements.

A questionnaire was developed in support of a 7th Framework Programme of the European Commission project entitled, Sea Ice Downstream Services for Arctic and Antarctic Users and Stakeholders (SIDARUS), to define user requirements for sea ice services. The EC PORS Services Task Team was permitted to add a section to this questionnaire to assess the needs and perspectives of these users/customers on weather, water, and climate products in the High latitude regions. Within the European Global Monitoring for Environment and Security

[11] http://www.arctic.noaa.gov/docs/NOAAArctic_V_S_2011.pdf

(GMES) project, ICEMAR, the same questionnaire was also used and the answers received are jointly handled by both projects.

In mid April 2011, the user questionnaire was distributed by the SIDARUS project to selected groups of maritime users within the area of Maritime safety, Marine and coastal environment as well as Climate and forecasting. A user requirement review document[12] has been published by the project and some result from it will be presented below. The ICEMAR project sent the questionnaire to additional users, and the U.S. National Weather Service used the same questions to survey a selected group of marine users in Alaska.

At present, the WMO Marine Meteorology and Ocean Affairs Division has a questionnaire published on the JCOMM website to monitor the effectiveness of weather and sea bulletins produced and transmitted by meteorological services. This questionnaire is trying to assess the broadcast effectiveness of Maritime Safety Information to vessels at sea, i.e., reception of GMDSS information, but the questionnaire is also evaluating the comprehensiveness, accuracy, timeliness, and usefulness of other information received by these vessels, i.e., storm and gale warnings, sea ice and iceberg information, sea state, and general issues in weather and sea bulletins. The results from this questionnaire may prove beneficial to EC PORS as well but is so far not included in the result below.

It is important to note that the extended SIDARUS questionnaire was sent to a very small subset of marine users/customers in the polar regions, so the results summarized below do not reflect the needs of other communities and does not address the "Third Pole." Furthermore, the Services Task Team does not include anyone from the southern polar region, who could bring those perspectives to this White Paper. Nonetheless, this White Paper gives us a snapshot of the needs expressed by very important user communities in the Arctic region (Table 1). Additional responses are still coming in, so results should be considered preliminary. A copy of the questionnaire can be found in Appendix 1.

[12] Document D.1.1: User requirement review document, SIDARUS – EC Grant Agreement 262922.

Table 1: Responders to the questionnaire

#	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	Arctia Offshore	Marine Safety	Finland
19	Expedition Shipping Company	Marine Safety	Canada
20	Swedish Maritime Administration, Ice breaker Atle	Marine Safety	Sweden
21	Swedish Maritime Administration, Ice breaker Atle	Marine Safety	Sweden
22	Australian Antarctic division	Marine and coastal environment	Australia
23	M/T Perseverance. Transpetrol	Marine Safety	Belgium

24	Swedish Maritime Admnistration, Ice breaker Frej	Marine Safety	Sweden
25	Research Vessel Marcus G. Langseth (Lamont Doherty Environmental Observatory)	(not included in SIDARUS survey)	U.S
26	US Coast Guard Healy	(not included in SIDARUS survey)	U.S
27	Horizon Anchorage	(not included in SIDARUS survey)	U.S
28	Crowley Maritime Corporation	(not included in SIDARUS survey)	U.S

Weather and Oceanographic Information:

The Services Task Team wanted to assess how marine customers in the Arctic used weather and ocean information for their mission. We asked the users to consider the use of weather and information for tactical purposes (hours up to two weeks), operational planning (30 days or on a seasonal to inter-annual basis), or for strategic planning, e.g., development of new logistics and investment on a time frame of years to decades. When asked about the impacts such information has to their mission, 19 respondents indicated that, for tactical purposes, such information was imperative for reducing or has a reducing effect on the costs and risks to their mission; and for operational and strategic planning, 13 respondents indicated the information was imperative for reducing or has a reducing effect on the costs and risks (Figure 1).

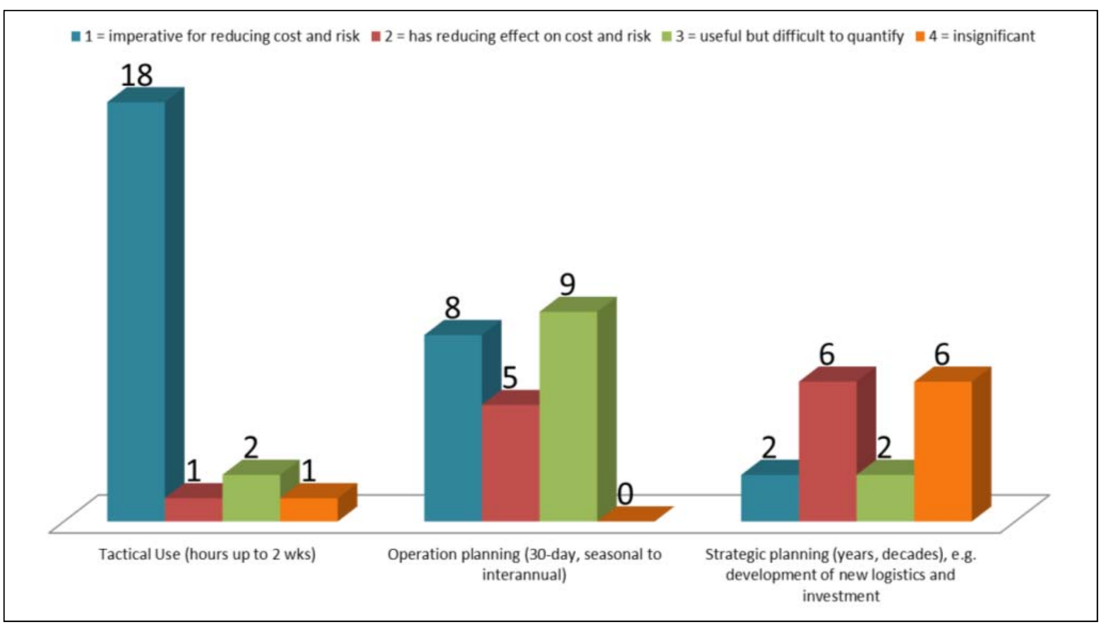

Figure 1

The results were even more illuminating when these marine users were asked to evaluate the impact of ocean information on their business, i.e., waves, currents, sea level, temperature, etc. For tactical purposes, 20 respondents indicated that such information was imperative for reducing or has a reducing effect on the costs and risks to their mission (Figure 2). Clearly, marine users in the Arctic consider weather and ocean information very important to enable them to accomplish their mission.

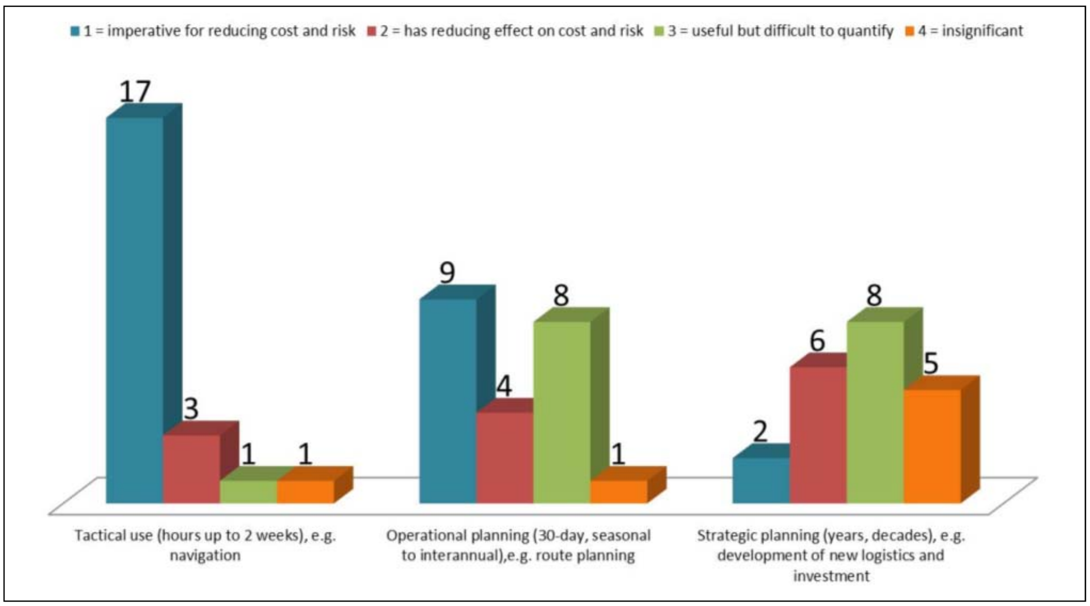

Figure 2

In the questionnaire, respondents were asked to assess the importance of spatially detailed weather and ocean information to their mission. Figure 3 summarizes the spatial needs for weather information by the respondents to the questionnaire and evaluates the impact of this information on their mission. Although 6 respondents indicated that it would be useful to have weather data at a resolution of 100 m, they also indicated that it would be difficult to quantify the impacts to their mission. Eight respondents indicated that having weather information at a spatial resolution of 100 m would be imperative for or have a reducing effect on their costs and risks. The greatest majority of respondents – 14 – indicated that having weather information at a spatial resolution of 10 km would be imperative for or have a reducing effect on their costs and risks.

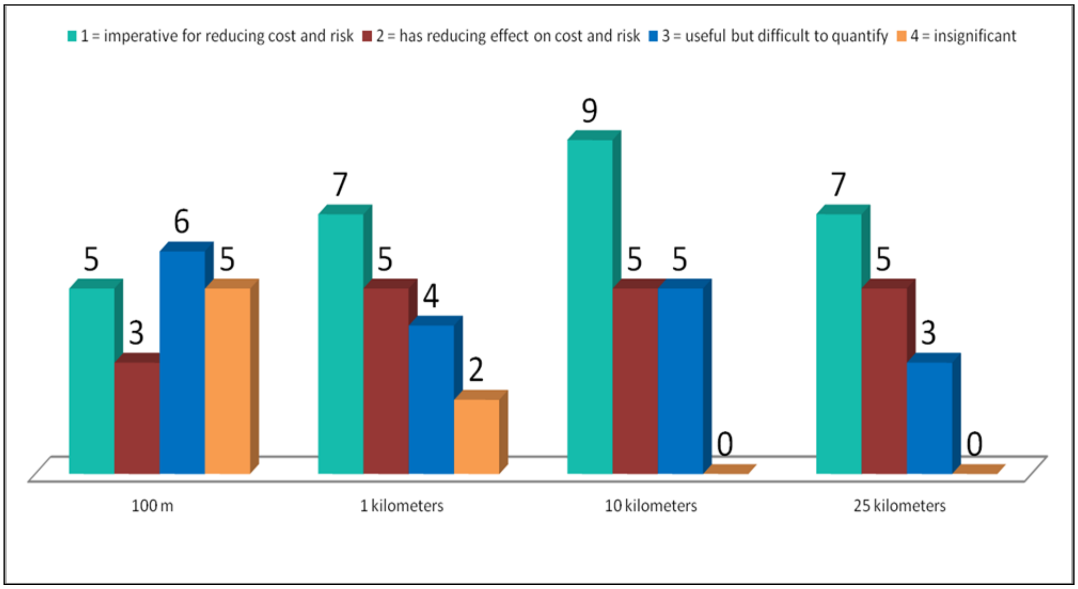

Figure 3

Forecasts are also perishable, and frequent updates are requested by users, often as frequently as possible. From the questionnaire, 11 and 14 of the respondents indicated that they would like to have oceanographic and weather information updated as often as possible, respectively. Having this information updated daily was the next highest preference (12 for weather; 14 for oceanographic data). Far fewer respondents indicated an interest in having this information updated either twice per day, weekly, monthly, or annually (7 for weather; 6 for oceanographic data).

To better understand what products the marine users found most useful in the operation of their business, 18 respondents provided an answer ranging from current conditions for temperature (air and sea surface), pressure (air and sea level), wind (direction and speed), visibility, currents, wave heights and direction, swell, weather conditions (snow, rain, fog, etc.), and ice reports. According to the SIDARUS preliminary report, the most important weather and oceanographic parameter for the "maritime safety" user segment seems to be wind and ocean currents; ice is presented separately below. The other user segments ("marine and coastal environment" and "climate and seasonal forecasting") have a more general need for weather and ocean parameters. The British Antarctic Survey indicated that they also valued access to historical archives of weather and oceanographic information to support science and modelling projects.

The Services Task Team would appreciate the help of EC PORS members in the southern polar region as well as for the "Third Pole" in order to better understand weather and oceanographic needs in those regions.

Sea Ice:

The SIDARUS survey broke up their analysis into three distinct user groups: maritime safety, marine and coastal environment, and climate and seasonal forecasting. The SIDARUS preliminary report indicates that sea ice is an important parameter for all of these user segments. Among the most important parameters are ice concentration, edge, type, drift, deformation and ice thickness. The SIDARUS preliminary report found that for both weather and ocean data, high spatial resolution is not critical as too much detail can be counterproductive and, therefore, confusing and hard to interpret. Fourteen respondents indicated a requirement for sea-ice information at 1 km resolution; 13 indicated a requirement for 100 m. The need for sea ice forecasts are especially highlighted by the "maritime safety" user segment where 19 respondents indicated that 2- or 3-day forecasts are most useful. When the users were asked how they used sea-ice information, 19 respondents indicated they use it for tactical purposes (defined as hours up to two weeks, i.e., navigation); 14 respondents indicated they use it for operational planning (defined as 30-day, seasonal to inter-annual, i.e., route planning); and 8 respondents indicated they use the information for strategic planning (defined as years or decades, i.e., development of new logistics and investment). Ice berg information is only requested by the "maritime safety" user segment and occurrence, size, drift, and shape are all valuable information. The U.S. Coast Guard *Healy* and Swedish ice breaker *Atle* were the only marine users indicating that they found satellite imagery of ice useful.

Furthermore, SIDARUS found that snow cover and water on ice are more important for users within the "marine and coastal environment" and "climate and seasonal forecasting" user segments.

Climate:

In the SIDARUS survey, only one question was asked on the need for long-term prediction, i.e., the effect of climate change on sea ice. The two respondents -- the Universite Louvain la Neuve and the Norwegian Meteorological Institute -- run climatological models for long-term prediction, but in climate models, sea-ice dynamics is still only represented in a very simplistic manner.

Information Delivery:

At present, many of the respondents to the questionnaire indicated that they receive their information via the Internet but some are receiving their data via facsimile, e-mail, or radio. The SIDARUS project found that 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, Automatic Identification System (AIS) and Navtex.

It is important to remind the reader again that our results were based on just a small sampling of users in the Arctic region, so results could be different not only for users/customers in the southern polar region but also for those in countries comprising the "Third Pole."

Service Gaps

There are a number of papers, essays, plans, and other documents articulating viewpoints on the information and understanding needed to improve weather, water, and climate services in the polar regions. This paper will endeavour to capture a consensus survey of the fundamental service requirements, specifically with regard to current gaps.

The WMO Strategic Plan provides direction for the period 2012-2015 to address global societal needs. The work of the EC PORS and the concept of a GIPPS will support the WMO's "Strategic Thrusts"[13] of improving service quality and service delivery, advancing scientific research and application, as well as development and implementation of technology, and

[13] ftp://ftp.wmo.int/Documents/SESSIONS/Cg-XVI/English/DOCs/d08-1%281%29_rev1_STRATEGIC_PLAN_en.pdf

building and enhancing partnerships and cooperation. Specifically, WMO priorities for improving decision-making through better integrated information and emphasizing disaster risk reduction will receive focus. The partnerships and collaborative opportunities possible through EC PORS and GIPPS will enable the leveraging and potential expansion of capabilities to meet these objectives.

Gap Analysis

Those who live or operate in the polar regions require more useful weather and water information for planning and decision-making to protect lives, property, and manage the region's many resources. Arctic weather also plays an important role in global weather; understanding this role is essential to improving global forecasts as well.

In general, predictive services in the high latitudes are not of equivalent accuracy, resolution (temporal and spatial), and reliability as similar products in mid-latitude regions. Forecasts of weather and ocean conditions lack detail generally beyond 60-72 hours and also lose reliability considerably thereafter.   A primary reason is the relative coarseness of the observational fields to support meteorological and oceanographic modelling; usually, weather and ocean forecasts have a resolution of 10 km or more.

New in-situ, airborne, and satellite observing technologies are needed to fill gaps in meteorological and oceanographic data sets, with the intent of improving both local and global weather forecasts. Science and technology will need to be leveraged based on advanced numerical models, including ranges of uncertainty. Improved Earth system models will include coupling of atmosphere, ocean, land and ice at local, regional, and global scales. As new data sets become available, it is also important to keep in mind how this information is disseminated to the user/customer.

Improving daily to weekly sea ice models and forecasts and new seasonal prediction services will fill a critical gap in marine weather and climate services that will benefit community activities, support the management of protected marine resources, and improve safe operation and navigation through these waters as marine transportation and industry use expands. Forecast improvements can be made by enhancing and integrating different types of observations of the atmosphere, sea ice and ocean, including use of local knowledge, classifying sea ice characteristics, and directly combining data-assimilating sea ice models and climatological information with forecast models. Satellite-based information is of great importance as large areas with sea ice can be covered with satellite observations. The satellite images and derived products are a valuable source of information for ice mapping and tactical planning, including those done on board a ship. In the future, near real-time satellite products may include information about various aspects of sea-ice including parameters such as ice concentration, edge, ice type, drift, deformation, and ice thickness. In addition, compressive regions can be identified from satellite products.

People that live and work in the polar regions have a great need for climate information, as expressed in the many reports documenting the impacts of climate change. Socio-economic decisions can benefit substantially from better knowledge of climate conditions at a scale useful for planning, mitigating and adapting. Higher resolution regional models are needed for climate prediction at these scales.

Seasonal predictions, particularly the period of open water that defines an extended operations and shipping season, are increasingly in demand. Multi-decadal sea ice projections are also required for infrastructure planning, ecosystem stewardship under rapidly changing conditions, and projection of global climate impacts forced by changes first occurring in the Arctic[14]. Special studies using climate and earth system models need to target Arctic processes. Global models are necessary but not sufficient for regional applications; downscaling methods are a part of the required methodology.

Retrospective and prospective studies of the linkages between changes in Arctic sea ice and hemispheric weather and climate will lead to new understanding of how these changes affect larger areas. Recent studies support an increased connection between shifts in Arctic climate and increased climate variability in mid-latitudes. Increased predictability of these connections requires detailed case studies of climate feedback processes and Arctic/mid-latitude connectivity-

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[14] NOAA's Arctic Vision and Strategy http://www.arctic.noaa.gov/docs/NOAAArctic_V_S_2011.pdf

also referred to as tele-connections. These studies are required to achieve improvements in weather and climate forecasts for the Arctic and northern mid-latitude regions.

Through the intergovernmental Arctic Council, Canada, Finland, and the United States led the development of the Arctic Marine Shipping Assessment (AMSA). The AMSA considered a set of scenarios, or plausible futures, for Arctic marine navigation and developed recommendations in the interest of marine safety and marine environmental protection. Among the recommendations are calls for increased linkages with international organizations, such as the WMO, to advance the safety of Arctic marine shipping, and investments in hydrographic, meteorological, and oceanographic data to support safe navigation and voyage planning in Arctic waters.

The International Polar Year (IPY) projects have helped document emerging issues and service gaps with respect to changes in the Arctic. IPY-TORPEX (THe Observing system Research and Predictability Experiment) found that the retreat of sea ice leads to rapid changes in weather conditions in the Arctic. Large increases in the potential for extreme weather events were found along the entire southern rim of the Arctic Ocean, including the Barents, Bering and Beaufort Seas. While these areas are sparsely populated, an increasing commercial marine activity is predicted there, because the sea ice is set to retreat. The reliability of forecasts of extreme weather and water events must be improved by reducing uncertainty and extending lead time. Sea ice services also need considerable improvements, both in terms of ice edge and iceberg mapping, analysis, and tracking, as well as predictive services on daily, weekly, monthly, seasonal, and inter-annual scales for decision support.

At its 15th Session, the WMO Commission for Atmospheric Sciences (CAS) recommended, as a legacy of IPY, the establishment of a WMO THORPEX Polar Prediction Research Project, which will provide an efficient framework for cooperative international research and development efforts to improve operational weather and environmental prediction capabilities for the polar regions and facilitate climate predictions up to a season. This project is intended as a contribution to the improvement of polar predictions and will, undoubtedly, benefit from an assessment of marine weather and sea-ice services needed by users/customers in the polar regions.

In September 2011, the U.S. National Oceanic and Atmospheric Administration (NOAA) conducted a Sea Ice Forecasting Workshop in Anchorage, Alaska, to address one of the six goals in NOAA's Arctic Vision and Strategy. The workshop was organized by NOAA and attended by other U.S. federal agencies, U.S. universities, representatives from the oil and gas industry, and Environment Canada. For NOAA, improved sea ice forecasts at various scales ("weather", seasonal, decadal) are needed to reduce the risk for operating in the Arctic and to improve social, ecosystem, and economic decision making. Improved forecasts will require regular observation of Arctic atmosphere, ocean, and sea ice; improved coupled atmosphere-ice-ocean models and process-level understanding; and development of services and information products for stakeholders. The workshop results will now be used as a basis for an Implementation Plan that will identify actions NOAA could take over the next few years to improve its sea-ice forecasting capability. This Plan will identify linkages to external partners with similar goals that could prove mutually beneficial.

There are other potential users for climate information, such as subsistence hunting by native indigenous communities around the circumpolar north, shipping and trade, offshore oil and gas, fisheries, and tourism. One of WMO's five priorities is the development of a Global Framework for Climate Services (GFCS). At present, a GFCS Implementation Plan is being developed, with contributions from over 100 experts from 36 countries. But it is important to note that the GFCS, at the recommendation of the High Level Task Force, should focus on building the capacity of climate-vulnerable developing countries. Thus, it is not clear to what extent the GFCS can be utilized to address the needs of EC PORS.

At the 15th Session of the Commission on Climatology (CCl) in February 2010, a side meeting on Polar Climate Outlook Forums (PCOFs) was held in which 20 countries participated. The meeting concluded that climate prediction skills for polar regions are severely limited and require substantial additional research, but some climate data sets and climate monitoring products are already available (mostly in research mode) that could be useful.

Existing international, intergovernmental opportunities and partnerships

Over the last several years, interest in the polar regions, particularly the Arctic, has increased considerably in concert with broader discussions regarding climate change, environmental stewardship, and resource management.

The WMO provides leadership and guidance for a number of activities emphasizing attention and focus on polar matters, and the International Polar Year (IPY) provided additional focus and momentum. The UNESCO Intergovernmental Oceanographic Commission (IOC), in its resolution XXV-14, recognized the important role that polar ocean processes play in the global climate system and decided to strengthen the collaboration of IOC with Polar organizations. Both WMO and IOC are considering the International Polar Decade as a lasting legacy of the IPY.

EC PORS:

In 2010, the WMO Executive Council decided to replace its Panel of Experts on Antarctic Meteorology by the EC Panel of Experts on Polar Observations, Research and Services (EC PORS) to embrace both polar regions. The Council also decided that in forming the new Panel, it should continue to give a high level of focus to Antarctic matters, a Region not covered by any of the WMO Regional Associations, while taking on its new responsibilities in the areas of research and services, thus recognizing that the polar regions are extremely important in terms of their global impacts on weather and climate.

The EC PORS membership includes 24 experts from 14 countries. The Panel is co-chaired by the Permanent Representatives of Australia and Canada with WMO. Panel meetings were held in Canada (2009) and Australia (2010). The Panel established task teams to address WMO Polar issues, especially to: (a) conduct its Antarctic responsibilities; (b) build a framework for its work in observations, research and services; (c) oversee development of the Global Cryosphere Watch (GCW); (d) provide leadership for development of a Global Integrated Polar Prediction System (GIPPS); (e) advance the concept for a potential International Polar Decade; and (f) build partnerships.

JCOMM:

WMO and the IOC created a partnership in 1999 to promote the coordination of oceanographic and marine meteorological observing, data management, and services. The Joint WMO-IOC Technical Commission for Oceanography and Marine Meteorology (JCOMM) combines the expertise, technologies, and capacity building capabilities of the meteorological and oceanographic communities. Within its Services and Forecast Systems Program Area (SFSPA), the Expert Team on Sea Ice (ETSI) has been the focal point for promoting and coordinating international cooperation in the acquisition, exchange, archival, and dissemination of sea-ice information.

The rapid retreat of the Arctic ice sheet in summer led to the establishment of new shipping routes in this region, with an associated requirement for enhanced maritime safety services. Icebergs will be a continued threat in the high arctic. JCOMM has consequently established, in coordination with the International Maritime Organization (IMO) and the International Hydrographic Organization (IHO), new Arctic "METAREAs" under the Global Maritime Distress and Safety System (GMDSS), which came into effect in 2011.[15] This expands to provision of weather and sea ice safety information services into Arctic waters, with Canada, the Russian Federation, and Norway acting as meteorological Issuing Services for the five new METAREAs. At a recent Marine Managers' Program in Washington, D.C., Canada has asked the U.S. to consider being a dissemination service for its two METAREAs.

Global Cryosphere Watch (GCW):

At the 16th session of the WMO Congress, a resolution was agreed upon to establish a Global Cryosphere Watch (GCW), in collaboration with international partners. GCW will provide data, information, and products that will help Members and the wider user community reduce the loss of life and property from natural and human-induced disasters, improve management of energy and water resources, contribute to a better understanding of environmental factors affecting human health and well-being, understand, assess, predict, mitigate and adapt to climate variability and change, improve weather forecasts and hazard warnings, aid in management and protection of terrestrial, coastal and marine ecosystems, and

[15] http://weather.gmdss.org/General_Arctic_Announcement_final-advance_notice.pdf

support sustainable agriculture. GCW will provide information for informed decision making and policy development related to climate, water and weather, for use in real time, for climate change adaptation and mitigation, and for risk management. Over time, this information will become more service-oriented.

<u>WCP/CLIPS:</u>

The WMO World Climate Programme (WCP) Climate Information and Prediction Services (CLIPS) project was established in 1995 based on the vision that socio-economic decisions can benefit substantially from better knowledge of both contemporary and near-future climate conditions. The CLIPS project was conceived as an implementation arm of the World Climate Applications and Services Programme (WCASP), to build on the ongoing research advances and evolving operational networks, particularly on the regional and national scales. Among CLIPS activities which would contribute to service improvements to meet the interests for the Polar region are: the promotion of operational climate prediction services, particularly on seasonal to inter-annual scales; the provision of an active interface between the research and operational communities; and the development of operational frameworks linking global, regional and national level long range forecasts.

WMO Congress has emphasized the importance of Regional Climate Centers (RCCs) and Regional Climate Outlook Forums (RCOFs) since these facilitate the development of "consensus" forecasts at a regional level as well as enhance regional networking by the NMHSs themselves and interaction with users at a regional level. And, in fact, such has been the topic by the WMO WCP CLIPS, which has stated that, post IPY, now would be a good opportunity to develop a collaborative mechanism for generating sustained, practical, and operational products and services to meet user needs for climate risk management in polar regions.

At the 2nd meeting of EC PORS in Hobart, Australia, in October 2010, the group agreed to a stepwise approach in establishing Arctic and Antarctic PCOFs and Polar Regional Climate Centers (PRCC). Formal encouragement was provided by the WMO Congress at its 2011 session to develop PCOFs and PRCCs. As suggested by the EC PORS members in Hobart, a good next step, therefore, is for the NMHSs in the Arctic and Antarctic regions to begin to identify linkages within their centres dealing with global climate monitoring and global climate prediction as well as linkages between operational, research, and user communities dealing with polar climate and begin to develop an integrated, seamless suite of products to address the needs of the users/customers in both poles.

ICEMAR:

In March 2011, the European initiative for the Global Monitoring for Environment and Security (GMES) launched a new project to aid ships' navigation in ice-infested waters in the European Arctic and the Baltic Sea. The consortium brings together 12 collaborators from Denmark, Finland, Germany, Norway, Sweden, and the United Kingdom, including system and satellite service providers, ice chart producers and maritime educators. Over the next three years, the consortium will work to establish a sea-ice information service, or ICEMAR, to improve access to existing and new ice information products. The ICEMAR service will provide continuous and accurate information on the ice conditions in these regions. The potential clients of this service include fishing, cargo, off-shore exploration, research, coastguard and passenger vessels navigating near or within ice-infested waters of the European Arctic and the Baltic Sea.

The ICEMAR service will allow a user to send a request for ice information based on the area of interest. Each request will also contain information related to the equipment on board the ship that will be used to display the received information and the communications link available. This will result in the user being able to receive and display the relevant, available information easily. This is in contract to today's situation where the user needs to know where to find the different layers of information, which, if and when received, cannot be overlaid for comparison purposes.

Although the initial focus of ICEMAR will be the European Arctic and Baltic Sea, in the longer term, ICEMAR will allow for future expansions and the inclusion of additional data and coverage of new geographical regions as they become available, including areas north of 75 degrees where only minimum Internet connections are available.

SIDARUS:

Sea Ice Downstream Services for Arctic and Antarctic Users and Stakeholders (SIDARUS) is a project under the auspices of the 7th Framework Programme of the European

Commission (Grant Agreement No. 262922) and coordinated by the Nansen Environmental and Remote Sensing Center. Other members of the SIDARUS Consortium include the Alfred Wegener Institute for Polar and Marine Research (Germany), Collecte Localisation Satellites SA (France), University of Bremen/Institute of Environmental Physics (Germany), University of Cambridge/Department of Applied Mathematics and Theoretical Physics (UK), and Norwegian Meteorological Institute/Norwegian Ice Service (Norway). The objective of the SIDARUS project is to develop and implement a set of sea-ice downstream services in the areas of marine safety, marine and coastal environment, and climate and seasonal forecasting.

The SIDARUS project will provide sea-ice data that can improve ice modelling, for both global and regional scales (including ice thickness, albedo, snow-cover characteristics, ice drift) and for regional/local scales (ice-edge morphology from high-resolution SAR products).

Science Priorities (Research and Observations)

One of the challenges facing all the partners and stakeholders involved in shaping new products and services is the alignment of strategic goals and science priorities, as well as the implementation of effective science and technology transfer mechanisms. It takes concerted effort to understand users' needs and translate those needs into opportunities for science advancements. In addition, effective technology transfer generally requires mature institutional mechanisms. One of the opportunities that GIPPS could offer is a mechanism to enable the science communities to interact more directly with users, align plans globally, and provide a starting point for driving more effective transfer of advances into operational products and services. A review of best practices where effective user engagement has shaped and informed research needs assessment could generate some useful lessons learned going forward.

Summary/Recommendations

The EC PORS Research Task Team developed a Concept Paper for the GIPPS. The paper states, "WMO needs an immediate, high-level and sustained focus on a polar prediction system (GIPPS) that would:

- involve the Earth System approach, from daily to seasonal to decadal and longer time scales, responding to societal needs

- stimulate the integration of environmental observations to enhance prediction systems
- provide forecasts, predictions, projections and related information to governments and relevant socio-economic sectors, contributing to the Global Framework for Climate Services."

A polar prediction system will draw and coordinate many research and operational elements of WMO and related agencies, national modeling centers, and other polar science organizations into a common purpose.

The development of a GIPPS will best be served by taking advantage of existing mechanisms that have the same mission envisioned by the EC PORS members, such as SIDARUS and ICEMAR. Currently, the only European meteorological service participating in the SIDARUS project is the Norwegian Meteorological Institute. Given the present SIDARUS effort to develop and implement a set of sea-ice downstream services in the area of climate research, marine safety, and environmental monitoring, many of which will likely be delivered (disseminated) by the meteorological services of the Arctic countries, the Services Task Team proposes that a logical next step would be for the EC PORS members representing the meteorological and/or ice services of Iceland, Finland, Sweden, Denmark, Russia, the U.S., and Canada to become partners of or Subject Matter Experts (SMEs) to this 7th Framework Programme project to ensure a coordinated, Arctic-wide integration of products and data that could demonstrate the viability of a GIPPS. Furthermore, the SIDARUS project is not just focused on the Arctic -- it also intends to support the needs within the Antarctic region. Thus, EC PORS members from the southern polar region could also serve as partners or SMEs to support the SIDARUS project.

Another European project that presents a good opportunity for the EC PORS membership is with the GMES ICEMAR project. As stated above, the current focus of ICEMAR will be the European Arctic and Baltic Sea. But ICEMAR will allow for coverage of new geographical regions, and it would be particularly beneficial for Canada and the U.S., as dissemination and issuing services for two Arctic METAREAs, respectively, and partners in a North American Ice Service, to collaborate with ICEMAR and ensure the inclusion of appropriate products and services that will benefit all users in the Arctic region.

And, finally, as indicated above, user requirements from both the southern polar region and the "Third Pole" are needed to complete this White Paper. The Services Task Team recommends that at least one EC PORS member from each of these regions be identified to help better articulate their needs.

Appendix I

	Marine Weather and Sea Ice Services for Arctic and Antarctic Users and Stakeholders
	Collaborative project under World Meteorological Organization EC PORS

A Task Team under the World Meteorological Organization's (WMO) Executive Council Panel of Experts on Polar Observations, Research and Services is assessing user/customer needs. We are interested in your perspectives on weather, water, sea ice and climate products in the polar regions in consideration of building a "Global Integrated Polar Prediction System". Thank you for providing your valuable input.

Your Name: ____________________
Name of organization: ____________________
E-mail: ____________________
Telephone: ____________________

Part I – Sea ice information

What fields is your organization involved with? (please select all that apply)

☐ 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 kind of sea ice information products/services are you interested in?

☐ New types of sea ice 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 check all that apply)

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

What types of sea ice information do you find most useful? (Please check 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	☐ Thickness in classes (e.g. WMO Ice Classes)	
	☐ Mean Average Thickness	☐ Modal Average Thickness	
☐ Icebergs	☐ Occurrence	☐ Size	☐ Drift
	☐ Shape (Normal/Tabular)		

☐ 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 check 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 check all that apply)

☐ As often as possible	☐ Daily ☐ Weekly	☐ Monthly	☐ Annually	☐ On request for historical data

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 check all that apply)

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

If you have a requirement for long-term predictions (i.e. on the effect of climate change on sea ice), which scale do you need?

☐ 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 check 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

How do you use weather and ocean information?

Please grade the impact of weather information on your operations (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 check one per line.)

Insignificant	Imperative - - - - - - - - - - - - - - - 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 operations (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 check one per line.)

Insignificant	Imperative - - - - - - - - - - - - - - - 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? Do you find it effective to meet your needs?
[open question]

What types of weather and ocean information do you find most useful
[open question]

How often would you like to have weather information updated? (Please check all that apply)

☐ As often as possible	☐ Daily	☐2 times/day	☐ 4 times/day	☐ Weekly	☐ Monthly	☐ Annually

How often would you like to have ocean information updated? (Please check all that apply)

☐ As often as possible	☐ Daily	☐2 times/day	☐ 4 times/day	☐ Weekly	☐ 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 check one per line.)

	Imperative 1	- - - - - - - - - - - - - - - 2	3	Insignificant 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 check one per line.)

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

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

☐ Not applicable			
☐ 0-6 hours	☐ 6-24 hours	☐ 2-3 days	☐ week

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

☐ Not applicable			
☐ 0-6 hours	☐ 6-24 hours	☐ 2-3 days	☐ week

What time period of weather forecast information for planning is most useful? (Please check all that apply)

☐ Not applicable			
☐ week	☐ month	☐ 3 months (seasonal)	☐ 1 year

What time period of oceanographic forecast information for planning is most useful? (Please check all that apply)

☐ Not applicable			
☐ 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 check all that apply)

☐ essential	☐ useful	☐ difficult to use	☐ distractive

Further contact?

☐ May the WMO executive council panel for experts for polar services contact you for further information on your needs?

Other Comments?