Sea-Ice Information Services in the World

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FOREWORD

The WMO publication '*Sea Ice Information Services in the World*' (WMO No. 574) is intended to provide to mariners and other users the latest snapshot of the sea ice services available world-wide, effectively extending the WMO publication No. 9, Volume D – Information for Shipping. In March 2007, following finalization by the WMO Secretariat of the 3rd edition of the publication (as hardcopy edition), the Joint World Meteorological Organization/Intergovernmental Oceanographic Commission Technical Commission for Oceanography and Marine Meteorology (JCOMM) Expert Team on Sea Ice (ETSI) 3rd session agreed on further annual updates of the electronic version of the publication, using the following scheme (JCOMM Meeting report No.51):

- using content of the 3rd edition of the publication as a model;
- national ice services to submit corrections to the ETSI Chairperson and WMO Secretariat for appropriate paragraphs of Parts I-II and annexes, as needed and as appropriate;
- the ETSI Chairperson in collaboration with the WMO Secretariat to incorporate these corrections or amendments, update the contents of the electronic version (including the 'Table for noting supplements received') within a three month period and make the updated version officially available on the JCOMM website;
- the WMO Secretariat to inform the respective National Ice Services and sea ice community on the availability of the updated electronic version with the use of a mailing list and/or appropriate news sections and methods (similar to 'ArcticInfo');
- the WMO Secretariat Publishing Department to prepare updated or amended CD-ROM versions of the publication and/or supplements on a regular basis.

The ETSI-III session also agreed for the publication to start each section for a national ice service on an individual page, to use a single-column layout and to include the following additional annexes:

- list of abbreviations;
- hemispheric map showing max/min ice extent plus dots showing location of ice services;
- list of contact persons, which serve as editors for the electronic version of the publication.

By May 2009, updates for the first annual edition (Part-II and Annexes) were provided and included into the annual 2009 edition of the publication with other ETSI-III decisions also being introduced in the document: the list of abbreviations as a first and the 'Sea-ice products by areas of the World Ocean available via the Ice Logistics Portal' as a second new annex. Several amendments were also introduced to Part I GENERAL, section 'International cooperation' reflecting new regional alliances, development of a new transfer format for ice charts ('Ice Objects Catalogue') and development of a new mechanism of ice charts dissemination ('Ice Logistics Portal').

The ETSI-IV session (March 2010) approved the concept and layout of the annual 2009 edition and agreed that the similar JCOMM ETMSS "fast track" procedure should be used to further revisions of the publication with regular updates be published on the JCOMM website and announced by the WMO Secretariat.

Further additions to publication reflecting new forms of collaboration between the services and delivery of the products were proposed by the ETSI-V (March 2014) and ETSI-VI (February – March 2017) sessions.

FOREWORD to 3rd edition

Many ocean and sea areas of the world, in addition to the polar seas, are susceptible to sea ice (for example, the Baltic Sea and parts of the Yellow Sea). Sea ice occurs in a wide range of types and forms, and affects significantly and directly marine transport and navigation. Economic and social developments are engendering significant increases in international shipping, particularly in areas susceptible to sea ice. The specialized meteorological services, which evolved initially in support of local marine users, have since developed into a wide range of sea-ice information services designed to meet many user requirements. The Joint World Meteorological Organization/Intergovernmental Oceanographic Commission Technical Commission for Oceanography and Marine Meteorology (JCOMM) Expert Team on Sea Ice (ETSI) (before 2001 called the Subgroup on Sea Ice – SGSI, of the WMO Commission for Marine Meteorology – CMM) has been the focal point for promoting and coordinating international cooperation in the acquisition, exchange, archival and dissemination of sea-ice information.

The WMO publication *Sea-Ice Information Services in the World* (WMO-No. 574) was first published in 1981. Following a recommendation of the CMM-XII in 1997, the SGSI undertook a major review of this important publication. As a result, a second fully updated version was published in 2000. Fast progress in sea-ice information systems, as well as the need for comprehensive sea-ice information, predetermined the decision of the second session of the JCOMM ETSI in 2004 to start a regular update of the publication on the annual basis. This present revised third version was prepared in 2005–2006 by the ETSI with the support of the WMO Secretariat, and includes contributions from 20 countries from the Northern and Southern hemispheres involved in sea-ice activities.

I believe that this publication will continue to enhance the exchange of information relating to sea ice and sea-ice services for the benefit of many National Meteorological Services, in particular in conjunction with the International Polar Year 2007–2008. In addition, to facilitate provision of operational information to mariners, marine operations and controllers, it will also aid other National Meteorological Services, which are developing their own sea-ice services.

On behalf of the World Meteorological Organization, I would like to express my sincere appreciation to all members of the Expert Team on Sea Ice and other experts from the national ice services for their contributions to the preparation of this valuable publication.

(M. Jarraud)

Secretary-General

INTRODUCTION

Mariners have known of the existence and perils of sea ice since vessels first ventured into northern regions. The numerous polar expeditions of the nineteenth and twentieth centuries brought new understanding of the types and variability of conditions affecting these vast ocean areas. It was not until misfortune struck the SS Titanic, however, that thoughts of international cooperation in sea-ice information gained any strength. After 1918, increasing emphasis upon navigational safety and the need for agreed shipping routes led to contacts between nations who had established their own sea-ice observational information systems. Discussions about reporting methods, code forms and symbology (within the confines of the limited extent of observation at that time) continued steadily until 1959. Advances in communications, the advent of aircraft observations and routine reporting created the basis for the development of sea-ice information services by several nations by the mid-1950s. The first international sea-ice conferences were held and the Commission for Marine Meteorology (CMM) established a working group concerned with sea-ice affairs.

Since that time many further strides forward have been made both in observational and processing techniques, and information services are provided now as routine for all the commonly frequented sea-ice regions. The first edition of *Sea-Ice Information Services in the World* (WMO-No. 574) was prepared and published by 1981. Since then, due to advances in remote sensing, computational means and telecommunications, significant progress has been made in the number and complexity of sea-ice products. In addition changes in the number of sea-ice services and their regions of responsibility have occurred. Following recommendation of the CMM-XII in 1997, the Subgroup on Sea Ice (SGSI) undertook a review of the publication and a second fully updated version was issued in 2000.

Further progress in sea-ice information systems, the need for comprehensive information on sea-ice services and planning for the International Polar Year 2007–2008 predetermined the decision of the SGSI successor – the JCOMM Expert Team on Sea Ice (ETSI) – in 2004 to update the publication on an annual basis. The third edition was finalized by ETSI and published in hardcopy by the WMO Secretariat in March 2007.

Current edition is based on the latest amendments from the national services, follows the structure of the previous publications, and has been designed to describe sea-ice services as they are today, and to provide clear factual and updated details of the sources, background, preparation and presentation of these services. Special attention is given to (a) processing and presentation of various satellite imagery; (b) information products based on the results of numerical modeling of the sea-ice cover; and (c) using the Internet to relay sea-ice products to users.

The publication consists of two parts:

Part I – A general description of the nature of sea ice, methods of observation, and the basis of ice-information services.

Part II – A listing of the sea-ice information services available from 20 nations, given regionally, and in each case detailing:

(*a*) Organization;

(*b*) Data acquisition;

(*c*) Output products;

(*d*) Forecasts;

(*e*) Publications;

(*f*) Mailing and Internet addresses.

These details are supported by annexes containing sample charts and illustrating a wide selection of the products mentioned in Part II, including charts remotely sensed or with numerically modelled backgrounds, complexity, dissemination methods and national and international practices where relevant.

The extent to which sea-ice information services have now developed will be very evident to readers. It is hoped that this third review may in turn, through its users and those involved in related services, itself contribute further to future advances.

PART I – GENERAL

24 January 2017 revision

1. THE NATURE OF ICE

Several forms of floating ice may be encountered at sea. The most common is that which results from the freezing of the sea surface, namely sea ice. The other forms are river ice and ice of land origin. River ice is encountered in harbours and estuaries where it is kept in motion by tidal streams and normally presents only a temporary hindrance to shipping. Ice of land origin in the form of icebergs is discussed separately below.

Both icebergs and sea ice can be dangerous to shipping and always have an effect on navigation. Sea ice also influences the normal processes of energy exchange between the sea and the air above it. The extent of sea-ice cover can vary significantly from year to year and has a great effect both on adjacent ocean areas and on the weather over large areas of the world. Its distribution is therefore of considerable interest to meteorologists and oceanographers.

1.1 FORMATION AND DEVELOPMENT OF SEA ICE

1.1.1 Ice less than 30 cm thick

The first indication of ice formation is the appearance of small ice spicules or plates in the top few centimeters of the water. These spicules, known as frazil ice, form in large quantities and give the sea an oily appearance. Sea surface temperatures for seawater of normal salinity of 35 psu have to be below -1.8°C. The environmental conditions during the initial stage of sea ice formation affects the type of new ice that develops.

With extreme light winds, and no waves, the frazil ice coalesces to form grease ice, which has a matt appearance. Under near-freezing, but as yet ice-free conditions, snow falling on the surface may result in the sea surface becoming covered by a layer of slush. These forms may be regrouped by the action of wind and waves to form shuga and all are classified as new ice.

With further cooling, sheets of ice rind or nilas are formed, depending on the rate of cooling and on the salinity of the water. Ice rind is formed when water of low salinity freezes into a thin layer of brittle ice which is almost free of salt. Ice rind may be up to 5 cm thick. When water of high salinity freezes, especially if the process is rapid and the wind is very light, the ice has an elastic property which is characteristic of nilas. Nilas is subdivided, according to its thickness, into dark and light nilas; the first one reach thickness of 5 cm, while the second, more advanced stage reaches a maximum thickness of 10 cm. Ice rind, dark and light nilas, may be referred to as nilas ice. Sheets of this have a tendency to raft rather than ridge if pushed together, sometimes interlocking in a distinct finger-rafting pattern.

Alternatively, under turbulent wave action frazil ice at or near the sea surface coalesces to form clumps. These collide with each other, accreting further frazil crystals around the edges. These create a raised rim, and with the clumps developing into rounded floes, give this type of distinctly new ice the name pancake ice. "False" pancake ice may be formed by the breaking up of nilas, or ice rind, due to the action of wind and waves.

Ice rind, nilas or pancake ice may thicken into grey ice and grey-white ice, the first being 10–15 cm thick and the latter attaining thicknesses of up to 30 cm. Ice crystals within these types of ice are randomly orientated due to their frazil ice origin. These forms of ice are referred to collectively as young ice. Rough weather may break this ice up into ice cakes, pancake ice or floes of varying size.

1.1.2 Ice 30 cm – 2 m thick

The next stage of development is known as first-year ice (FY) and is subdivided into thin, medium and thick categories. Thin first-year ice has a thickness of 30–70 cm and is subdivided according to its thickness into thin first-year ice first stage (30–50 cm) and thin first-year ice second stage (50–70 cm). Medium first-year ice has a range of thickness from 70 to 120 cm while in polar areas thick first-year ice may attain a thickness of 2 m or more by the end of the winter. A major characteristic to distinguish first-year ice subdivision is based on the roughness of the surface, thin first-year has smooth surfaces, medium first-year shows incipient ridges and thick first-year surface has fully developed ridges. The ice thickness development is through either vertical downward growth of ice crystals, producing a distinct columnar ice crystal structure distinct from the randomly orientated crystals for the new ice growth, or through snow accumulation on the surface (especially in the Antarctic). The

weight of the snow can cause the ice surface to become flooded by seawater that then freezes into a layer of superimposed ice.

1.1.3 Old ice

Thick first-year ice may survive the summer melt season and is then classified as old ice. This category is subdivided into second-year (SY) and multi-year ice (MY) depending on whether the floes have survived one or more summers. The thickness of old ice is normally in the range 1.2 to 5 m or more prior to the onset of the melt season. During the melt season, the ice becomes less saline because of brine drainage and air pockets in the ice are removed. After two summer melts, MY ice is almost free of salt and is very hard. Old ice can often be recognized by a bluish surface colour in contrast to the greenish tinge of first-year ice.

1.2 DECAY OF SEA ICE

During the winter, the ice usually becomes covered with snow of varying thicknesses. While this snow cover persists, almost 90 per cent of the incoming radiation is reflected back to space. Eventually, however, the snow begins to melt as air temperatures rise above 0°C in early summer and the resulting fresh water forms puddles, called melt ponds, on the surface. These melt ponds absorb (instead of reflect) around 90 per cent of the incoming radiation and rapidly enlarge as they melt the surrounding snow or ice. Eventually the ponds penetrate to the bottom surface of the floes and are known as thawholes. At the same time, salt pockets in the ice enlarge and move downward through the ice. These channels are another path for the ponded water to drain.

This decay process is characteristic of ice in the Arctic Ocean and seas where movement is restricted by the coastline or islands. Where ice is free to drift into warmer waters (e.g. the Antarctic and the Labrador Sea) melt ponds are less prevalent. The warmer air and water temperatures serve to weaken and melt the ice and decay is accelerated by breakup of the floes from wave erosion.

1.3 MOVEMENT OF SEA ICE

Sea ice is divided into two main types according to its mobility. One type is drift ice, which is continually in motion under the action of wind and current stresses. The other is fast ice, attached to the coast or islands, which does not move.

Wind stress in the drift ice causes the floes to move approximately in a downwind direction. The rate of movement due to wind drift varies not only with the wind speed, but also with the concentration of the drift ice and the extent of deformation (see below). In very open ice (1/10–3/10) and open ice (4/10–6/10), there is much more freedom to respond to the wind than in close ice or pack ice (7/10–8/10) and very close ice (9/10–10/10) where free space is very limited. No water is visible within the compact ice (10/10) or consolidated ice (10/10) where the floes are frozen together. Two percent of the wind speed is a reasonable average for the rate of ice drift caused by the wind in close ice, but much higher rates of ice drift may be encountered in open ice. Due to its momentum, the ice may continue to move even after the wind as stopped.

A force is also exerted on drift ice by currents that are present in the upper layers of the water, whether these are tidal in nature or have a more consistent direction due to other forces. It is usually very difficult to differentiate between wind- and current-induced ice drift but in any case where both are present the resultant motion is always the vector sum of the two. Wind stress normally predominates the short-term movements, particularly in offshore areas, whereas the average long-term transport is dominated by the prevailing surface currents.

1.4 DEFORMATION OF SEA ICE

Where the ice is subjected to pressure, its surface becomes deformed. In new and young ice this may result in rafting as one ice floe overrides its neighbor. In thicker ice it leads to the formation of ridges and hummocks according to the pattern of the convergent forces causing the pressure. During the process of ridging and hummocking, when pieces of ice are piled up above the general ice level, large quantities of ice are also forced downward to support the weight of the ice in the ridge or hummock. The underwater parts may be termed respectively ice keel and bummock. The maximum draught of a ridge is mostly three to six times as great as its maximum height but may occasionally exceed a factor of 10. These deformations are thus major impediments to navigation. Freshly-formed ridges are normally less difficult to navigate than older, weathered and consolidated ridges.

1.5 ICEBERGS

Icebergs are large masses of floating freshwater ice derived from glaciers. The underwater mass and draught of an iceberg, compared with its mass and height above water varies widely with different composition and shapes of bergs. The ratio of the underwater to above water mass of an Antarctic iceberg derived from a floating ice shelf is usually less than that of icebergs derived from Greenland glaciers. A typical Antarctic tabular berg, of which the uppermost 10–20 m is composed of old snow, will show one part of its mass above the water to about five parts below. The ratio for an Arctic iceberg, composed almost wholly of ice with much less snow is generally smaller, rather one to seven. However, because of their irregular shape the latter icebergs have a height-to-draught ratio averaging one to three.

Antarctic icebergs may be many nautical miles in diameter and of the tabular category. Through deterioration, other iceberg types, bergy bits and growlers, may be present. In Arctic waters, icebergs are smaller, and icebergs larger than ½ nautical miles are only observed occasionally.

Icebergs diminish in size in three different ways: by calving, by melting, and by combined melting plus erosion caused by wave action. An iceberg is said to calve when a piece breaks off; disturbing its equilibrium and causing it to float at a different angle or capsize. Large underwater projections, which may be difficult to observe, are a usual feature of icebergs in any state. In cold water, melting takes place mainly on the water line while in warm water an iceberg melts mainly from below and calves frequently. It is particularly dangerous to approach an iceberg in this state for it is unstable and may calve or overturn at any time. There are likely to be many growlers and bergy bits around rapidly disintegrating icebergs, which form a particular hazard to navigation.

Icebergs surrounded by sea ice can be protected from waves and be less likely to calve. They can be quite difficult to detect. Since the icebergs tend to be driven by deeper currents, they can move at a different rate than the surrounding sea ice.

Weathered icebergs are poor reflectors of radar pulses and cannot always be detected by such means. Their breakdown fragments – bergy bits and growlers – are even more difficult to detect with ships' radar for the background clutter from waves and swell often obscures them. These smaller fragments are especially dangerous to shipping for, despite their low profile they represent sufficient mass to damage a vessel that comes into contact with them at normal cruising speed. Some growlers consisting of pure blue ice hardly break the sea surface and are extremely difficult to detect.

Depending on keel depth, icebergs may be grounded for longer periods, but they will typically also travel long distances with drifting sea ice or cold ocean currents. Icebergs and debris ice is a serious hazard in ocean shipping lanes.

2. ICE OBSERVING METHODS

Although broad knowledge of the extent of sea-ice cover has been totally revolutionized by satellite imagery, observations from shore stations, ships and aircraft are still essential in establishing the "ground truth" of satellite observations. At present, observations of floating ice depend on instrumental and, to lesser extent, on visual observations. The instrumental observations include coastal radar, airborne radar, electro-magnetic induction sensors, and Synthetic Aperture Radars (SAR). Satellite-borne instruments include visible and infrared imagers, passive microwave radiometers, scatterometers, laser and radar altimeters, and SAR.

The five most important features of floating ice, which affect marine operations, are:

(*a*) Its origin (sea ice or icebergs)

(b) Its thickness (stage of development);

(*c*) The amount present – for sea ice, the concentration, usually estimated according to the tenths or percentage of the sea surface covered by the ice; and for icebergs, the size and shape of the iceberg;

(d) The form of the ice, whether it is fast or drift ice and the size of the constituent floes; and

(e) Any movement of the ice.

From the bridge of a ship 10 m above the sea, the horizon is about 12 km away, and observations can cover a radius of 7–8 km. From the top of a coastal lighthouse 100 m above the sea, the visual range is almost 40 km, and the observation may then cover a radius of 20 km.

Shore locations may provide an ice report several times a day as the ice changes in response to wind and current but the total area of ice being reported is very small. From a ship progressing through the ice, a summary report of the ice encountered during daylight progress may represent an area of the sea ice 15 km wide and 100 km long

(assuming a ship's speed of approximately 5 kts). In some marine areas, such as the Baltic Sea, coastal settlements, lighthouses and ships may be present in sufficient numbers that a reasonable proportion of the ice cover can be reported each day by an organized surface network. In others, such as the Gulf of St Lawrence, where the waterways are broad and the shores often unsettled, the shore reporting system can only provide data on a small percentage of the total ice cover. Surface based reports can provide excellent detail about the ice, especially its thickness,.

Reports about the ice cover taken from the air, i.e. helicopters and fixed-wing aircraft, have the advantage of a much better viewing angle; the platform's flying speed allows a great deal more of the sea ice or icebergs to be reported; and problems of remoteness can be overcome by using long-range aircraft. Trained ice observers can recognize the various stages of development of sea ice, estimate its amount, note its deformation and the snow cover or stage of decay. For icebergs, these ice observers can determine size and shape of the icebergs which is critical for accurate drift and deterioration modeling.

Comprehensive aerial reporting has its own particular requirements beginning with an accurate navigational system when out of sight of land. Inclement weather – fog, precipitation and low cloud – will restrict or interrupt the visual observations and the usual problems of flying limits at the aircraft base may also be a factor even if the weather over the ice is adequate for observing.

Recent advances in technology are now permitting more precise data to be obtained by aerial observations. Sophisticated radar systems used with real aperture, SAR, and inverse SAR modes can provide information, which documents precisely the distribution and nature of the ice 360 degrees around the flight path of the aircraft for distances of up to 100 km. Unlike most other sensors, the radar has the capability of monitoring the ice under nearly all weather conditions. It responds mainly to the roughness of the ice surface but the dielectric properties of each ice floe also affect the response.

When no fog or low clouds are present, a laser airborne profilometer can be used to measure the height and frequency of ridges on the ice, and under similar conditions an infra-red airborne scanning system can provide excellent information with regard to floe thickness in the ranges below 30 cm.

Earth-orbiting satellites are the predominant mode of observing sea ice but again there are some restrictions. The spectral range of the sensors may be visible, infrared, passive or active microwave or a combination of these. Satellite coverage may be broad at low resolution or cover a narrow swath at high resolution. The higher the resolution, the smaller is the area that can be imaged and the less frequent an area can be re-sampled.

In general, most meteorological satellites provide complete coverage of polar regions once or twice a day. These satellites provide visible and infrared imagery with resolutions of 250 m–1 km (NOAA AVHRR, and Visible Infrared Imaging Radiometer and Suite VIIRS, METEOR, MODIS, DMSP OLS, Sentinel-3); and passive microwave and scatterometer data at coarser resolutions of 6–70 km (AMSR2, NOAA AMSU, DMSP SSMIS,ASCAT). Visible and infrared data do not have cloud-penetrating capability while microwave data are practically cloud independent. Active microwave SAR data (RADARSAT-2, Sentinel-1, TerraSAR-X, COSMO-SkyMed, and ALOS-2) are characterized by improved ground resolution (approximately 10–100 m) but a reduced coverage due to narrow swaths and greater revisit time between exact repeat orbits. Ice services are also starting to use data from radar altimetry satellites such as Cryosat and Sentinel-3 and high resolution (30 m or better) optical imagery from Sentinel-2.

Spaceborne sensors can provide precise data on the location and type of ice boundary, concentration or concentration amounts (in tenths or percentages) and the presence or absence of leads, including their characteristics, if radar sensors are used. Less accurate information is provided on the stages of development of the sea ice including the FY/MY ratio, forms, with an indication of whether ice is land-fast or drifting, stages of ice melting and ice surface roughness. Floe motion over approximately 12–24-hour intervals can often be determined through the use of imagery from sequential orbits.

Manual or visual interpretation of imagery from visible and infrared sensors requires a certain amount of skill, for example, a picture element composed of 50 per cent white ice and 50 per cent water will have the same greyness in the visible image as another element in which the whole surface is covered with thin (grey) ice. Snow cover on the ice and puddles on the floes are other complicating factors. Interpretation of SAR images may be even more difficult due to the ambiguities associated with SAR backscatter from sea-ice features that vary by season and geographic region. This has been helped with SAR satellites having dual or full polarimetry modes of operations, the cross-polarisation channels being better for distinguishing between areas of sea ice and open water. In recent years there has been a focus on automated digital processing techniques for aiding the interpretation of satellite data. Techniques are usually implemented within geographical information systems (GIS) and include automatic

and/or interactive image georeference, enhancement and various types of image recognition and classification, which are based on data from a single sensor or combination from several ones.

3. INTEGRATED OBSERVATIONAL SYSTEMS

Any well-designed ice service system must consist of three major components:

(*a*) A surface observation network consisting of *in situ* reports and remotely sensed data;

(*b*) A communication system to gather and distribute the ice information; and

(*c*) A digital data integration, analysis and production system.

Surface reports from shore stations, ships and drifting buoys provide accurate information on ice amount, thickness, motion and its deformation over rather small areas. When many vessels and fixed observing points are available accurate information can be provided in restricted waterways. Many areas of the Kattegat and Baltic Sea coastline fall into this category and landline facilities are available for the relay of these reports to national or regional centres.

When waterways are more open or more remote from populated areas, either satellite data or aerial observations must be integrated into the system. Aerial data are normally prepared by the observers in map format as they fly along the prescribed track. An air-to-ship communication line is needed to pass the data directly to vessels in the area. This may be merely a voice channel, a radio facsimile broadcast or a digital network link, which enables radar data or the ice chart itself to be passed to the ships. In most cases, these data are also passed to the ice centre for integration into regional-scale analysis products.

Satellite data are typically passed in real-time (less than six hours) from satellite ground stations to the ice centres via high-speed communication links. Visible, infrared, passive microwave, SAR data are then digitally processed, integrated with meteorological guidance products and ice model output and then analysed by computer, typically using GIS. Image enhancement techniques and various other automated algorithms are often employed in the production of an ice analysis.

Ice analyses are produced as charts at varying scales (typically ranging up to 1:2,500,000) depending on the size of the area and the level of detail required. The ice charts are made available as data coverages in GIS formats and/ or as simple electronic charts in such graphic formats as GIF or PNG, which can be viewed with almost any web browser or graphics viewer. Charts are typically labelled and coloured using the WMO international sea-ice symbology (WMO-No. 259) and *Ice Chart Colour Code Standard* (WMO-TD-No. 1214). Other ice analysis products include annotated satellite imagery, usually in JPEG and TIFF formats, text messages and electronic charts.

4. ICE INFORMATION SERVICES

The observed ice data can also be combined with meteorological and oceanographic parameters in a prediction model to provide further guidance to vessels in or near the ice.

Usually, ice forecasts are prepared once a day for a period of 24 to 144 hours. These are tactical forecasts, which may provide advice on difficult ice conditions forming or dissipating, the general motion of the pack, opening and closing of leads, etc. They are strongly influenced by meteorological prediction and should always be used in concert with the weather forecast.

Other longer-range predictions – those covering periods from 7–10 days to 30 days and seasonal predictions – are usually based on climatological and analogue methods.

Ice information that has been collected over a long period of time can be used for climatological purposes. Information such as the average ice concentration at different times or the average ice stage of development can be provided. This information can be used for planning.

Relay of charts of operational ice conditions is mostly conducted by radio facsimile or via a digital network link. Time slots and schedules usually dictate the scale and number of charts provided by the broadcast station in the area of concern. Direct broadcast by the ice centre or communication stations is ideal and occurs when feasible. Many ice charts and other ice information is available on the internet.

5. INTERNATIONAL COOPERATION

In some areas of the world a regional approach to ice services is far more economical and efficient than one based solely on national facilities. For example, in 2003, the USA and Canada established a joint service know as the North American Ice Service (NAIS). The NAIS is composed of the Canadian Ice Service (CIS), the US National Ice Center (NIC), and the USCG International Ice Patrol (IIP). Detailed information on NAIS joint products is provided in Part II below. The similar Baltic Sea Ice Services (BSIS) is under steady development and includes informational exchange between Denmark, Estonia, Germany, Finland, Latvia, Lithuania, the Netherlands, Norway, Poland, the Russian Federation and Sweden. A common numerical ice-reporting code (the Baltic Sea Ice Code), sea-ice charts (international sea-ice symbols), integrated data broadcasts in English and similar shipping control regulations are used. In Finland and Sweden, icebreaker assistance is integrated in the Gulf of Bothnia. In special situations, such as when the Baltic Sea is totally ice covered, all icebreaker assistance in the Baltic Sea is integrated, with the common aim of supporting marine traffic. This is done under the development of BIM (Baltic Icebreaking Management), which is the cooperation body of the Baltic Sea icebreaking organizations. Within Europe, the ice services of Denmark, Finland, Iceland, Norway and Sweden have a similar agreement in the form of the European Ice Services (EIS). The European Union Copernicus Marine Environment Monitoring Service (CMEMS), previously the Global Monitoring for Environment and Security (GMES) programme includes partners from national services as well as from research and industrial communities and is aimed at the implementation of a coherent operational oceanography system for the high latitudes, consisting of sea ice, meteorological and oceanographic services.

On a larger scale, the WMO/IOC JCOMM Expert Team on Sea Ice (ETSI) has been instrumental in developing an internationally accepted terminology, formats to exchange operational and archived data on sea ice, and other guidance material. To this effect, the ETSI also collaborates with other international sea-ice groups – the International Ice Charting Working Group (IICWG) and the Baltic Sea Ice Meeting (BSIM). The international sea-ice terminology including an illustrated glossary and a set of chart symbols was developed and first published in 1971 in English, French, Russian and Spanish (*WMO Sea-Ice Nomenclature*, WMO-No. 259) with the latest additions and corrections introduced in 2017. From November 2004 an electronic version of the nomenclature (predefined English, French, Russian and Spanish versions in alphabetic/subject order, equivalents, search/selection option), is available (http://www.aari.ru/gdsidb/xml/wmo_259.php).

A set of formats was designed in 1980s-1990s for the archive mode sea-ice information exchange (SIGRID, WMO 1989, SIGRID-2, WMO 1994).

Further, in cooperation with IICWG, two JCOMM Technical Report Series documents – SIGRID-3: *A Vector Archive Format for Sea Ice Georeferenced Information And Data* (WMO/TD-No. 1214) and *Ice Chart Colour Code Standard* (WMO/TD-No. 1214) were prepared and issued in 2004 with the latest additions introduced in March 2017.

The ETSI in March 2007 adopted the "Ice Objects Catalogue" version 4.0" (JCOMM TR-No.80) as the sea ice extension of the IHO S-57 format for the ENCs and agreed on a formal mechanism for its maintenance and development with JCOMM ETSI recognized as the competent international technical group on sea ice and icebergs by the WMO, IOC and IHO Committee on Hydrographic Requirements and Information Systems (CHRIS), the WMO Secretariat as Register Owner and Manager, Register Users as anyone interested in sea ice or iceberg MIOs, the Control Body as the ETSI ENC Ice Objects Task Group (TG ENCIO), the Submitting Organization as WMO and proposers as ETSI Members from Canada, Germany, Russian Federation and USA. The latest 5.2.1 version of the document adopted in March 2017 is now available within the IHO Register of Registers. In March 2014, based on the "Ice Object Catalogue" the "S-411 Ice Information Product Specification" (JCOMM TR-No.81) has been produced by the BSH as part of JCOMM/ETSI in response to a requirement to produce an ice data product that can be used within Electronic Chart Display and Information Systems (ECDIS). The Ice Information product specification is based on the IHO S-100 framework specification, Geography Markup Language (GML) Encoding Standard and the ISO 19100 series of standards. It is a vector product specification that is primarily intended for encoding the extent and nature of Sea Ice for navigational purpose.

All specified documents are in electronic form from the JCOMM Sea-Ice regulatory documents web page http://jcomm.info/index.php?option=com_oc&task=viewDoclistRecord&doclistID=160

Until the 1980s, most ice services were directed towards shipping and offshore exploration. As a result, the needs were very specific but national or regional in nearly every case. With more interest and study being directed towards the world's climate in recent years, there is a growing need for international data exchange for use by meteorological and oceanographic researchers. This required the creation of data banks at a coarser scale than in

operational services. Within the WMO project, Global Digital Sea Ice Data Bank (GDSIDB), which started in 1989, historical sea-ice information for the major part of the 20th century was archived in electronic form due to collaborative efforts of several ice services, institutions and data centres (from Argentina, China, Canada, Denmark, Finland, Japan, the Russian Federation, Sweden and the USA). Presently, the GDSIDB has two archiving centres, located at the Arctic and Antarctic Research Institute, St Petersburg, Russian Federation (http://wdc.aari.ru/) and the National Snow and Ice Data Center, Boulder, USA (http://nsidc.org/noaa/gdsidb) and holds 7- or 10-day-period mapped ice data for the Arctic starting from March 1950 and for the Antarctic from January 1973 and to near the present for both regions. From 1970s GDSIDB ice charts may serve as a ground-truth to SSM/I products or be the unique source of data on ice conditions and climate for before 1978. During 2002–2003 the first blending technique for Northern Hemisphere GDSIDB charts was developed, with the final update developed in 2016, so that the resulting blended data set presently contains the greatest amount of ice data for 1930s–201Xs. The product is scheduled to be extended as new data become available.

IICWG jointly with ETSI contributed to the development of the Ice Logistics Portal (http://ipy-ice-portal.com/) as a joint initiative with the European Space Agency through the EarthWatch GMES Service Element PolarView in support of the IPY 2007/2008. This Portal provides a single interactive website to operational sea ice information from National Ice Services for regions in the northern and southern hemispheres. The Portal has been active since May 2007. It contributes to the Global Cryosphere Watch (GCW) and the MyOcean project, funded by the European Commission. In 2009-2010 the Ice Logistics Portal has been transferred from PolarView to the German Ice Service, Bundesamt fuer Seeschifffahrt und Hydrographie (BSH), http://www.bsis-ice.de/IcePortal, with two versions running in parallel mode at the current time.

In December 2014, following ETSI and IICWG recommendations and decisions, Norway (Norwegian Meteorological Institute – NMI), Russian Federation (Arctic and Antarctic Research Institute – AARI) and USA (National Ice Center – NIC) initiated the pilot project on integrated sea ice analysis for Antarctic waters. By July 2017 joint activities include a) weekly (each Thursday) hemispheric sea ice charting and weekly (each Friday) hemispheric tabular iceberg analysis by US NIC, b) bi-weekly (each Thursday) hemispheric sea ice charting and weekly (each Wednesday) hemispheric tabular iceberg analysis by AARI, and c) weekly (each Monday) regional Antarctic peninsula sea ice charting by NMI. All products are based on common 'Specifications for collaborative product on sea ice analysis for Antarctic waters', and are archived at http://ice.aari.aq in vector SIGRID-3, S-411 and raster PNG formats.

PART II - REGIONAL AND NATIONAL PRACTICES

Northern Hemisphere

North and North-east Asia and North Europe

CHINA

02 August 2017 Revision

0. Sea ice situation near China coast

There are different degrees of icing in winter in Bohai Sea and the north of Yellow Sea each year, they are the lowest latitude sea ice areas in the northern hemisphere, so the sea ice in these areas is one-year ice, and the differences of ice conditions between light and heavy ice years are very obvious.

Sea ice disaster frequently happens in Bohai Sea and the northern Yellow Sea (Figure II-1, Annex II). According to the statistics, heavy sea ice disaster occurs almost every 5 years. For example, the sea ice disaster happened in Bohai sea was very serious in 2009-2010, while in recent several years, the temperature in Northern China goes up in winter, it is 6℃ higher than normal in January 2017 along the Bohai Sea, which directly lead to the lighter result than usual in the Liaoning coastal area.

1. Organizations

North China Sea branch of State Oceanic Administration, National Satellite Ocean Application Service and National Marine Environment monitoring Center are responsible for the daily observation and emergency observation of sea ice, observation methods include satellite remote sensing, aerial remote sensing,radar, and in-situ observation.

National Marine Environmental Forecasting Center(NMEFC), North China Sea Marine Forecasting Center(NMFC), National Marine Environment monitoring Center, which are the subordinate units of the State Oceanic Administration, and the marine forecasting agencies of Tianjin, Liaoning, Hebei, Shandong provinces are responsible for the daily and emergency forecasting of sea ice, and forecast products producing and distributing.

2. Data acquisition

China has been monitoring the sea ice from the 1960s, and the shore-based radar monitoring station was established in the 1980s.Until now, multi-platform and stereo sea ice observation system has already been established to facilitate the sea ice monitoring and warning, which includes platform radar and shore-based radar, satellite remote sensing, aerial remote sensing, observation stations, field observation, UAV observation and so on (Figure II-2, Annex II).

(a) Platform radar, installed on the oil platform in Bohai Sea, could be able to monitor the sea ice distribution, development and movement with high frequency in 360 degrees with weatherproof. The shore-based radar can monitor the coastal sea ice conditions.

(b) Satellite remote sensing data, including visible / infrared sea ice imagery, is mainly provided by NOAA, MODIS, HY-1 satellite (HY-1 is the China ocean color satellite). Airborne remote sensing of sea ice is carried out by airborne microwave radiometer, radar scatterometer and synthetic aperture radar (SAR).

(c) Station observations are used for fixed observation of sea ice conditions.

(d) Field observations are used to monitor and measure the ice on-site, including ice thickness, density, temperature, salinity, sea condition, visibility and weather conditions etc. Unmanned aerial vehicles (UAV) are additionally used to assist surveyors to carry out sea ice monitoring, which greatly reduce the workload and the risks of activities on ice.

3. Outputs and distribution

(a) Forecasting products

(i) Annually forecast products. The sea ice conditions from this winter to the coming spring are forecasted every November based on the weather forecast in winter. The main forecasting information is the new ice stage, heavy ice stage and final stage, and the distribution of drifting ice, ice thickness and maximum ice thickness etc.

(ii) Monthly, ten-day, weekly forecast products. The shorter period forecasts of ice conditions are produced based on in-situ observation and satellite remote sensing monitoring. The main forecasts contain the distribution of drifting ice, ice thickness and maximum ice thickness.

(iii) Ice warning information is broadcasted, which is caused by the sudden catastrophic weather.

(iv) Operational forecasting. Numerical models based on operational forecast are utilized to predict the different thickness of sea ice cover and distribution for 7- day every 6 hours.

(v) High resolution and refined numerical forecasting. High resolution and refined numerical models to predict sea ice distributions are used in the key areas and ports. The models contain different thickness of sea ice cover and wind- and current-driven sea ice drifting.

(b) Sea ice conditions imagery products

Satellite remote sensing imagery products are provided by NOAA、MODIS、HY-1, radar sea ice imagery products are from platform radar and shore-based radar (Figure II-3, Annex II).

(c) Sea ice bulletins

Annually, monthly, 10-day and weekly ice condition bulletins in Bohai Sea and the north of Yellow sea are produced in forms of textual and graphic bulletins, including thematic maps, in-situ photos (Figure II-4, Annex II).

(d) Products release

All the products are posted on the official websites, broadcasted on radio and TV, and via mobile operators, e-mail or telefax to the public, governments and enterprises.

4. Forecasts

Numerical sea-ice forecasts for up to five days ahead for the Bohai Sea are prepared daily by the NMEFC using a PIC ice model with fine resolution and a thermodynamic- dynamic operational ice model at the same time. The forecast products contain fields of ice thickness, concentration and velocity, ice edge, parameters of ice ridge and local estimates of ice thickness and tracks of ice floes near drilling platforms.

The 10-day and the 30-day forecasts are prepared using statistical methods to determine ice edge, and mean and maximum of ice thickness in the Liaodong Gulf, Bohai Gulf, Laizhou Bay and northern Yellow Sea by the NMEFC and NMFC/SOA.

The long-range seasonal outlook is prepared using statistical methods to estimate the ice conditions of the Bohai Sea and the northern Yellow Sea the following winter.

5. Publications

The China Ocean Annuals, China Marine Environment Annual Report and China Marine Disaster Bulletin (all in Chinese) are annually prepared by SOA. These publications include sea-ice conditions, disasters and activities about sea ice for the year.

6. Mailing and Internet addresses

National Marine Environment Forecast Centre (NMEFC)
8 Dahuisi Rd
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http://www.nmefc.gov.cn

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http://www.nmfc.org.cn

JAPAN

09 February 2017 revision

1. Organization

Sea-ice information services in Japan are provided by two governmental agencies (the Japan Meteorological Agency (JMA) and the Japan Coast Guard (JCG)) for fishing, shipping, coastal/harbor and other activities.

At JMA's Tokyo Headquarters, analysis is performed in relation to sea ice from November to July for the Sea of Okhotsk, the northern part of the Sea of Japan, the northern part of the Yellow Sea, the Bohai Sea and the areas of Hokkaido, the Kuril Islands and the Kamchatka Peninsula.

JMA's Sapporo Regional Headquarters monitors sea ice around Japan's northern island of Hokkaido from December to June.

2. Data acquisition

Three JMA Local Meteorological Offices and six JCG Coast Guard Office and station facilities in Hokkaido conduct daily visual observation of sea-ice amounts and conditions. JCG patrol vessels also routinely report on sea-ice conditions including type, concentration, thickness and difficulty of navigation. JMA and JCG exchange sea-ice data by e-mail/telefax and disseminate derived products to users.

Around 15 aerial observations are carried out per year jointly by the Ministry of Defense and JMA, and JCG also carries out around the same number. Both sets of data are used for sea-ice analysis by JMA and JCG.

Satellite remote sensing data provided by Himawari/AHI, NOAA/AVHRR, Metop/AVHRR, Terra/MODIS, Aqua/MODIS, Suomi-NPP/VIIRS and GCOM-W1/AMSR2 are also used for sea-ice analysis.

3. Forecast

JMA operates a numerical sea-ice model system to provide seven-day forecasts of sea-ice distribution in the southern part of the Sea of Okhotsk and neighboring waters. The model incorporates physical processes of sea-ice formation/melting and wind-and-current-driven sea-ice drift.

4. Output products

(a) Daily sea-ice condition charts are issued by JMA and made available via the Internet both in color (http://ds.data.jma.go.jp/gmd/goos/data/rrtdb/jma-pro/man_ice_okh_D.html (Figure VII-1, Annex VII)) and in monochrome (http://www.data.jma.go.jp/gmd/kaiyou/db/seaice/analysis/okhotsk_all.html (in Japanese)) every day from December to May.

(b) Sea-ice condition charts (Figure VII-2, Annex VII) issued by JMA are broadcast by meteorological radio facsimile on short wave (call sign: JMH) and posted on the JMH website (http://www.jma.go.jp/jmh/sml_00_stpn.html) on Tuesdays and Fridays from December to May. The charts detail sea-ice conditions and provide one-week forecasts in Japanese and English.

(c) Local sea-ice information (Figure VII-3, Annex VII) issued by the Sapporo Regional Headquarters is made available via the Internet (http://www.data.jma.go.jp/gmd/kaiyou/shindan/c_1/okhotsk_anal/hokkaido_iceinfo.html (in Japanese)) on Tuesdays and Fridays and as necessary from December to May. The information includes details of sea-ice conditions and one-week forecasts in Japanese for the area around Hokkaido.

(d) Numerical sea-ice condition forecast charts showing the distribution and concentration of sea ice for two and seven days ahead (Figure VII-4, Annex VII) are also broadcast by JMH and posted on the JMH website (http://www.jma.go.jp/jmh/sml_00_fioh0416.html) on Wednesdays and Saturdays when the southern edge of the sea-ice extent in the Sea of Okhotsk is located south of 48°N.

(e) The Ice Information Center of JCG's 1st Regional Coast Guard Headquarters also disseminates daily sea-ice condition charts for the area around Hokkaido via the Internet (http://www1.kaiho.mlit.go.jp/KAN1/drift_ice/eng.html) in Japanese, English and Russian.

5. Publications

Kaiyou Gaihou – Kaihyou Hen: a yearly publication provided by JCG's 1st Regional Coast Guard Headquarters containing an annual summary of observations made by six Coast Guard Office and station facilities, patrol vessels and aircraft; published on paper (in Japanese).

6. Mailing and Internet addresses

Mailing address

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Ice Information Center
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Japan Coast Guard (JCG)
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Hokkaido 047-8560, Japan
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Fax: +81 134-32-9301 (polling mode, Otaru)
E-mail: kanri01@jodc.go.jp

Internet addresses

JMA:
http://www.data.jma.go.jp/gmd/kaiyou/shindan/index_seaice.html (in Japanese)
http://www.jma.go.jp/en/seawarn/1010.html (marine warnings for the Sea of Okhotsk)

JMA's Sapporo Regional Headquarters:
http://www.jma-net.go.jp/sapporo/kaiyou/seaice/seaice.html (in Japanese)

JCG's Ice Information Center:
http://www1.kaiho.mlit.go.jp/KAN1/drift_ice/eng.html (Japanese, English and Russian)

JMH:
http://www.jma.go.jp/jmh/jmhmenu.html (in Japanese)

North-East Asian Regional GOOS (NEAR-GOOS):
http://ds.data.jma.go.jp/gmd/goos/data/database.html

RUSSIAN FEDERATION

15 February 2017 Revision

1. Organization

Sea-ice information services in the Russian Federation are provided by the Arctic and Antarctic Research Institute in St Petersburg (AARI), the Scientific Research Center of Space Hydrometeorology "Planet" in Moscow, the Moscow Hydrometeorological Centre (HMC Moscow) and the regional hydrometeorological offices in the Arctic, Far-Eastern Russia, Baltic, Black and Caspian seas; all belonging to the Russian Federal Hydrometeorological Service (Roshydromet).

AARI provides centralized services for shipping, coastal and harbor activities within the Northern Sea Route (NSR), for the Central Arctic Basin, Eurasian Arctic seas (Greenland, Barents, Kara, Laptev, Eastern-Siberian, and Chukchi Seas), and the Southern Ocean. Planet and HMC Moscow provide similar centralized services for the Bering, Okhotsk, Japan, Caspian, Black, Azov and White Seas. In addition to the ice services the AARI is responsible for the SafetyNet ice and weather information for METAREAs XX and XXI (Arctic), while the regional Roshydromet offices are responsible for provision of NAVTEX weather messages within the coastal areas of METAREAs XX, XXI, XIII (NW Pacific), Black, Azov and Caspian Seas.

2. Data acquisition

Coastal weather polar stations of Roshydromet make daily visual and instrumental ice observations on sea ice concentration and stages of ice development, ice thickness, forms of ice, ice drift and other phenomena. Icebreakers and icebreaking vessels on the NSR routes routinely (commonly once a day) report the main ice parameters describing ice navigation. Before 1994 aircraft ice reconnaissance flights were conducted in the Arctic usually on a monthly basis from November to April and on a 10-day internal during the summer navigation period. Since 1995 aircraft (mostly helicopter) ice reconnaissance flights are conducted only occasionally during tailored hydrometeorological support of applied and scientific activities in the Eurasian Arctic. The scope of ice information collected during air ice reconnaissance includes visual observations on a full scope of sea ice parameters essential for navigation and marine safety (egg-code, icebergs, openings, dynamics, surface features). Though being nowadays not the prime sources, the stated information (coastal, aircraft) is used, if available, for validation of the sea ice analysis and prognostic products at the ice centers.

The AARI and Planet satellite reception stations provide operational optical imagery for the Arctic Ocean and North Pacific from a series of satellites (NOAA, EOS TERRA, Aqua, Suomi NPP, FY3, Meteor, Ocean). Information for other regions (e.g. Antarctic), from other satellites and ranges (Sentinel-1,2,3, Radarsat-2, TerraSar-X, etc.) is received via Internet from corresponding data portals directly or from commercial satellite data providers. All data are further processed within ice information systems and utilized for regional, pan-Arctic or pan-Antarctic ice analysis. Sample satellite products are available via the AARI and Planet web pages.

AARI, Planet, HMC Moscow, and the regional Roshydromet offices exchange the described sea ice data and disseminate derived products to users using applicable transmission means (Internet, satellite connections, GMDSS Inmarsat and HF, facsimile etc).

3. Output products

(a) Chart output

(i) General sea-ice conditions charts of the Arctic Ocean are prepared by AARI on weekly scale (every Tuesday) and available via the AARI web page for public use. Charts depict drifting and fast ice boundaries and major classes of sea-ice concentration in the summer period or stages of development in the winter period and are available in graphic GIF format and in digital WMO SIGRID-3 format. A sample sea-ice conditions chart for the Arctic is presented in Figure X-1, Annex X.

(ii) Detailed hemispheric Southern Ocean (SO) sea-ice conditions charts are prepared by AARI every two weeks on Thursdays to provide tailored support for national activities and general ice monitoring in the region. SO tabular iceberg analysis (point and polygon) is done weekly on Wednesdays. Output products are available in graphic PNG and in digital WMO SIGRID-3

formats via SO AARI-NIC-NMI collaborative project web-site.. Sample chart is given in Figure X-2, Annex X.

(iii) Detailed regional sea-ice conditions charts and annotated imagery for the seas Greenland, Barents, Kara, Laptev, East-Siberian, Chukchi, Bering, Okhotsk and Baltic are prepared by AARI on weekly (every Tuesday) or shorter scales and on request and are disseminated via various telecommunication means to captains, shipping companies, local authorities and other users requesting tailored support. Informational products are relayed to the users accordingly in graphic georeferenced formats (GIF, PNG, JPEG), in WMO SIGRID-3, S-57 formats. Detailed regional sea-ice charts in national coding are available via the AARI web site in GIF and SIGRID-3 formats. Sample detailed ice charts for the Barents, Kara and Chukchi Seas are presented in Annex X, figures X-3 and X-4.

(iv) Detailed regional sea-ice conditions charts and annotated imagery for the Bering, Okhotsk, Japan, Caspian, Azov and White Seas are prepared by Planet and HMC Moscow on weekly (every Tuesday) scale. Informational products are relayed to the users accordingly in graphic georeferenced formats (GIF, PNG, JPEG) and in WMO SIGRID-3 formats. Detailed regional sea-ice charts in national coding are available via the Planet and HMC Moscow web sites in GIF and SIGRID-3 formats and AARI GDSIDB web-site. Sample detailed ice charts and annotated imagery for the Azov, Caspian and Okhotsk Seas are presented in Annex X, figures X-5, X-6 and X-7.

(b) Plain language information

(i) Coastal and high sea sea-ice and weather GMDSS and other plain language reports are prepared routinely on twice a day, daily, weekly or other scales and on request by AARI and the local meteorological offices of Roshydromet for METAREAs XX, XXI, XIII, sub-areas of Black, Azov, Caspian Seas, and are disseminated via GMDSS and other telecommunication means to the customers.

(ii) Synoptic bulletin on weather conditions in the Eurasian Arctic is prepared routinely on daily scale by AARI and is disseminated via various telecommunication means to the customers and published on AARI web-site.

4. Forecasts and forecasts methods

(i) Daily diagnosis and forecast charts of mean daily and instantaneous ice drift, surface currents and level elevation in the Arctic Ocean for period 0d…+6d on a basis of dynamic AARI sea-ice model;

(ii) Weekly or shorter period diagnosis and forecast charts of the evolution of ice cover in the Eurasian Arctic Seas including sea ice total concentration, thickness (stages of ice development), hummocks concentration and level of compacting for period 0d…+6d on a basis of the dynamic thermo-dynamic AARI model;

(iii) Weekly or shorter period prognostic charts of the type of ice conditions in accordance with the Northern Sea Route Administration 'Rules of navigation in the water area of the Northern Sea Route' on the basis of the output from the dynamic thermo-dynamic AARI model;

(iv) Daily diagnosis and forecast charts for winds, wave significant height and direction and ice accretion for open water areas in the Western and Eastern Eurasian Arctic Seas for period 00…+72h with 6-h interval on the basis of the AARI wave model;

(v) Numerical forecast for water level at selected coastal points of Eurasian Arctic for period 0d…+6d;

(v) Seasonal forecasts of ice conditions in the Eurasian Arctic seas and big Siberian rivers estuaries based on AARI empirical-statistical techniques (textual bulletins);

(vi) Weekly-monthly forecasts of ice phenomena in the big Siberian rivers estuaries based on AARI empirical-statistical techniques (textual bulletins).

Sample numerical forecast charts are presented in figure X-8, Annex X.

5. Publications

The following publications are issued by AARI at different periods:

(a) The quarterly and yearly bulletin *Review of the hydrometeorological processes in the Arctic Ocean* (in Russian);

(b) The quarterly bulletin *State of the Antarctic Environment* (in Russian and English);

(*c*) Bulletin "Long-term forecast of the ice conditions in the Arctic seas": 3 bulletins are published per year in the end March, June and August (in Russian);

(d) *Trudi AANII* (AARI Transactions): irregular two to three volumes are published per year (in Russian);

(*e*) *Problemi Arktiki i Antarktiki* (Problems of the Arctic and Antarctic): two volumes are published per year (in Russian);

(f) Irregular express information, informational bulletins of the Russian Antarctic expedition, monographs etc.

6. Mailing and Internet addresses

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St Petersburg Center for Hydrometeorology and Environmental Monitoring. (NW Hydromet)
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E-mail: hydromet@online.ru

Internet addresses

AARI:

http://www.aari.ru (main page)
http://www.aari.ru/odata/_d0015.php?mod=1&lang=1 (Arctic weekly ice charts)
http://www.aari.ru/odata/_d0004.php?mod=1&lang=1 (Eurasian Arctic seas weekly detailed ice charts)
http://ice.aari.aq (Southern Ocean)
http://www.aari.ru/projects/ecimo/index.php?im=101 (prognostic products)
http://193.227.232.57/meteo/default/bulluten (synoptic bulletin)
http://wdc.aari.ru/datasets/ (WDC Sea Ice / WMO GDSIDB – SIGRID-3 files)

Planeta:

http://planet.iitp.ru/english/products_eng.htm (Satellite data products)
http://planet.iitp.ru/Oper_pr/Oper_pr.html (Operational products)
See also direct links:
http://planeta.infospace.ru/prod-cgi/last.pl?product=67 (Ice charts – Black and Azov Seas)
http://planeta.infospace.ru/prod-cgi/last.pl?product=107 (Antarctic mosaic)

Hydrometcentre of Russia: http://wmc.meteoinfo.ru

NW Hydromet: http://www.meteo.nw.ru
Primpogoda: http://www.primpogoda.ru
FERHRI: http://www.hydromet.com

North-East Atlantic and Baltic Sea areas

DENMARK

Two governmental institutions in Denmark issue sea ice information:

(a) The Admiral Danish Fleet is responsible for the Danish Ice Breaking Service and ice information for the Danish Waters.

(b) The Danish Meteorological Institute is responsible for sea ice monitoring and information for the Greenland Waters.

DANISH ICE SERVICE

25 March 2014 Revision

1. Organization

The Danish Ice Service in general

The ministry of Defense, which through subordinate authorities also carries out assignments for the civil society, has the overall responsibility for the Danish Ice Service. The Ice Service activities include Ice Reporting, Ice Breaking and icing warnings.

In Denmark, it is Admiral Danish Fleet, which is the authority responsible for the Ice Service. The Ice service is collocated with the Maritime Assistance Service and the Joint Rescue Coordination Center in Århus.

On the following pages you can find more detailed information on the Danish Ice Service. In connection thereto an annex dealing with more details on the Danish Ice Service is published annually with Danish Notice to Mariners No. 1, including contact details to other ice services within the Baltic.

2. Data acquisition

To create the best possible overview of and publish accurate information on the current ice conditions, Admiral Danish Fleet is in contact with ice observers across the country.

A large numbers of observers, ferries, ports and naval units, reports daily to Admiral Danish Fleet on ice conditions. Up to 240 daily reports from different areas compile a good picture of ice conditions in Denmark

It is also possible to obtain information on ice conditions in Danish waters by calling the Danish Ice Service FAX ON DEMAND, on phone number +45 89 43 32 44, and you can find the current view on this website

3. Output products and icebreaking services

The ice reports are submitted to Admiral Danish Fleet in a four digit code, called the Baltic Code. This reporting format is common to the countries around the Baltic Sea.

Ice observations are collected in an overview of ice and navigational conditions in the Danish waters. The overview is published in clear text, and also contains the situation in the Baltic Code. On the Danish part of the Admiral Danish Fleet web-page you will find a graphical overview.

List of ice and navigational conditions are daily exchanged with other countries around the Baltic Sea.

During periods where the ice causes problems for shipping in Danish waters, Lyngby Radio and Danish Radio transmit Ice Reports.

Ice breaking in Danish waters is generally open for competition, and therefore shipping is responsible for contacting and paying for the requested ice breaking capacity. For help and guidelines for this, Admiral Danish Fleet has an overview on the Danish part of this website, containing possible providers of ice breaking capacities, and contact information.

Shipping can choose to use the overview to contact ship owners for possibly concluding contract for icebreaking. Such contracts shall be concluded on a bilateral basis between the requesting vessel and the icebreaker and is irrelevant to the Danish Ice Service.

Response areas

Within special appointed areas, named response areas, the Danish Ice Service maintain the possibility to activate icebreaker assistance to shipping from 15 December to 31 March.

Four specific response areas are established as follows:

- Limfjord West of Aalborg
- Limfjord between Aalborg and Hals Barre
- The waters South of Funen
- Smaalandsfarvandet (waters South of Zealand)

Ships bound for a port in an activated response area, must in due time, report expected time of arrival to the Danish Ice Service, which will coordinate with the icebreaker in the response area.

Contact Admiral Danish Fleet:
Phone: +45 89 43 32 10 or
E-mail: mas@sok.dk

The requesting ship must pay 25% of the hourly rate for actual effective icebreaking within the response area

4. Forecasts

Forecasts are only given in qualitative form indicating, for example, that ice is likely to compact, grow or melt rapidly, drifting into the area or out of the area, etc. during the next 24 hours.

5. Statistics

No weekly or monthly summaries are issued. An annual publication indicating the number of frost days, freezing degree-days, etc. from selected stations and number of days with various ice types present at each reporting site is made. Further, the annual report may contain several statistics comparing various years.

6. Mailing address

Admiral Danish Fleet
P.O. Box 1483
DK-8220 Brabrand
Phone: +45 89 43 32 08
Direct: +45 89 43 34 07
Mobile: +45 41 15 14 63
Email: sok-ob060@mil.dk
Email: sok@mil.dk
Internet: http://www.sok.dk

THE DANISH METEOROLOGICAL INSTITUTE

25 February 2017 Revision

1. Organization

The Greenland Ice Service at the Danish Meteorological Institute is responsible for sea ice and iceberg monitoring and information for the Greenland Waters. The purpose of the routine ice mapping is to aid navigation and to provide strategic and tactical support in the Greenland waters. The main areas of concern are the waters around Cape Farewell. Furthermore, parts of East and West Greenland are mapped in selected periods, depending on navigational needs and the actual ice distribution.

DMI operates a two branch ice service. At Narsarsuaq Airfield in South Greenland, the DMI Ice Observation and Warning Service, 'Ice Patrol Narsarsuaq' positioned at 61°10' N, 45°25' W was established in 1959. A Eurocopter AS 350 B3 helicopter is permanently chartered for the ice piloting and serves the ice reconnaissance of the South Greenland inshore routes and the inner parts of the Julianehåb Bay. Four ice observers are based at Ice Patrol Narsarsuaq and all are ships officers associated with the shipping company Royal Arctic Line and thus have several years of experience in ice navigation in Greenland waters. A twenty-four hour watch duty is maintained to ensure that calls are answered and ice piloting can be provided at short notice. The primary objective for the Narsarsuaq team is inshore ice reporting and advisory to ships. No ice breaking service is provided except for a few local arrangements.

The second Greenland Ice Service branch is located at the Danish Meteorological Institute in Copenhagen, staffed by a team of 8-9 ice analysts and experts in satellite image analysis, Arctic sea ice and icebergs, oceanography and IT/R&D. The production of ice charts for all Greenland Waters takes place at the Copenhagen office but can be supplemented by ice products issued by Ice Patrol Narsarsuaq. Ship piloting in ice covered waters is coordinated by Ice Patrol Narsarsuaq.

Ships and shipping companies can order existing routine ice charting information free of charge, while special services (e.g. piloting or information requiring separate flights or additional acquisition of radar images) are delivered against a marginal fee. Customized services for the offshore and mining industry, cruise industry etc., among these are tactical and strategic support, monitoring, outlooks are always covered by fees.

The inner Danish Straits form the entry to the Baltic Sea and are only occasionally covered by sea ice. The Danish Defense is responsible for monitoring and reporting of ice in the Danish Straits.

2. Data acquisition

Visual observations are recorded from helicopter for issue of ice reports. All received satellite imagery are automatically processed, resampled, geocoded and displayed by dedicated computers and software for sea ice mapping. The Greenland Ice Service at DMI has developed two ESRI ArcGIS-extensions used in sea ice mapping, named SIKU after the Greenlandic word for sea ice, for the production of ice charts. Actual meteorological information (observations, model output) and observations by ships are utilized when analyzing the satellite data.

The primary satellite dataflow for ice analysis is provided by the European Space Agency, via DMI's active role in EC Copernicus Marine Environment Monitoring Service.

The primary data sources used for ice mapping are acquired from RADARSAT-2, CosmoSkyMed constellation, Sentinel 1A/1B, NOAA-AVHRR, TERRA/AQUA MODIS and AMSR-2. Satellite data are always analyzed by experienced and specially trained ice analysts.

3. Output products

Through the ice season, typical January – July, regional sea ice charts for the South Greenland area are updated and issued 3-4 times a week when sea ice occurs or required by shipping. Outside ice season, typically August-December ice charts are published once a week. Ice charts for other areas in Greenland, primarily based on Sentinel 1, are produced 1-6 times a week depending on the actual ice situation and navigational requirements. A summary ice chart for all Greenland waters is published every Monday and Thursday. All published ice charts are exported standard graphical formats and to SIGRID3 for exchange with ice services and data centers. Ice conditions near or inshore ship routes in South Greenland are mapped 1-3 times weekly and reported in plain language following international ice nomenclature.

All ice charts follow international ice charting standards and are published by use of via email and internet Reduced ice edge information is broadcasted via Navtex and shore radio. Further, ice information is broadcasted by telephone and email.

DMI provides daily low resolution sea ice and iceberg products to Copernicus Marine Environment Monitoring Service, based on satellites and numerical models.

Samples of output products are given in Annex III.

4. Forecasts

Reduced ice information, in plain language is included in the daily ocean outlooks and warnings, for the Greenland Waters. Experimental medium range sea ice forecasting using the HYCOM CICE modelling setup is in progress.

5. Publications

No weekly or monthly summaries are prepared.

6. Mailing and Internet addresses

Danish Meteorological Institute
Operations / Greenland Ice Service
Lyngbyvej 100
DK-2100 Copenhagen
Denmark

Contact: Email: iskort@dmi.dk
Internet:
http://www.dmi.dk (DMI main page),
http://www.dmi.dk/en/groenland/hav/sea-areas-forecast/ (DMI ice charts and outlooks)
http://ocean.dmi.dk (test site)
http://marine.copernicus.eu (Copernicus Marine Environment Monitoring Service)
https://arcticweb.e-navigation.net/ (Danish Maritime Authority website on shipping safety in Greenland Waters)
http://www2.forsvaret.dk/eng/About/National/Pages/National.aspx (ice information reported for the Danish straits by Defense Command Denmark)

Ice Patrol Narsarsuaq
P.O. Box 505
3923 Narsarsuaq
GREENLAND
Email: icepatrol@dmi.dk

ESTONIA

16 March 2005 Revision

1. Organization

The Estonian Meteorological and Hydrological Institute (EMHI) is responsible for the sea-ice information service in Estonia. The service is, in particular, intended to meet the needs of international and Estonian shipping services. Service is also given to all other activities, where sea-ice information is required: fisheries, coastal and harbour activities, meteorological forecasting and climatology.

The ice service in the Baltic begins at the end of October, when ice starts to form, and lasts until the end of May.

2. Data acquisition

Daily ice information is reported in Baltic Sea Ice Code, from 16 stations, which are situated along the Estonian coast.

In addition to the daily coded information, each station sends some information about the thickness of fast ice with the depth and density of snow cover on it. Most observations are visual.

All meteorological information, such as observations, weather charts, forecasts, are received from the weather service of the EMHI.

Ice information in Baltic Sea Ice Code is received daily via the Global Telecommunications System (GTS) from Finland, Germany, Norway, Poland, Sweden, Latvia, Lithuania and Russia. Ice charts are received by facsimile from Finland and by e-mail from Germany, Sweden, Poland and Russia.

3. Output products

(a) *Ice charts*

The ice bulletin/chart covers the Gulf of Finland, Gulf of Riga, the Irben Strait and the northern part of the Baltic proper. The actual chart contains ice information and sea-surface isotherms of wave height. The symbology used on actual charts is common for all countries around the Baltic Sea and is printed on the chart.

(b) *Coded information*

A complete listing of Estonian areas in Baltic Sea Ice Code is issued daily and sent by the GTS to Riga.

(c) Plain language information

(i) The sea-ice bulletin: a description of the ice situation at sea and restrictions to navigation is issued in Estonian and English and sent daily by fax to Sweden, Latvia, Lithuania and Russia;

(ii) Ice reports, ice charts and ice forecasts are distributed daily by fax or e-mail to users (approximately 20);

(iii) Similar sea-ice bulletins (as in item (i)) are issued in Estonian once a day by Estonian Radio.

A sample ice chart is in given in Annex IV.

4. Forecasts and forecast methods

An ice forecast is published daily in the printed sea-ice bulletin. The forecast describes in general terms the expected ice development such as ice drifting, opening of leads, areas with ice pressure, ice formation or melting.

An ice information forecast includes: date of ice formation, freeze-over, break-up and ice disappearance up to 30 days in advance. The predictions are produced by statistical methods.

5. Publications

Tables of sea-ice observations from shore stations are prepared as internal reports of EMHI, but not published.

6. Mailing address

Estonian Meteorological and Hydrological Institute (EMHI)
(Eesti Meteoroloogia ja Hьdroloogia Instituut)
Toompuiestee 24, 10149 Tallinn
Estonia
Telephone: +372 6660-914
Telefax: +372 6660-911
E-mail: mere@emhi.ee
Internet: http://www.emhi.ee/

FINLAND

27 February 2017 Revision

1. Organization

The Finnish Meteorological Institute (FMI) is responsible for the sea-ice information service in Finland. The operational Ice Service started in 1915. The service is intended to meet the needs of national and international shipping as well as other activities where sea-ice information is required, in particular fisheries, coastal and harbour activities, forecasting and climatology. The ice season in the Baltic normally begins at the middle of November, when ice starts to form in the northernmost archipelagoes of the Bay of Bothnia and lasts until the end of May. Sea surface temperature (SST) charts are published from beginning of November to the end of ice season.

2. Data acquisition

(a) Sea ice

Ground truth observations: Finnish and Swedish icebreaker reports several times a day in plain language; daily or weekly coastal station reports from 15-20 stations; ice and snow thickness profiles; daily or weekly reports from ships in plain language.

Space-borne: Data received from satellites is the main source for spatial analysis. The operationally used satellite data is MODIS Aqua and Terra, VIIRS, Sentinel-1A and B, Radarsat-2, CosmoSkyMed and TerraSAR-X data. Sentinel-2 in experimental use.

(b) Sea surface temperatures

Ground truth input data: 14 automatic coastal stations, 5-10 buoys, once a week measurements from 5-10 coastal stations; icebreakers; five merchant vessels with hull thermometers measuring along tracks covering the Baltic Sea.

Space borne: Copernicus SST analysis that uses several satellite based radiometer instrument observations.

3. Output production

(a) Ice charts

About 170 Ice Charts are issued daily during the ice season. On Mondays and Thursdays SSTs are included with 30-year averages. Charts are e-mailed or available to users via dedicated service packages or internet (www.iceservice.fi).

Type of chart (scale, areas, others): Mercator projection, and since 1 January 2006, covering east of 9°00´E the Baltic Sea, Skagerrak and the Swedish Kattegat and Vanern and Malaren lakes. A simplified ice chart over the Baltic Sea is issued once a week and published on the internet.

(b) Bulletins on ice situation

Bulletins (ice reports) on ice situations in the Baltic Sea, including restrictions to navigation, operational areas of icebreakers and traffic information, are e-mailed, broadcasted in the radio and published in internet. The Finnish Ice Report in plain language in Finnish, Swedish and English is broadcast in GTS network and in coastal radio stations on a daily basis. Coded sea-ice information from 95 areas or fairways in Baltic Sea Ice Code is included on bulletins over GTS network.

(c) Other information products

Digital satellite images (SAR and visual bandwidth) sent to Finnish and Swedish icebreakers. High-resolution (500-m) ice thickness charts over the SAR images are available operationally at http://ice.fmi.fi. A sample daily ice chart is shown in Appendix V.

4. Forecasts and forecasting methods

(a) Forecast models: HELMI Northern Baltic Sea dynamic-thermodynamic ice model. HIGHTSI Thermodynamic sea ice model (Finnish-Chinese).

(b) HELMI forecasts are provided for the Baltic Sea, 48 hours in advance for ice concentration, level ice thickness, total ice thickness, ridged ice density, ridged ice height, ice motion (direction and velocity), and areas of ice compression. Ice forecasts with six parameters in 3-hour time intervals are available on a daily basis at ice.fmi.fi. Sample charts are given in figures V-2 and V-3, Appendix 2.

(c) Once a week 10-day ice thickness development and brief weather forecasts in plain language are provided to the Finnish Transport Agency the Winter Navigation department.

(d) Once a month seasonal outlook for the Baltic Sea ice conditions in plain text and monthly charts is are provided to the Finnish Transport Agency the Winter Navigation department.

(e) The Finnish Ice Service responds to enquiries from users and provides a range of specialized forecasting, consultation and advisory services on a best-effort, cost-recovered basis.

5. Publications

(a) Description of the ice conditions for each winter is published yearly basis in internet (http://en.ilmatieteenlaitos.fi/baltic-sea-ice-winters)

(b) Irregular. -

6. Mailing and Internet addresses

Finnish Meteorological Institute (FMI)
Finnish Ice Service
PO Box 503
FI-00101 Helsinki
Finland

Telephone: +358 29 539 3464 (during ice season)
Fax: +358 29 539 3413
E-mail: iceservice@fmi.fi
Internet: http://www.iceservice.fi, http://ice.fmi.fi

GERMANY

15 February 2017 Revision

1. Organization

The ice service provided by the Federal Maritime and Hydrographic Agency (BSH) covers the whole Baltic during the winter, with special emphasis on the German Bight and the Baltic Sea west of Bornholm. The agency is separate from the Meteorological Service but both are part of the Federal Ministry of Transport and Digital Infrastructure. The products of the ice service are provided for fisheries, national and international shipping in the Baltic Sea and for harbor activities, maritime agencies and off-shore activities. On request world-wide ice information is provided.

A joint web page for the Baltic Sea Ice Services (BSIS) has been developed and established as an independent domain at BSH (http://www.bsis-ice.de), which also includes the JCOMM Ice Logistics Portal.

2. Data acquisition

Daily ice information is reported in Baltic Sea Ice Code from 134 areas or fairway sections along the coast of the southwestern Baltic Sea and the German Bight. A selection of these form 54 main areas or fairways grouped in 11 districts. Details are given in WMO No.9, Volume D – Information for Shipping. In addition to the coded information, observers at many stations also perform ice thickness measurements. The other main data sources are satellite observations, mostly from freely available sources (NOAA, MODIS, Sentinel and VIIRS in the optical, passive microwave from AMSR and active microwave (SAR) from Sentinel). Reports, data and charts are also exchanged with foreign ice services via e-mail and GTS. Internet access to ice information products of foreign services is greatly used. Information over sea surface temperature is taken from coastal stations, satellite data and from the operational model.

3. Output products

All regular products are freely available on the Internet at www.bsh.de. The ice charts are also available at the JCOMM Ice Logistics Portal and part of them (in black and white) are also broadcasted as radio facsimile over long wave using the station at Pinneberg (search on Website of the DWD at www.dwd.de). The radio facsimile transmission also include the iceberg charts for the North-West Atlantic provided by IIP (International Ice Patrol) and CIS (Canadian Ice Service), the Swedish ice chart of the Baltic and the Norwegian ice chart of the European Arctic.

(a) *Ice charts*

(i) A reference ice chart of the ice conditions in the Baltic Sea using the international system of sea-ice symbols is produced once a week.

(ii) An ice chart showing ice conditions in the western Baltic and German Bight using the international system of sea-ice symbols is made as necessary (up to daily) when ice is present in considerable amounts at sea in the Skagerrak or Kattegat.

(iii) An ice chart showing ice conditions at the German coast using the international system of sea-ice symbols is made as necessary (up to daily) when ice is present in considerable amounts.

(iv) A daily facsimile broadcast is (re-)transmitting the North American Ice Service (NAIS) iceberg charts for the North Atlantic provided by IIP (International Ice Patrol) and CIS (Canadian Ice Service), (Figure XII-1, Annex XII).

Note: all charts are constructed with the ArcMap program using Mercator projection. The standard format for the regular user is PDF, but the data is also made available on the internet as shapefiles and in S411. Larger scale (approximately 1:850,000) sub-regional charts are prepared as needed in PDF format.

Sample ice charts are given in Annex VI.

(b) *Coded and plain language information*

(i) A bulletin describing ice conditions and traffic restrictions in the whole Baltic Sea and North Sea using plain English and German and the Baltic Sea Ice Code is made Monday to Friday. An ice outlook for three to six days is included.

(ii) Similar bulletins covering the western Baltic and the German Bights are prepared daily in English and German for GTS and national NAVTEX.

(iii) Detailed descriptions of the ice at the German coast are made in plain German, there are separated in a Baltic report and a North Sea report.

4. Forecasts

An operational, 3-dimensional numerical ocean model including sea ice is run twice a day with a forecast length of 72 hours. The model covers the whole Baltic and North Sea. As the model does not assimilate sea ice data, the direct use of the model output for operational sea ice products is very restricted. But the model output is used at times by the sea ice analyst for additional information regarding formation of new and young ice, sea ice thickness and the decay of ice.

5. Publications

Each year a description of the last ice season is done in summer and made available at the BSH website. Other publications are prepared at irregular intervals, like summaries of several winters as special BSH reports, and sea ice chapters for nautical publications. There are two actual ice atlases (published 2012 and 2015), one for the western and southern Baltic and the other for the German Bight and Limfjord.

6. Mailing and Internet addresses

BSH – Eisdienst
Neptunallee 5
18057 Rostock Germany
Telephone: +49 (0) 381 4563 782 (and 787)
Telefax: +49 (0) 381 4563 949
E-mail: ice@bsh.de
Internet:
http://www.bsh.de/de/Meeresdaten/Beobachtungen/Eis/index.jsp (in German/English)
http://www.bsis-ice.de (a joint web page for the Baltic Sea Ice Services), with a mirrored backup at http://www.eisdienst.de .

ICELAND

Reproduced from 2007 Revision

1. Organization

The Icelandic Meteorological Office provides all sea-ice information services in Iceland. The Icelandic sea-ice service covers Icelandic waters, defined by the ocean area inside the limit of the economic zone around Iceland.

2. Data acquisition

Sea ice in Icelandic waters is mainly encountered in the eastern side of the Greenland Strait (Denmark Strait) between Iceland and Greenland and in the Iceland Sea north of Iceland.

Visual observations are collected from lighthouses and coastal meteorological stations, and both visual and radar observations from ships at sea.

Aerial reports, both visual and radar, are made by Icelandic Coast Guard ice reconnaissance aircraft and ice is also reported by commercial aircraft.

Satellite imagery is also received and integrated into the charts. These are mainly NOAA visible and infrared images received many times a day at the forecast department of the Icelandic Meteorological Office. Additionally, sea-ice charts are received from abroad. Ice charts and satellite imagery on the Internet are also utilized.

3. Output products

Ship reports are prepared for display on the Internet, as well as Icelandic Coast Guard sea-ice charts giving ice edges and, when available, concentration and stage of development. The area covered is variable within 65–69°N and 11–28°W. Information on the position of ice edges is sent to ships by NAVTEX. Ice charts are sent to customers and other ice centres by fax. Information on sea ice in Icelandic waters is easily accessible through the web site of the Icelandic Meteorological Office.

4. Forecasts

Regular, formal ice forecasts are not prepared. However, probability statements on future sea-ice movements and changes in sea-ice extent are made available on request or made public through news media.

5. Publications

A monthly summary is prepared and included in a climatic bulletin issued by the Icelandic Meteorological Office. An annual report, Sea Ice off the Icelandic Coasts, is also issued in Icelandic and English.

6. Mailing and Internet addresses

Icelandic Meteorological Office
Bustadavegur 9
150 Reykjavik
Iceland
Telephone: +354 522 6000
Telefax: +354 522 6001
E-mail: office@vedur.is
Internet: http://www.vedur.is

LATVIA

7 May 2009 Revision

1. Organization

The Latvian Environment, Geology and Meteorology Agency (LEGMA) provides the national sea-ice service.

The collection, processing and dissemination of operational sea-ice information as well as further ice development forecasts are carried out for the Gulf of Riga and the Latvian economic zone in the Baltic Sea. The ice season in the region begins in November–December, when ice starts to form in the northern part of the Gulf of Riga and in the Bay of PΔrnu. The season lasts until the complete decay of the ice in April–May.

The service collaborates with all ice services around the Baltic Sea through operational data exchange using the international Baltic Sea Ice Code.

The major users of sea-ice data are the Latvian Naval Fleet, coast guard, Maritime Rescue and Coordination Centre (MRCC), Maritime Administration, local port authorities, fishing industry and various private companies involved in operations at sea or in harbours.

2. Data acquisition

The principal data sources are visual observations from the coast and satellite data (visual and infrared imageries) from the LEGMA-operated HRPT station.

Visual sea-ice observations are carried out by nine LEGMA-operated coastal stations on the Baltic coast and in the Gulf of Riga daily at 0600 UTC during the ice season. The ice observation data (total concentration, stages of ice development, topography, thickness of fast ice and snow depth on it), accompanied by records of sea level, wind, wave, air and water temperatures are transmitted through telecommunication lines to the central office in Riga in coded form. In addition, some plain language information from vessels in the Gulf of Riga comes through the harbour master's services. Daily ice reports both coded and in plain language, are received from other Baltic Sea ice services using the GTS. Additionally, ice charts covering all the Baltic Sea regions from Sweden and Germany, regional ice charts from Estonia, and ice bulletins from German ice service are received as well.

All the data, mentioned above, are the principal sources of information for analyzing the ice conditions and producing output products.

3. Output products

(a) Coded and plain language information

(i) A daily Latvian Ice Report, both in the international Baltic Sea Ice Code and in plain language (English) are transmitted via the GTS circuit Riga-Norrkцping. The data refer to the main fairways, harbour approaches and harbours in accordance with Latvia's area of responsibility as defined in the Baltic Sea Ice Code. It includes ice condition data in the harbours of Riga, Liepaja, Ventspils and approaches to them, ice information on the fairways Riga – Irben Strait – Lithuanian sea border.

(ii) A daily plain language (Latvian) ice condition description for the Gulf of Riga and the Latvian coastal area in the Baltic Sea.

(iii) A daily Ice Condition Report for the area around the Baltic Sea in plain English. Ice charts for the Gulf of Riga and adjacent to Latvia's Baltic Sea waters were not produced during the 2003–2004 ice season due to technical problems with the HRPT (High Resolution Picture Transmission) satellite image receiver.

(b) Ice charts

Ice charts for the Gulf of Riga and Latvia's Baltic Sea waters are produced once per week during ice season.

4. Forecasts

Expected ice development forecasts (in Latvian and English) for the following 10 days for the Gulf of Riga and the Latvian economic zone in the Baltic Sea are produced three times a month. Expected ice conditions on the main Latvian fairways are presented in forecasts as well.

5. Publications

Information in Latvian about monthly ice conditions can be found on http://www.meteo.lv/public/informativie_materiali.html

6. Mailing and Internet addresses

Latvian Hydrometeorological Agency
165, Maskavas Str.
LV- 1019 Riga
Latvia
Telephone: +371 7 032 600
Telefax: +371 7 145 154
E-mail: marine@lvgma.gov.lv
Internet: http://www.meteo.lv

LITHUANIA

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1. Organization

At present there are two subdivisions of the Ministry of Environment involved in sea-ice information: the Centre of Marine Research (CMR) and the Klaipeda Department of the Lithuanian Hydrometeorological Service (LHMS). The CMR, besides other observation units in sea hydrology, includes three sea-ice observation posts. Daily observation data are promptly transmitted to the LHMS Klaipeda Department. From here data exchange is conducted with hydrometeorological services of foreign countries. Data on sea-ice observations are accumulated and archived as well as analysed in the CMR.

Referring to CMR data on sea ice and including extra information, the LHMS provides information and advises on sea-ice conditions as well as on navigation conditions in the Baltic Sea at users' requests.

2. Data acquisition

There are three sea-ice observation posts in the Lithuanian coastal area. Observations begin when ice appears and continue until full ice break. The state of the ice at the ice observation posts is observed daily at 0800 local time. When ice break occurs later in the day the observation time is changed to be closer to noon. Under circumstances of poor visibility, the observations are repeated once visibility has improved.

Basic drifting and fast sea-ice characteristics are determined during observations, including ice pollution, snow on ice, ice drift and ice thickness. The sea-ice state, determined from observations, is outlined in diagrams. The daily express information on sea ice from posts is sent by telegram to the LHMS Klaipeda Department.

To ensure safe navigation in the Baltic Sea the LHMS Klaipeda Department picks up the following information:

(a) CMR daily sea-ice observation data in the Lithuanian Baltic Sea coastal area;

(b) Daily sea-ice observation data in the Latvian Baltic Sea coastal area and Gulf of Riga from the Latvian Hydrometeorological Agency;

(c) The sea-ice report of the Estonian Hydrometeorological Institute in the Estonian coastal area Baltic Sea and Gulf of Riga;

(d) The sea-ice report of the Russian Hydrometeorological Service in the Gulf of Finland;

(e) The sea-ice report of the Hydrometeorological Service of Finland in the Bothnia Sea and Bothnian Bay and Gulf of Finland;

(f) Monthly sea-ice forecast from the Latvian Hydrometeorological Agency in the Irben Strait and Gulf of Riga;

(g) All available information on sea-ice distribution and development received from fishing-boats and merchant vessels entering Klaipeda seaport;

(h) Sea-ice map on ice situation in the Baltic Sea and the Belts from the Swedish Meteorological and Hydrological Institute broadcast through Germany;

(i) The sea-ice report taken during air surveys over the Lithuanian economic zone in severe winters.

3. Output products

The LHMS Klaipeda Department publishes information on sea ice in the Lithuanian coastal zone in a daily marine bulletin. At the request of ships' owners and masters, according to the information available, maps are provided on the sea-ice situation in the following parts of the Baltic:

(a) In the Gulf of Riga (sailing to Riga port);

(b) In the Gulf of Finland (sailing to St Petersburg);

(c) In the Belt Sea (sailing to the North Sea and Atlantic Ocean).

4. Forecasts and forecasts methods

In addition to the sea-ice observations and information on sea-ice distribution, the CMR and LHMS Klaipeda Department also carry out observations and forecast the ice situation in the Curonian Lagoon.

The Curonian Lagoon is a very closed freshwater basin connected by a narrow (600–800-m wide) strait with the Baltic. The main Lithuanian river, the Nemunas runs into this lagoon. The northern part of the Curonian Lagoon belongs to Lithuania. This part is significantly influenced by Baltic Sea waters during storms in the autumn and winter season, and the ice formed, often has the sea-ice properties.

There are three ice observation posts in the Lithuanian port of the Curonian Lagoon. Daily express information on the ice situation there is received by the LHMS Klaipeda Department. This department provides forecasts and warnings to shipping and fishing companies with the following details:

(a) Information on formation of new ice forms;

(b) Information on fast ice formation and total freezing of the lagoon;

(c) Information on ice break out;

(d) Information on total ice-break.

5. Mailing and Internet addresses

CMR
Taikos Str. 26
5802 Klaipeda
Lithuania
Telephone: + 3706 250324
Telefax: + 3706 250930
E-mail: CMR@klaipeda.omnitel.net

LHMS Klaipeda Department
Taikos Str. 26
5802 Klaipeda
Lithuania
Telephone: + 3706 252247
Telefax: + 3706 252247
E-mail: khmo@klaipeda.aiva.lt

NETHERLANDS

15 April 2009 Revision

1. Organization

Institution providing sea services: Rijkswaterstaat/Riza.

2. Data acquisition

Daily ice information reported in Baltic Sea Ice Code. Number of areas, regions, stations: 9 stations Nationwide, including Belgium Antwerp. Other sources of information: government ships, cargo ships, pilots. Data exchanged with foreign services daily by email. Ice charts are received from Sweden and Germany.

3. Output products

(a) Ice information

In ice season the ice situation is issued in code daily. The ice reports are sent to Germany and Sweden by e-mail. The coastguard sent the ice reports by navtex (518kHz) and VHF 23 or 83 to the ships.

(b) Coded information

Coded and/or plain language in Dutch and English.

4. Forecasts and forecast methods

For Netherlands coastal waters is no ice forecast

5. Publications

Regularly.

Irregularly: seasonally.

6. Mailing and Internet addresses

Rijkswaterstaat/Waterdienst
Information and Warning Centre (Infocentrum Binnenwateren)
Postbus 17
NL-8200 AA Lelystad
Netherlands
Telephone: +31 320 298-888
Telefax: +31 320 298-580
E-mail: infocentrum@rws.nl
Internet: http://www.infocentrum-binnenwateren.nl

NORWAY

24 January 2017 Revision

Two government institutions in Norway issue sea-ice information:

(a) The Ice Service of the Norwegian Meteorological Institute is responsible for ice monitoring within the Atlantic part of the Arctic with the emphasis on Svalbard.

(b) The Ice Service belonging to the Norwegian Coastal Administration is responsible for informing vessels about the ice situation in Norwegian waters in Skagerrak Strait from the Swedish border to Kristiansand.

I. NORWEGIAN METEOROLOGICAL INSTITUTE

1. Organization

The Norwegian Ice Service is located in Tromsø, and shares offices with the Forecasting Division for Northern Norway, which is in turn part of the Norwegian Meteorological Institute (MET Norway). The Ice Service provides daily (working day, Monday-Friday) ice charts for the Atlantic part of the Arctic, covering the east coast of Greenland to the western coasts of Siberia, with the emphasis on Svalbard. In addition it provides a weekly (on Mondays) ice chart for the Weddell and Bellingshausen Seas of the Antarctic during the austral summer (October to April), covering the area between Peter I and Bouvet Islands with an emphasis on the Antarctic Peninsula.

The main users of the Ice Service are fishing vessels, sailing close to the ice edge in northern and south-eastern parts of Spitsbergen throughout the year. The majority of these ships consist of non-ice class shrimp trawlers that are dependent on good ice information to be able to work and plan their activities in a safe and cost-efficient manner. Cruise ships and private yachts are very active during summertime and reliable charting of the highly dynamic nature of sea ice within the fjords, narrow straits and sounds of the Svalbard archipelago is critical for their operations. Detailed and accurate ice information on the ice conditions is therefore important, and in high demand by the users.

The Ice Service analysts study the current conditions primarily via remotely sensed data and provide ice charts, ice-edge information and an overview of the sea surface temperatures.

The ice charts are high-resolution and based on SAR, and contain sea ice concentration as well as delineating areas of fast ice. Sea surface temperatures are included as contours from thermal imaging satellite data..

2. Data acquisition

Data received from satellites are the main source for analysts, augmented by visual observations and meteorological weather forecasts. The following informational products are used (in order of preference):

in Extended Wide (EW) and Interferometric Wide (IW) modes at 50 and 10 metres resolution respectively. Typically these are dual (HH+HV) polarisation.

(b) RADARSAT-2 ScanSAR wide scenes covering the Svalbard area at 100 metres resolution. Typically these are dual (HH+HV) polarisation.

(c) COSMO SkyMed X-band single polarisation (HH) SAR images in ScanSAR (Huge Region) and Spotlight (Himage) modes at 100 and 5 metres resolution respectively.

(d) High resolution optical images from the EU Copernicus programme Sentinel-2A satellite.

(e) NOAA VIIRS optical images.

(f) NASA MODIS Terra and Aqua optical images.

(g) NOAA/EUMETSAT AVHRR optical images.

(h) Sea ice concentrations processed from JAXA AMSR-2 passive microwave data at 3.125 km resolution provide background global coverage and are used when no SAR or cloud-free optical images are available.

(i) Sea ice concentration and type images from the EUMETSAT OSI SAF (Ocean and Sea Ice Satellite Application Facility) at 10 km resolution.

3. Output products

(a) Ice charts are issued daily (working day, Monday-Friday) throughout the year and are typically e-mailed users and distributed by the web page. The position of the ice edge for GMDSS METAREA-XIX is also relayed to users by telex. The overview ice chart, covers the European Arctic. A sample chart is given in Figure VIII-1, Annex VIII.

(b) Formatted sea ice data are prepared regularly for use in the AROME weather prediction and ROMS ocean prediction models. These gridded products are also distributed via the EU Copernicus Marine Environment Monitoring Service (CMEMS)

(c) High-resolution ice charts are issued for the Svalbard area. A sample chart is given in Figure VIII-2, Annex VIII.

(d) A weekly (Mondays) Antarctic chart has been produced in austral summers (October-April) since the 2010-11 season. From 2014, this was produced in collaboration with the U.S. National Ice Center and Russian Arctic and Antarctic Research Institute. A sample chart is given in Figure VIII-3, Annex VIII. In addition, a high-resolution chart is issued for the Bransfield Strait and Adelaide Island areas of the Antarctic Peninsula.

4. Forecasts and forecast methods

Several forecast models are under development and are being tested on a pre-operational basis. These include:

(a) Arctic-20km and Nordic-4km Regional Ocean Modelling System (ROMS), and

(b) The "(Towards) an Operational Prediction system for the North Atlantic European coastal Zones" (TOPAZ) model, run by MET Norway for the EU Copernicus CMEMS.

5. Publications

Publications are issued both on a regular and irregular basis.

6. Mailing and Internet addresses

Istjenesten
Vervarslinga for Nord-Norge
Postboks 6314 Langnes
NO-9293 Tromsø
Norway
Telephone: +47 77 62 14 62
Telefax: +47 77 62 13 01
E-mail: istjenesten@met.no or iceservice@met.no
Internet: http://www.met.no
http://polarview.met.no/ (regular ice charts)
http://marine.copernicus.eu/ Coperncius Marine Environment Monitoring Service (gridded products)
Twitter: @istjenesten (climatological reporting, text alerts)

II. NORWEGIAN COASTAL ADMINISTRATION

1. Organization

The main task of the Norwegian Coastal Administration Ice Service is to inform vessels about the ice situation in Norwegian waters from the Swedish border to Kristiansand including the Oslofjord.

The Norwegian Ice Service does not include assistance by icebreaker to and from ports. The larger ports have icebreaker service in the harbour and for assistance during approach and departure from the port. Please contact local port authorities for information.

2. Data acquisition

The coast is divided into observation areas that are identified by a code of letters and numbers according to "The Baltic Sea Ice Code".

3. Output production

Plain language ice reports and coded ice observations according to "The Baltic Sea Ice Code" are available and regularly updated: 1 December to 31 March, see http://www.kystverket.no/Maritime-tjenester/Meldings--og-informasjonstjenester/Istjenesten-i-Norge.

4. Mailing and Internet addresses

Kystverket Southeast, Ice Service
Serviceboks 625
N-4809 ARENDAL, NORGE
Telephone: +47-3701 9700/ -3701 9718 / -3701 9759
Cell phone: +47-4815 4142 / -9593 0261
Fax: +47-3701 9701/ -3702 7619
E-mail: ismelding@kystverket.no
Internet: http://www.kystverket.no

POLAND

10 February 2017 Revision

1. Organization

The ice service is provided by the Hydrological Forecasting Office, Institute of Meteorology and Water Management, Maritime Branch in Gdynia (IMGW-PIB Instytut Meteorologii Gospodarki Wodnej-PIB, Oddzial Morski w Gdyni, Biuro Prognoz Hydrologicznych). It covers Polish waters, Southern Baltic and South-Eastern Baltic during an ice winter. Radio transmission of ice reports and bulletins, ice charts are provided for national and international shipping in the Baltic Sea and for harbour activities, fisheries, maritime agencies and off-shore activities.

2. Data acquisition

Visual daily ice information in Baltic Ice Code are available from coastal stations along Polish Coast. Additional sources of information includes: ship reports and Harbour Masters reports in plain language, webcams, meteorological guidance products, satellite visual/infrared imagery from MODIS and from Sentinel. Aerial reconnaissance made only under very severe ice conditions.

Details on coastal stations are listed in publication WMO-No. 9, Volume D – Information for Shipping.

Reports, bulletins, data and charts are also exchanged within foreign ice services via e-mail, ftp, joint web page for the BSIS and GTS - transmission in plain language reports and coded data.

3. Output products

(a) Ice observations / Ice reports

A coded ice report is broadcast daily by Witowo Radio on ice conditions in Polish waters. A plain language report is provided in Polish and English. A coded ice report is also exchanged via GTS transmission.

(b) Ice charts

(i) An ice chart (colour) of ice conditions in the Southern and South-Easten Baltic (Polish Baltic coast) is produced from one to three times a week when ice is present using the international system of sea-ice symbols. It is distributed via e-mail and presented on the Internet. Type of chart: Mercator projection, Baltic Sea between 53°20'N and 55°30'N, 13°40'E and 20°30'E.

(ii) A printed ice chart (colour) of ice conditions in whole Baltic Sea is produced once a week using the international system of sea-ice symbols. It is e-mailed and presented on the Internet. Type of chart: Mercator projection, Baltic Sea between 53°30'N and 66'N, 12'E and 30°30'E.

Note: charts (i)-(ii) are constructed with the digital ArcMap program.

Sample ice charts are given in Annex IX.

(c) Ice bulletins

A bulletin of ice conditions in the Baltic Sea is prepared using plain Polish during ice season twice a week (Tuesday, Friday). In case of very severe winter, the ice bulletin is prepared daily from Monday to Friday. Bulletin includes coded reports for the open Baltic Sea and coastal waters for all the Baltic countries. Short term subjective forecast of ice conditions for Polish Coast is included during severe winter. It is distributed by e-mail and presented on the Internet.

4. Forecasts and forecast methods

A short term ice forecast for Polish waters is included in the ice bulletins. It uses subjective dynamical methods and a forecast of meteorological conditions. The freezing of sea ice is forecasted by empirical model.

5. Publications

A descriptive summaries of the ice season is prepared annually and published on the Internet. Other publications are prepared irregularly.

6. Mailing and Internet addresses

Instytut Meteorologii i Gospodarki Wodnej – PIB (IMGW-PIB)
Oddzial Morski – Biuro Prognoz Hydrologicznych - Gdynia
ul. Waszyngtona 42
PL 81-342 Gdynia
Poland
Telephone: +48 58 6288 146/+48 781 774 173
Telefax: +48 58 620 1641
E-mail: hydrologia.gdynia@imgw.pl
Internet:
http://www.imgw.pl
http://www.baltyk.pogodynka.pl//index.php?page=2&subpage=64
http://www.bsis-ice.de (a joint web page for the Baltic Sea Ice Services)

SWEDEN

1 February 2017 Revision

1. Organization

The Swedish Meteorological and Hydrological Institute (SMHI) is responsible for the sea ice information service in Sweden since 1930. SMHI provides ice information for the Swedish icebreakers and international shipping through the National Maritime Administration, the Royal Swedish Navy and the general public and media.

Further, the Swedish Ice Service is, as the national expert authority on sea ice, often involved in marine accident investigations as well as other external inquiries. The Swedish Ice Service is operational seven days a week during the ice season, and produce daily ice charts and ice reports as well as client specific products such as ice formation forecasts. The ice season in the Baltic Sea normally begins in late November when ice starts to form in the northernmost archipelagos of the Bay of Bothnia, and lasts until end of May. The Swedish Ice Service is represented in IICWG and the JCOMM Expert Team on Sea Ice as well as in other international collaborative forums.

2. Data acquisition

(a) Ice observations – plain language

When at sea, icebreakers report on current ice conditions 3-4 times per day. Ice information is also provided in plain language by merchant vessels, either on their own initiative or upon request, and by a few coastal observation stations.

Ice observations - Baltic Sea Ice Code

Ice observations in Baltic Sea Ice Code are reported by a few observers along the coast. National ice reports in Baltic Sea Ice Code from Sweden, Denmark, Estonia, Finland, Germany, Latvia, Lithuania, Netherland, Poland and Russia are available via the WMO GTS network.

(b) Satellites

100 m resolution SAR images from RADARSAT-2 and Sentinel-1 are used during ice season. A variety of optical images are used from the NOAA (AVHRR), Suomi-NPP (VIIRS) and Metop A and B satellites, received daily all year. OSISAF images are received daily and used in SST analysis.

(c) Sea surface temperature observations

Hourly or daily SST observation data is collected from buoys and automatic stations (both Swedish and international via ftp), coastal stations and some merchant and passenger vessels (mainly by Ferrybox).

(d) Meteorology forecasts

For meteorological forecasts the weather service at SMHI use a number of international meteorological models including SMHI's HIRLAM (High Resolution Limited Area Model) and the operational atmospheric model at European Centre for Medium-Range Weather Forecasts (ECMWF).

3. Output products

(a) Ice charts

Ice charts in Mercator projection are produced daily and cover the Baltic Sea including the Gulf of Finland and Gulf of Riga, Kattegat and Skagerrak, and the major Swedish lakes (Vänern and Mälaren). The scale at 60° N is 1:4 000 000. Charts display ice concentration, thickness and type using WMO international sea-ice symbols and colour code standard. Ice charts also include navigational restrictions for ports in Sweden and Finland and information on position of the operating icebreaker vessels. For ports in other countries in the Baltic area, info is available at www.baltice.org. Twice weekly, the ice chart is complemented by a sea surface temperature (SST) chart for the same area.

All charts are uploaded on the SMHI webpage for public access. On request, vessels can receive the ice chart by email or fax. The Swedish ice charts are also transmitted on radio facsimile by the German stations Hamburg/Pinneberg.

(b) Ice bulletins / Ice reports

Daily bulletins, in English, on current ice situations at sea, navigational restrictions and icebreaker information are distributed by NAVTEX, the GTS network and are available for public access on the SMHI web page both in Swedish and English. The ice reports are also uploaded on the Baltic Icebreaker Management website. An abridged ice report is broadcasted daily on Swedish Public Radio.

(c) Baltic Sea Ice Code

Ice information for selected fairway sections is distributed in Baltic Sea Ice Code via WMO GTS network and is available on the SMHI web page. All Swedish and international Baltic Sea Ice Code data is stored in SMHI's Ice Database.

(d) Ice forecasts

SMHI produce ice forecasts for up to 15 days. The forecasting service is both a commercial service available to shipping companies, but also a service to other authorities including the Swedish Maritime Administration, Swedish Navy and Coastal Guard. For more information on ice forecast methods see section 4.

(e) Other output products

Ice charts are converted to grid files which are used in data assimilation for SMHI's ocean circulation model NEMO (see section 4). SMHI send daily wind, atmospheric pressure and water level forecast data to an external database for access and visualization onboard Swedish and Finnish icebreakers.

4. Forecasts and forecast methods

Sea ice forecasts are prepared using SMHI's operational ocean circulation model NEMO-Nordic. NEMO is an abbreviation for Nucleus for European Modelling of the Ocean. NEMO-Nordic is a three dimensional baroclinic model, with a coupled ice model. NEMO-Nordic currently runs with horizontal resolutions of 1 and 2 nautical miles. The ice model is based on LIM3.

The forecast parameters are; ice concentration, thickness, and ice drift. The ice model can produce forecasts up to 10 days and is from winter 2017, forced with a combination of ECMWF and AROME model or the operational ECMWF meteorological model. Using the combined AROME and ECMWF forcing, ice forecasts of up to 60 hours are produced with 1 nm resolution. For longer forecasts (up to 10 days) the ECMWF model is used to force NEMO-Nordic at 2 nm resolution.

Initial conditions are determined by assimilation of data from observations, gridded SST charts and satellite data through the method of 2D or 3D ensemble variational data assimilation. The above described ice modelled forecasts, together with other meteorological models and ensemble models such as the ECMWF, are used as a basis, by experienced marine forecasters, to produce ice formation forecasts up to 15 days to our clients.

5. Publications

SMHI publish a monthly summary of meteorological, hydrological and oceanographical conditions in which ice conditions are presented during ice season.

Every year SMHI and the National Maritime Administration publish a joint report summarizing the past ice season. This report includes month by month description of ice development, statistical information on selected fairways, weather and SST summaries and a summary of icebreaking activities.

6. Mailing and Internet addresses

Swedish Meteorological and Hydrological Institute (SMHI)
Swedish Ice Service
601 76 Norrköping
Sweden
Telephone: +46 (0) 11 495 8533
Telefax: +46 (0) 11 495 8053
E-mail: ice@smhi.se

Internet:
http://www.smhi.se
http://www.smhi.se/iceservice (Ice products)
http://www.smhi.se/oceanweb/forecasts (visual ice forecast)
http://www.baltice.org (icebreaker activities, ice reports)

UNITED KINGDOM

1. Organization

Since the first issue of the WMO publication Sea-Ice Information Services in the World (1981) the UK Met Office is not producing routine sea-ice analyses. No sea-ice information is available.

2. Mailing address

Meteorological Office
FitzRoy Road
Exeter
Devon EX1 3PB
United Kingdom
Telephone: +44 (0)1392 885680
Telefax: +44 (0)1392 885681
E-mail: enquiries@metoffice.gov.uk
Internet: http://www.metoffice.gov.uk

North America

CANADA

09 February 2017 Revision

1. Organization

The Canadian Ice Service (CIS), a division of the Meteorological Service of Canada at the Department of the Environment is a center of expertise providing reliable and timely marine ice and iceberg information for Canada and its surrounding waters. The Ice Service works closely with the Canadian Coast Guard which operates a fleet of icebreakers to assist marine transportation in Canadian waters.

Ice information products and services are provided for Canada's waters in areas of known marine activity. Arctic areas are typically active from June to November while southern areas, including the Gulf of St. Lawrence and the Great Lakes are usually active from December to May. In addition to Canadian waters, the CIS also provides ice information for METAREA XVII and METAREA XVIII.

Major users of Ice Service products and services are marine interests and researchers.

The Canadian Ice Service has expertise in ice reconnaissance, analysis and forecasting, modelling, remote sensing and Canadian ice climatology. The CIS maintains an archive of Canadian ice information products.

It has a staff of approximately 90 people working in Ottawa and in field offices. The office in Ottawa is staffed 7 days a week.

2. Data acquisition

Radar and visual imagery from satellites are the principle data sources, augmented by visual observations transmitted by ice observers onboard fixed-wing aircraft and helicopters. RADARSAT-2 and SENTINEL synthetic aperture radar (SAR) data provides extensive and detailed (typically 100 m resolution) coverage of ice conditions. The Ice Service uses approximately 11,000 SAR images annually. Data are received in near real-time by Canadian satellite receiving stations and are processed and delivered to the Canadian Ice Service typically within an hour.

Visual and infrared imagery from U.S. polar orbiting satellites is also used in the ice analysis program. Passive microwave imagery is received daily to provide background information on the general ice distribution at low resolution.

3. Output products

Ice information products are available on the Canadian Ice Service web site, the marine weather section on Environment Canada's weather.gc.ca, the Canadian Coast Guard website, and through Canadian Coast Guard marine radio broadcasts. All products are available in English and French.

Specialized products and services to meet the short-term tactical and longer-range planning needs of clients are also available. These products and services include detailed ice charts, satellite imagery, special forecasts covering days to months and onsite briefings. Products are distributed via e-mail, fax, and internet.

(a) Ice charts

Ice charts illustrate ice or iceberg conditions at a particular time, presenting full and partial concentrations using the complete egg code. Each chart is produced using both WMO colour codes as well as black and white and custom colour palettes. Sea ice and lake ice charts are available in .gif and .pdf formats. Sea ice and iceberg data are available electronically in Sigrid3 and .e00 formats. The following charts are available:

(i) Regional (weekly) Ice Chart (Figure I-1, Annex I);
Regional ice charts show the analysis of ice conditions for a given region valid on Mondays. They are based on an analysis of satellite imagery collected over a few days and integrate weather and oceanographic data.

(ii) Daily Ice Charts (Figure I-3, Annex I);

Daily Ice charts represent the best estimate of ice conditions at the valid time of the chart. A variety of satellite imagery is used as well as model output to forecast the location and condition of the ice. These charts are provided daily in areas of marine activity in Canadian waters.

(iii) Satellite Image Analysis Charts (Figure I-4, Annex I);
Image analysis charts provide a visual interpretation of the ice conditions extracted from synthetic aperture radar imagery frames. The charts are valid at the image acquisition time. The areal extent of an image analysis chart varies depending on the satellite's orbit as well as on operational requirements to support shipping. These charts are available in areas where the satellite pass covers areas with marine activity.

(iv) Ice Reconnaissance Charts (Figure I-5, Annex I);
Reconnaissance charts present very detailed information on ice conditions at the time of the aircraft survey. They are provided for active marine areas where ice conditions are challenging.

(v) Daily Iceberg Forecast Charts (Figure I-2, Annex I);
This chart presents an estimate of iceberg conditions in East Coast waters south of 60° N based on visual observations of icebergs from aircraft, ships, and occasionally from satellite imagery. Positions are forecast to 00:00 UTC along with an iceberg limit line. For areas north of 53ºN, the iceberg limit is estimated when there is a lack of aircraft observations. The chart includes an estimate of the number of icebergs per degree square of latitude and longitude.

(b) *Bulletins*

Text bulletins provide information on present iceberg conditions. The following bulletins are available:

(i) Daily Iceberg Bulletins
(ii) METAREA bulletins

(c) *Imagery Mosaics and Composite*

Imagery mosaics and composites are automatically generated from multiple scenes and/or swaths of satellite imagery and provide an overview of ice conditions for the area of interest for the time period of the data collection. The following imagery mosaics are available:

(i) 3-day RADARSAT Mosaics – Western Arctic; Eastern Arctic; Hudson Bay (Figure I-6, Annex I)
(ii) 7-day MODIS Composites - Arctic (Figure I-7, Annex I)

4. Forecasts and Outlooks

Forecasts provide information on present and forecast ice conditions in text format.

The following forecasts are available:

(a) Daily Ice Forecasts (Figure I-8, Annex I);
Daily forecasts describe the ice edge location, and for each marine area the total ice concentration, the predominant stage of development and the concentration of the oldest ice type. The forecasts are valid from the time of issue until the end of the following day. Warnings are issued for strong ice pressure, rapid closing of coastal leads, and unusual ice conditions that may pose a threat to navigation.

(b) 30 Day Ice Outlooks
The long-range outlook describes the general advance or retreat of ice in a region over a 30-day period. It estimates the stage of ice development and identifies any anticipated departure from normal conditions. Forecasts are issued around the third business day following the 1st and 15th of each month.

(c) Seasonal Ice Outlook (graphical and text format)
The seasonal outlook describes the expected timing of the ice breakup in the Arctic or freeze-up in the Great Lakes or the East Coast. This product is not updated or amended and is replaced by the 30-day forecast.

5. Publications

The following publications are available in print and on-line as indicated:

(a) Seasonal Summary for the Canadian Arctic since 2004 (available on request)
(b) Seasonal Summary for the Great Lakes and Eastern Canadian Waters since 2004(available on request)
(c) MANICE - Manual of Standard Procedures for Observing and Reporting Ice Conditions.
(d) Sea Ice Climatic Atlas - Northern Canadian Waters 1981-2010
(e) Sea Ice Climatic Atlas - East Coast of Canada 1981-2010
(f) Lake Ice Climatic Atlas - Great Lakes 1973-2002

(g) Annual Arctic Ice Atlas 1990 – present (available on request)

6. Mailing and internet addresses

Canadian Ice Service – Environment and Climate Change Canada
373 Sussex Drive, Block E – 4th floor
Ottawa, Ontario
Canada K1A 0H3
Telephone: +1 (877) 789-7733 | Fax: +1 (613) 947-9160
E-mail: ec.ecweather-meteo.ec@canada.ca
Internet: http://ice-glaces.ec.gc.ca

NORTH AMERICAN ICE SERVICE

11 November 2016 Revision

1. Organization

The mission of the North American Ice Service (NAIS) is to leverage the strengths of the Canadian Ice Service (CIS), US National Ice Center (NIC), and the International Ice Patrol (IIP) to monitor and provide the highest quality, timely and accurate ice analysis, in order to meet the needs of the maritime interests of the United States and Canadian governments in support of:

- Safe and efficient maritime operations;
- Weather and environmental modeling;
- National and environmental security;
- Research and climate understanding; and
- International treaty and other obligations

Since December 2004, CIS, NIC, and IIP have jointly produced ice charts, ice forecasts, 30-day forecasts, iceberg warning products, and seasonal outlooks for the Great Lakes, North American waters, and the North Atlantic under the banner of the North American Ice Service. The North American economy is dependent on the reliable and efficient movement of goods and materials through ice-encumbered coastal waters. The ice services of Canada and the United States enable this by providing timely and accurate strategic and tactical ice information to the maritime community. In doing so, these agencies reduce the risk of loss of life, property, and environmental damage from ice-related accidents and disasters. Government operations in the polar regions (land and sea patrols) depend on regular ice information to enhance their domain awareness and to plan their operations under, through and on the surface of sea ice. The mandate of the NAIS is to create harmonized products and services for ice information for North American waters to serve the needs of users for safety of navigation and informed decision-making. The integrated service combines the strengths of the existing centers and results in seamless products of high quality and consistency. The NAIS offers a single point-of-entry for ice information and will provide a suite of common North American ice products that may be produced at any of the three centers equally, effectively, and indistinguishably to the user. Each center is recognized as a contributing partner to the NAIS, and products may be issued jointly without specific attribution to the center of production**.** Ultimately, the product suite of the NAIS may evolve into a set of constantly updated databases of past, current, and forecast ice conditions from which users will retrieve the information they desire, rendered and delivered in a format of their own specification.

2. Output products

(a) Iceberg chart for the North Atlantic. A sample chart is given in Figure XII-1.

(b) Ice charts issued weekly for the Great Lakes. A sample chart is given in Figure XIII-1, Annex XIII.

(c) Ice hazard bulletins for the Great Lakes in plain language.

3. Forecasts and forecast methods

(a) 30-days forecasts and seasonal outlooks for the Great Lakes.

(b) 30-days forecasts and seasonal outlooks for waters surrounding North America in the Arctic.

(c) 30-days forecasts for icebergs in North Atlantic waters.

4. Internet address

http://www.navcen.uscg.gov/?pageName=NAIceService

1. Organization

A. U.S. NAVAL/NATIONAL ICE CENTER (NIC)

Sea ice products and services in the United States are provided by the National Ice Center located just outside of Washington, D.C., in Suitland, Maryland. Through the collective efforts of three Federal Government agencies: the National Oceanic and Atmospheric Administration (NOAA), the United States Navy (USN), and the United States Coast Guard (USCG), manpower and fiscal resources are contributed and used in the collaborative operation of the NIC.

The mission of the NIC is to provide the highest quality, timely, accurate, and relevant snow and ice products and services to meet the strategic, operational, and tactical requirements of the United State's interests across a global area of responsibility.

The NIC's global area of responsibility includes:

(a) Arctic – All routinely ice covered Arctic Ocean waters, to include the Sea of Japan, Sea of Okhotsk, and the Yellow Sea.

(b) Antarctic – All routinely ice covered Antarctic waters.

(c) United States – Alaskan waters, Great Lakes, Chesapeake Bay, and the Delaware Bay.

(d) In addition to the global sea ice analyses and forecasts, the NIC produces a daily Northern Hemisphere Snow and Ice Cover Analysis Chart, and maintains an Antarctic Iceberg Database.

Internationally, the National Ice Center actively participates in the International Arctic Buoy Program (IAPB), International Ice Charting Working Group (IICWG), North American Ice Service (NAIS), and the World Meteorological Organization-Intergovernmental Oceanographic Commission's (WMO-IOC) Expert Team on Sea Ice.

Sea ice analyses for Alaskan areas are also prepared by the NOAA National Weather Service (NWS) in Anchorage, Alaska.

B. USCG INTERNATIONAL ICE PATROL (IIP)

Iceberg warning products and services in the United States are provided by the International Ice Patrol located in New London, Connecticut.

The mission of the IIP is to monitor the iceberg danger in the North Atlantic Ocean and to provide relevant iceberg warning products to the maritime community.

Along with CIS and NIC, IIP is one of the three members of NAIS as well as an integral part of the IICWG.

2. Data acquisition

NIC ice products are produced primarily using radar, visible, and infrared imagery from a variety of sources. Satellite imagery constitutes over 95 per cent of the information received and integrated into NIC analysis products. Microwave and scatterometer data is also used in product production. In addition to imagery, drifting buoy data, ice model predictions, limited ship reports, and meteorological and oceanographic input is available to the analyst, as well as ice information provided by other international centers. The NIC has an extremely productive and active working relationship with the Canadian Ice Service (CIS) and receives some shared imagery from their center – and vice versa.

IIP directs aerial reconnaissance from U.S. Coast Guard HC-130J aircraft to detect and identify icebergs in the North Atlantic Ocean. Satellite imagery from RADARSAT-2 and Sentinel-1a is downloaded and analyzed at IIP using iceberg detection software. Iceberg reports are also received from commercial aerial reconnaissance based in St. John's Newfoundland and from vessels transiting the area. All of this iceberg data is then analyzed using IIP's iceberg drift and deterioration model. Watchstanders produce an Iceberg Limit based on the model's forecast that is displayed graphically on the NAIS Iceberg Chart (ANNEX XII, Figure XII-1) and textually on

the NAIS Iceberg Bulletin each day, valid at 00Z. These iceberg products warn shipping traffic of the areas to avoid. Ships are encouraged to immediately report sightings of icebergs or stationary radar targets that may likely be icebergs to the nearest Canadian Coast Guard MCTS Center or through INMARSAT using Service Code 42, as there is no charge when using this code.

3. Output products and forecasts

NIC produces a variety of ice analyses and forecasts in support of operations and climate data covering both the northern and southern polar region. Routine NIC ice products include a daily ice edge analysis of the northern and southern hemispheres, marginal ice zone analysis in the northern hemisphere, a daily snow cover product, weekly or bi-weekly regional scale graphical ice analysis, alphanumeric text messages, and WMO Sea Ice in GRIDed (SIGRID) format. Geographical Information System (GIS) formats such as shape files, .e00 files, and coverage information is created either daily or weekly. Additionally, electronic charts in .pdf format, annotated imagery, and short term forecasts are available. All sea ice analysis, text messages and GIS products are available via the NIC website at http://www.natice.noaa.gov. Outlooks for the Ross Sea, Western Arctic, and Great Lakes are produced regularly and posted to the NIC website.

Special requests such as route recommendations, pre-sail ship briefs, ship rider support, legacy ice information (1972 to present), long term ice forecasts, location and orientation of exploitable openings or thin ice features in the ice pack, multi-year ice locations, estimated ice thickness based on ice stage of development, and tactical annotated imagery are available with some restrictions based on the requesting customer, (i.e., Department of Defense, research, academia, etc.).

Except for the Great Lakes analyses, which are produced in Lambert Conformal, all NIC ice products use polar stereographic projections, and WGS84 datum.

During the Great Lakes ice season, bi-weekly ice analyses, seasonal outlooks, 15 and 30 day forecasts, .e00 files, ASCII files, and an ice concentration product are provided as a service of the NAIS. The NIC and CIS alternate the twice weekly chart, providing a seamless, identical product available to customers. These products can currently be located on the NIC and CIS (http://ice-glaces.ec.gc.ca) website.

The USCG's International Ice Patrol resumes creation of the NAIS Iceberg Warning Products from the Canadian Ice Service in late January when icebergs typically begin to threaten the transatlantic shipping lanes. IIP continues production of the NAIS Iceberg Products until September when icebergs typically only threaten Canadian coastal waters. According to the International Convention for the Safety of Life At Sea (SOLAS), the Ice Season formally begins in mid-February and continues into July. IIP deployments to St. John's, Newfoundland to conduct aerial reconnaissance run from February through August to ensure that the iceberg danger is being monitored regularly. IIP creates two products for the maritime community each day, the NAIS65 Iceberg Chart (graphical representation) and the NAIS10 Iceberg Bulletin (text representation). They are normally released at 1830Z and are valid for 0000Z the following day. The iceberg chart is broadcast over radiofacsimile (RADIOFAX) and the Internet. The iceberg bulletin is broadcast over SafetyNET, Navigational Telex, Simplex Teletype Over Radio (SITOR), and the Internet. On the Internet, they are available on the IIP website, on the CIS website, on the National Weather Service (NWS) website. SOLAS requires that ships transiting the IIP area of the North Atlantic Ocean utilize the IIP iceberg warnings.

The NAIS Iceberg Chart (ANNEX XII, Figure XII-1) includes the following information:

- The Iceberg Limit is denoted by a solid line and represents the extent of the iceberg population based on recent reconnaissance and computer simulated iceberg drift and deterioration. Drifted iceberg positions have an area of uncertainty that is fully encompassed by the Iceberg Limit.
- The Estimated Iceberg Limit is represented by a dotted line. This line represents a rough estimate of the current extent of the iceberg population in this region. It is based on climatological data provided by the Danish Meteorological Institute.
- The Sea Ice Limit is denoted by the dashed line and represents the estimated extent of at least 1/10 sea ice coverage. The Sea Ice Limit is valid for 1600Z on the day prior to the date on the chart. The Sea Ice Limit is provided by the Canadian Ice Service and the Danish Meteorological Institute.
- Numbers on the chart represent the total number of icebergs including growlers, bergy bits, and radar targets, whose estimated positions are within the respective area bounded by one degree of latitude and one degree of longitude.

- Stationary Radar Targets will not be used to establish the Iceberg Limit but still represent a potential hazard to the Mariner. When a stationary radar target's estimated position is outside the Iceberg Limit, the radar target symbol will be used in the estimated position to represent the potential hazard.
- The Most Recent Reconnaissance is at the end of the NOTE block. It indicates what area was most recently surveyed (SW, S, SE, E, or W limit), whether the work was a dedicated iceberg flight, a general flight, or a satellite pass, and when the work was done. Northern Survey indicates reconnaissance focused on counting icebergs north of 50N instead of delineating the iceberg extent. If a dedicated iceberg flight has flown in the last seven days, it will be considered the most recent reconnaissance.
- The NOTE block will be used to indicate if a special situation applies to the chart. Examples include a chart revision (when new information is received that affects the accuracy of the chart) and a significant expansion or reduction of the Iceberg Limit (defined as at least one degree of change in latitude or longitude from the previous Iceberg Limit).

The NAIS Iceberg Bulletin will be updated each day by 00Z and when changing ice conditions require a revision. The Bulletin contains the same information displayed on the chart with the exception of the numbers of icebergs per square degree of latitude and longitude. Estimated positions of stationary radar targets will be included.

If an iceberg is detected and reported outside the published NAIS Iceberg Limit, a Notice to Shipping (NOTSHIP) will immediately be sent by the Canadian Coast Guard Marine Communications and Traffic Service (MCTS) and an urgent NAVAREA IV message will be distributed over GMDSS by the National Geospatial-Intelligence Agency (the NAVAREA IV Coordinator). These warnings will remain in effect for 24 hours. Iceberg products will be revised shortly after notification between 1200 UTC and 0000 UTC or by 1400 UTC the following day if reported between 0000Z and 1200Z. No updates to the Iceberg Chart will be made between 0000Z and 1200Z.

A full list of IIP products and broadcast times, in addition to reporting requirements, can be found at http://www.navcen.uscg.gov/?pageName=iipProducts.

The Ice Desk of the NWS Anchorage, Alaska office produces sea ice advisories, sea ice analyses of Alaskan waters, including Cook Inlet, sea surface temperature analysis, and five day forecasts. These products can be accessed at http://pafc.arh.noaa.gov/ice .

4. Publications

(a) EWG Arctic Sea Ice Atlas - an Arctic compendium of sea-ice information. Information included on this CD-ROM is derived from unclassified and classified ice data (1972-1990). Statistics include: probability of occurrence of all ice, ice extent extremes (maximum, mean, minimum) and median ice concentration charts.

(b) The NIC Polar Science team regularly publishes papers and reports. The majority of these reports are available via the NIC website.

(c) Great Lakes climatology is available from the National Snow and Ice Data Center (NSIDC), Canadian Ice Service, and NOAA's Great Lakes Environmental Research Laboratory (GLERL).

(d) North Atlantic Iceberg Summary – As required by SOLAS, the USCG's International Ice Patrol publishes an annual report summarizing its operations and the ice, meteorological, and oceanographic conditions experienced during the North Atlantic Ice Season. All historical reports can be located on the International Ice Patrol's website at http://www.navcen.uscg.gov/?pageName=IIPAnnualReports.

5. Contact Information

National Ice Center

Mailing address
Director, National Ice Center 4251 Suitland Road
NSOF Washington, D.C., 20395

Physical address
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Administration: (301)-394-3200
Operations Floor: (301)-394-3099
Operations Department Head: (301)-394-3020
Operations Technical Advisor: (301)-394-3028
Information Technology Department Head: (301)-394-3007
Science Department Head: (301)-394-3120
Chief Scientist: (301)-394-3105

E-mail: liaison@natice.noaa.gov

International Ice Patrol

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Telephone:
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IIP Duty Watch Officer Cell: (860) 235-8171
IIP Ice Operations Officer: (860) 271-2633
IIP Ice Information Officer: (860) 271-2643
IIP Information Technology Specialist: (860) 271-2783
IIP Chief Scientist: (860) 271-2757

E-mail: iipcomms@uscg.mil

NWS Anchorage Alaska – Ice Desk

Mailing address:
NWSFO Anchorage 222 West 7th Avenue
Building #23, Room 517 Anchorage, AK 99513-5113 USA

Telephone: Ice Desk: (907)-226-5138

E-mail: nws.ar.ice@noaa.gov

SOUTHERN HEMISPHERE

ARGENTINA

04 February 2017

1. Organization

Sea ice information and related services in Argentina are provided by the Argentine Navy Meteorological Service (SMARA) of the Naval Hydrographic Service (SHN), through the Glaciological Division at city of Buenos Aires. This information is regularly provided for ships sailing or operating in Antarctic waters, with focus in Antarctic Peninsula and Weddell and Eastern Bellingshausen Seas.

As responsible for NAVAREA VI, a complete set of ice charts, iceberg location and complement information is periodically provided to secure maritime activities, considering the main objective of secure life at sea and contribute to safety of navigation.

In accordance with these purposes, sea ice and iceberg information is delivered by SafetyNET and NAVTEX throughout all NAVAREA VI (in Spanish and English) and simultaneously uploaded in the SHN web page (www.hidro.gob.ar/Smara/glacio/sglaciologica.asp, only in Spanish). Besides, specific information can be requested by email (hielo.marino@hidro.gov.ar, in Spanish or English).

Users of these products include the Argentine Navy Ships during the Antarctic Campaigns, and fishing or tourist vessels of all nationalities mostly sailing and operating in Antarctic Peninsula and Bellingshausen Sea.

The Argentine Naval Hydrographic Service assumes the Argentina international representation in the International Ice Charting Working Group (IICWG) and in the Expert Team on Sea Ice (ETSI) of the Joint World Meteorological Organization-Intergovernmental Oceanographic Commission Technical Commission for Oceanography and Marine Meteorology (JCOMM).

2. Data acquisition

The principle data source are based on satellite images such as those derived from SENTINEL, RADARSAT, COSMO SKYMED, AQUA and TERRA-MODIS, among others.

Satellite information is complemented with ice observations from land and ship stations through the coding with SIGLAC software. These observations are made twice a week from land stations and every six hours from ships. Argentina counts with six permanent stations in Antarctica and other seven during the summer, which allows having a very good representation of ice conditions near the cost and inside bays and coves. Around five Argentine Navy Ships deploy to Antarctica every summer, increasing the observational information and helping with validation of satellite imagery.

Another source of information is provided by glaciological flights, on board helicopters or airplanes, that allows the ice analysts to confirm and validate information obtained by satellite images and establishes the general conditions of concentration and state of development of sea ice.

All ice observations are made by experienced personnel who have a specific training course focused in the different techniques of observations based on the Argentine Ice Observers Manual and in the codification of the information with SIGLAC software.

3. Output products

Sea ice and icebergs information is provided for public service by different media, depending in the type of product: ice charts, icebergs charts, sea ice edge chart, ice observations report and sea ice concentration forecast

The following information is available for Antarctic Peninsula, Weddell and Bellingshausen Sea and South Atlantic Ocean:

(a) Sea ice edge chart: position and concentrations are provided, with updates twice a week. The information is displayed in the SHN web page: http://www.hidro.gob.ar/Smara/glacio/sglaciologica.asp#, then click on 'Borde de Hielo Marino' (Sea Ice Edge).

(b) Ice charts: concentration and stage of development are provided, with twice a week updates. These charts are made considering 9 different zones (see Annex XIV) for better details. The information is displayed in the SHN web page: http://www.hidro.gob.ar/Smara/glacio/sglaciologica.asp#, then click on 'Cartas de Hielo' (Ice Charts).

(c) Iceberg charts: the information provided in these charts includes actual position and track of icebergs greater than 10 NM according with names assigned by U.S. NIC, position and track of icebergs lesser than 10 NM but significantly identifiable by satellite imagery and polygons of icebergs, bergy bits and growlers. Direction and intensity of local currents are shown to determine the possible drift of icebergs. This product is updated twice a week. The information is displayed in the SHN web page http://www.hidro.gob.ar/Smara/glacio/sglaciologica.asp#, then click on 'Carta de Témpanos' (Icebergs Chart).

(d) Sea ice and iceberg information in NAVAREA VI message is transmitted by SafetyNET and NAVTEX system with daily updates. In the link http://www.hidro.gob.ar/nautica/cnv.asp can be found the entire NAVAREA VI message which includes the ice information. In red letters there is a link to an English version.

(e) Ice Observations Report: a glaciological report is displayed with ice observations of land based stations, during the entire year by the Argentine permanent stations. Updates are twice a week. The information is displayed in the SHN web page http://www.hidro.gob.ar/Smara/glacio/sglaciologica.asp#, then click on 'Observaciones Glaciológicas' (Glaciological Observations). At the bottom of the page there is a link to the English version.

(f) Sea Ice Concentration Model: climatological model of sea ice concentration and anomalies of concentration with monthly update. See section **4. Forecasts** for details about the Model. The information is displayed in the SHN web page http://www.hidro.gob.ar/smara/sb/sb.asp.

4. Forecasts

Since 2001, the Argentine Navy Meteorological Service of the Naval Hydrographic Service has implemented of a forecasting model for Variables Sea Ice Concentration and Anomalies of Sea Ice Concentration. Based on this information, monthly climatological estimations are made for the anomalies fields of air temperature, surface pressure and precipitation.

To obtain these results it is used monthly data of sea ice concentration, derived from the information generated by NASA algorithms and provided by the National Snow and Ice Data Center (NSICC). The data base that is used is composed with full information since November 1978.

This forecasting model is based on Principal Component Analysis applied to the monthly anomalies series of Sea Ice (S-Mode) and monthly anomalies fields of Sea Ice (T-Mode)., from which are obtained 6 temporal patterns, valid in some regions of Antarctica, assuming the importance on determining the sea regions around Antarctica that will have Sea Ice anomalies.

To improve the results of the forecasting model it has been added multi neural networks Perceptron with supervised learning and backward propagation algorithms This artificial neuronal network is dedicated to the images recognition and it is been implemented through the anomalies fields of temperature and pressure associated to the anomalies spatial patterns of Sea Ice concentration.

5. Publications

Two Sea Ice Atlases have been published for Antarctic Seas between 0ºW and 90ºW; one covering the period 1972-1990 and the other for 1973-1982. Statistics on sea ice boundaries for nonstandard periods can be compiled, with archived data since 1972 to date.

Ice Observers Manual, with a full description of ice formation processes, stages of development, classifications and different techniques of observations from land, ships and airborne.

Photographic Atlas of Floating Ice: Identification and Coding. Available in printed version and through the SHN web page: http://www.hidro.gob.ar/Smara/glacio/generalidades.asp#, then click on 'Mural'.

Annual Technical Reports on Antarctic Sea Ice Conditions and Climatological Forecasts, since 2005 to date.

6. Mailing and internet address

Argentine Navy Meteorological Service (SMARA)
Naval Hydrographic Service (SHN).
Edificio Libertad
Av. Comodoro Py 2055 – Piso 15.
BUENOS AIRES - ARGENTINA.
P.O. Box: C1104BEA
Telefax: +54 11 4317 2309
E-mail: hielo.marino@hidro.gov.ar
Web page: www.hidro.gob.ar

AUSTRALIA

Reproduced from 2006 Revision

1. Organization

During the Austral summer (approx November to March) the Antarctic Meteorological Centre at the Australian Station, Casey, Antarctica, provides on request sea-ice concentration analyses for any Antarctic coastal area between around 180°E and 20°E. These analyses are provided via e-mail.

NOAA satellite AVHRR imagery of the following coastal areas are routinely updated on the World Wide Web (currently provided to registered users, but subject to change): Terra Nova Bay area, Cape Adare, Dumont D'Urville area; Wilkes Coast area, Sabrina coast area, Casey area, Shackleton Ice Shelf area, West Ice Shelf area, Davis area, Mawson area, Enderby Land area, Ragnhild Coast area. These images include both infrared and visible AVHRR data during the Austral summer and infrared data only during the Austral winter. The images on the web are in GIF format.

As of 2004 the International Antarctic Weather Forecasting Handbook had been prepared under the auspices of a number of organizations, including the British Antarctic Survey (BAS), the Australian Bureau of Meteorology, the Scientific Committee on Antarctic Research (SCAR), the WMO International Commission on Polar Meteorology and the Council of Managers of National Antarctic Programmes (COMNAP), and is available in hardcopy version and in PDF format (at http://www.bom.gov.au/weather/ant/handbook/handbook.shtml).

2. Mailing and Internet addresses

Bureau of Meteorology Tasmania/Antarctica Region
GPO Box 727, Hobart
111 Macquarie Street
AUSTRALIA, 7001
Telephone: +61 3 6221 2021
Telefax: +61 3 6221 2080
Internet:
http://www.bom.gov.au/weather/ant/ (Antarctic and Southern Ocean Weather)
http://www.bom.gov.au/weather/tas/inside/amc/satindex.shtml (satellite imagery)

NEW ZEALAND

Since the first edition of the WMO publication Sea-Ice Information Services in the World (1981) the New Zealand meteorological service is not producing routine sea-ice analyses. No sea-ice information is available.

ANNEXES - SAMPLE CHARTS AND OUTPUT PRODUCTS OF NATIONAL SERVICES

ANNEX I – Canada

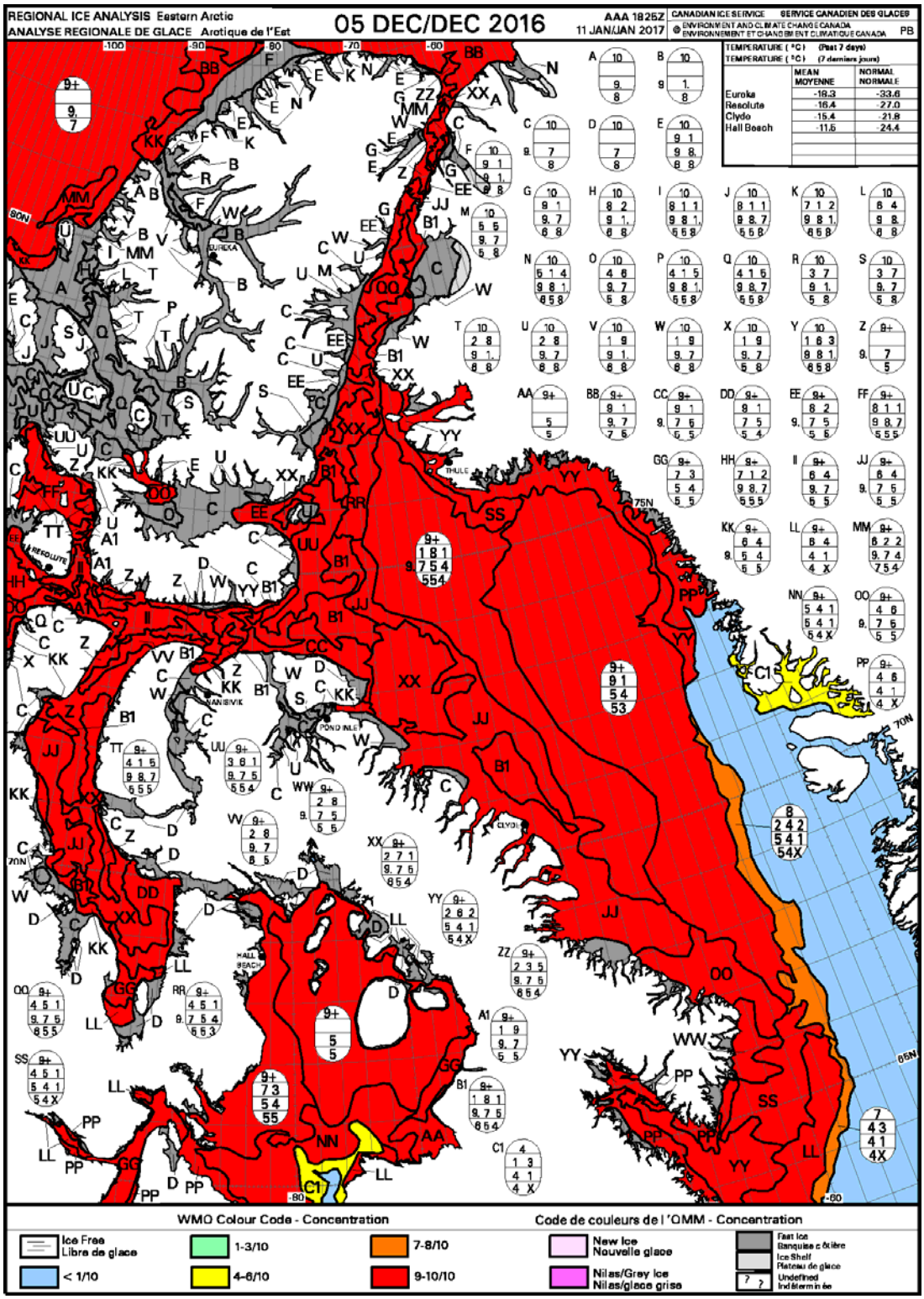


Figure I-1 – Regional Ice chart for the Eastern Arctic for 05 December 2016

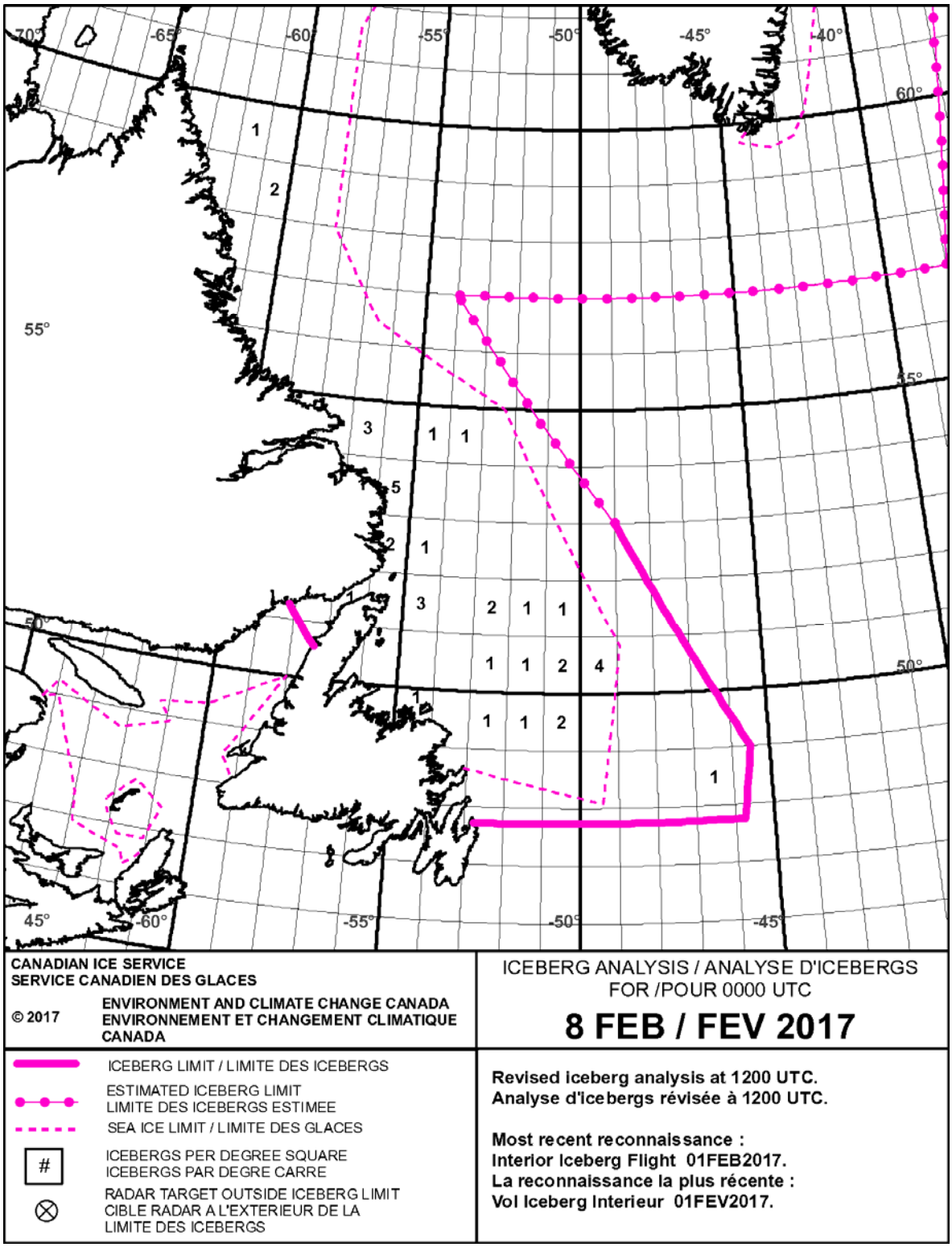


Figure I-2 – Daily Iceberg Analysis chart for the Canadian East Coast for 8 February 2017

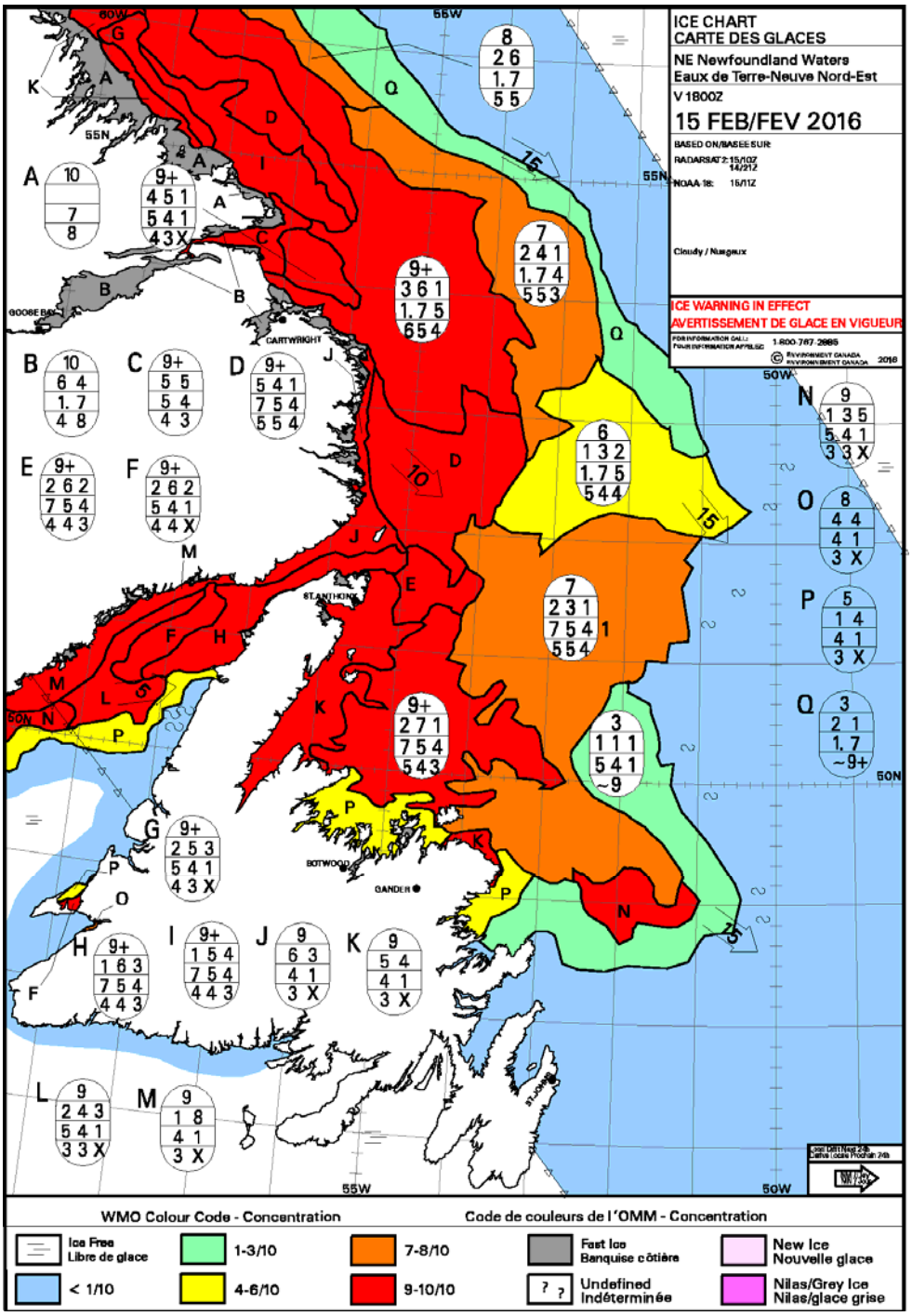


Figure I-3 – Daily ice chart for the Canadian East Coast for 15 February 2016.

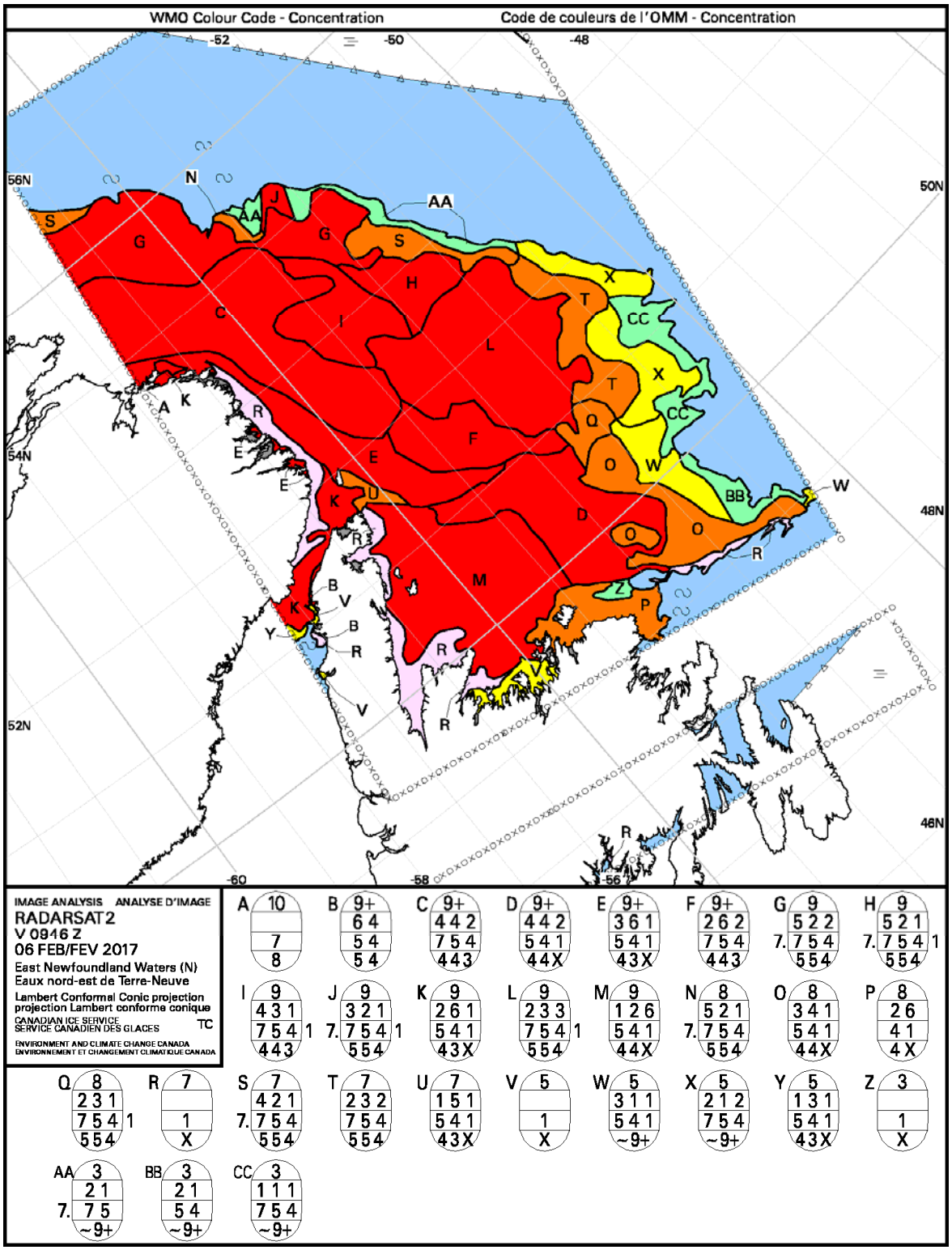


Figure I-4 – Image analysis chart for East Newfoundland Waters on 06 February 2017

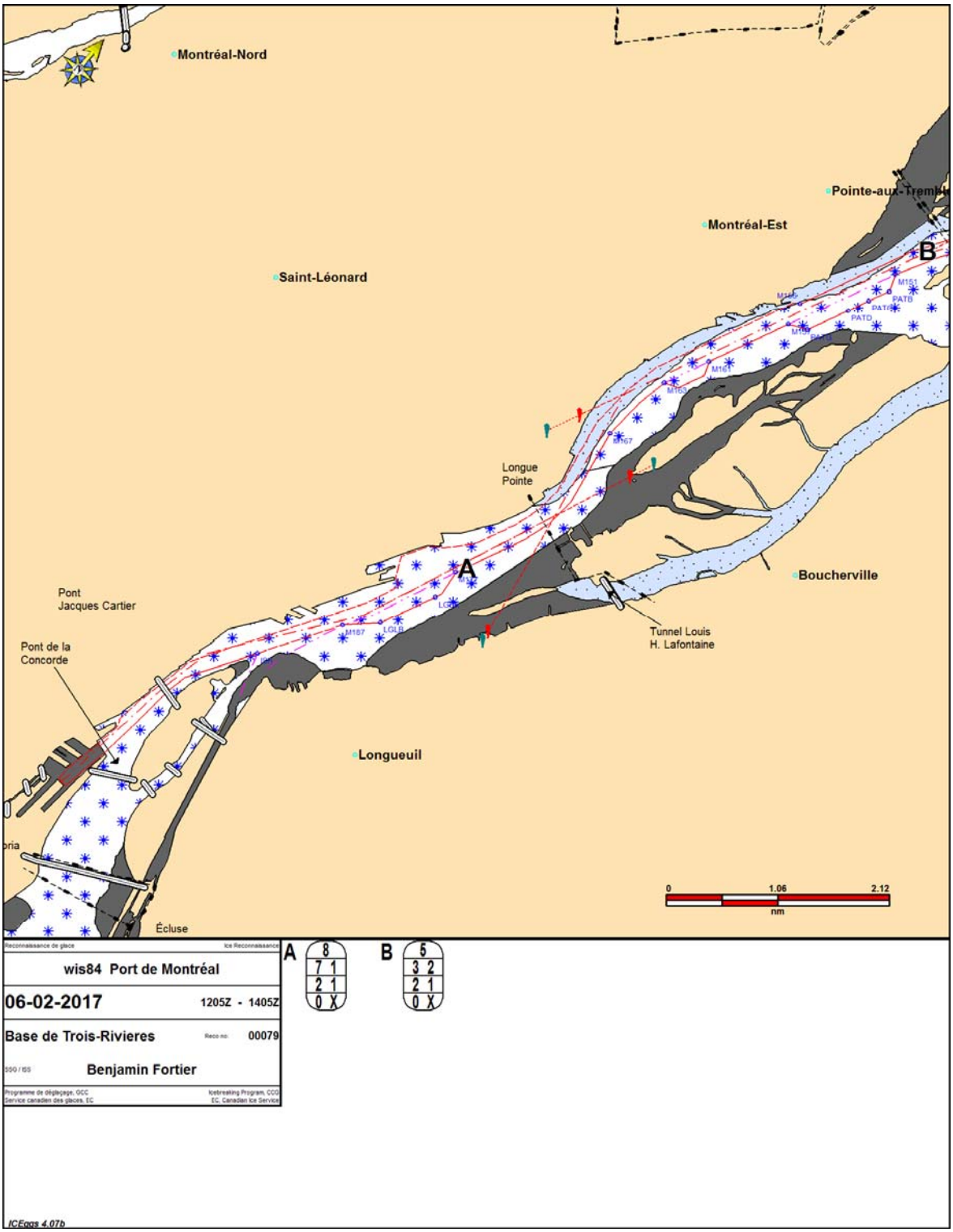


Figure I-5 – Ice Reconnaissance chart for the Port of Montreal on 06 February 2017.

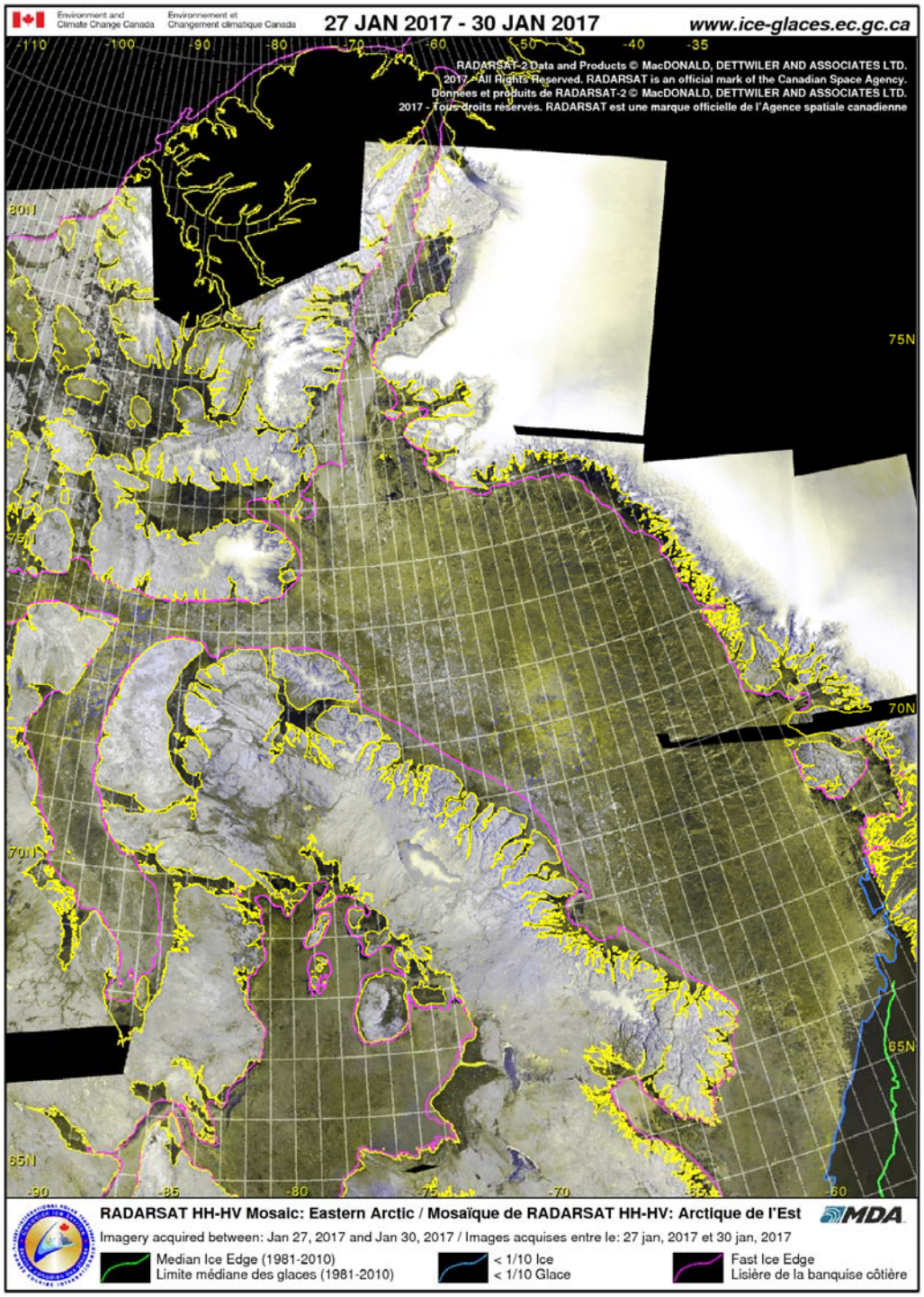


Figure I-6 – RADARSAT Mosaic (27 to 30 January, 2017)

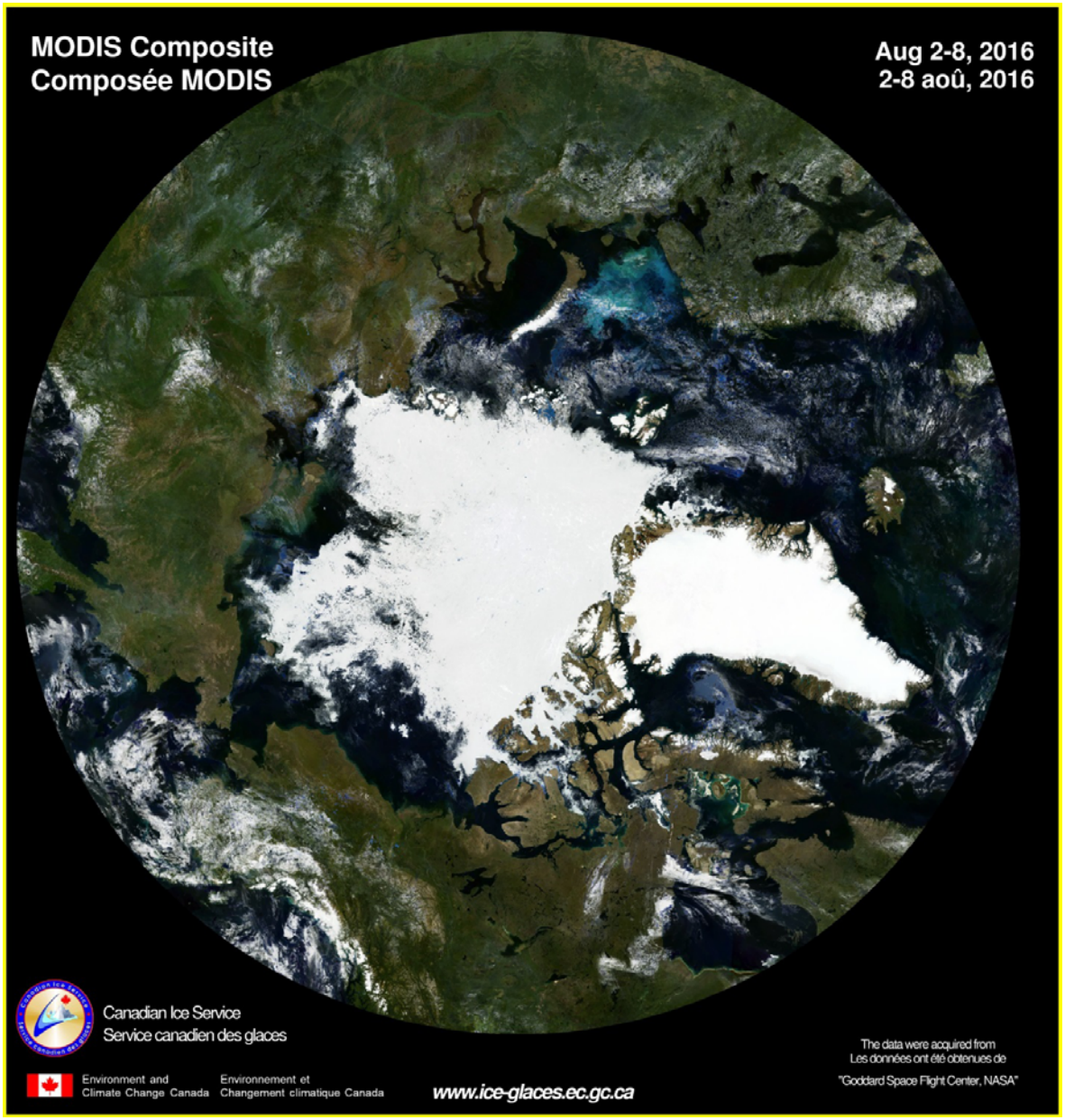


Figure I-7 – MODIS Composite (02 to 08 August, 2017)

FICN18 CWIS 071446

Ice forecasts for the eastern waters of Newfoundland and Labrador issued by Environment Canada at 10:00 a.m. EST Tuesday 7 February 2017 for today tonight and Wednesday. The next scheduled forecasts will be issued at 10:00 a.m. Wednesday.

Ice edge estimated from Newfoundland near 4840N 5305W to 4805N 4925W to 5050N 4855W to 5500N 5220W to 5625N 5630W to 5800N 5815W then northward. Sea ice west of the ice edge.

Strait of Belle Isle - eastern half.
9 tenths of new ice including 2 tenths of grey ice except 9 plus tenths of grey ice including 3 tenths of grey-white ice in the eastern and southern sections.

Strait of Belle Isle - western half.
Ice pressure warning in effect.
9 tenths of grey ice including 3 tenths of grey-white ice except 9 plus tenths of grey-white ice including 1 tenth of first-year ice along the Newfoundland coast. Strong ice pressure along the Newfoundland coast easing this evening.

Belle Isle Bank - northwestern half.
Bergy water except 6 tenths of first-year ice including a trace of old ice in the western section.

Belle Isle Bank - southeastern half.
Bergy water except 6 tenths of grey-white ice including a trace of old ice.

South Labrador Coast.
9 tenths of grey ice including 3 tenths of first-year ice except 9 plus tenths of first-year ice including a trace of old ice in the northeastern section.

Lake Melville.
Consolidated first-year ice.

Mid Labrador Coast.
9 plus tenths of first-year ice except 9 plus tenths of first-year ice including a trace of old ice in eastern sections.
(…)

Contact ECAREG Canada via marine radio for routing advice. East coast ice analysis charts can be copied on CFH Halifax at 2222 UTC and 0001 UTC and on VCO Sydney at 1142 UTC and 2331 UTC.

End

Figure I-8 – Daily Ice Forecast for East Coast Newfoundland for 07 February 2017

ANNEX II – China

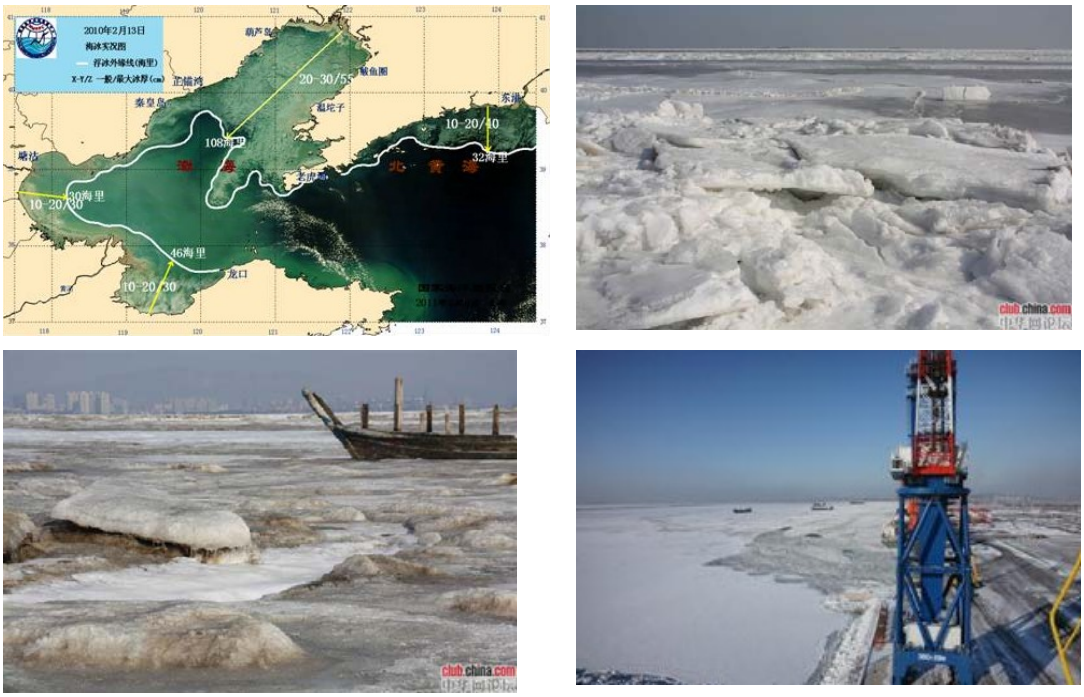
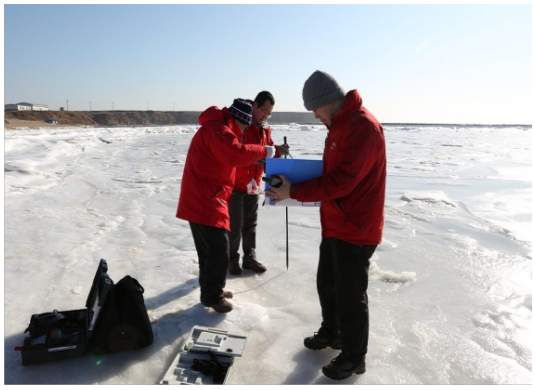


Figure II-1 – Sea ice in Bohai Sea and north Yellow Sea

a)

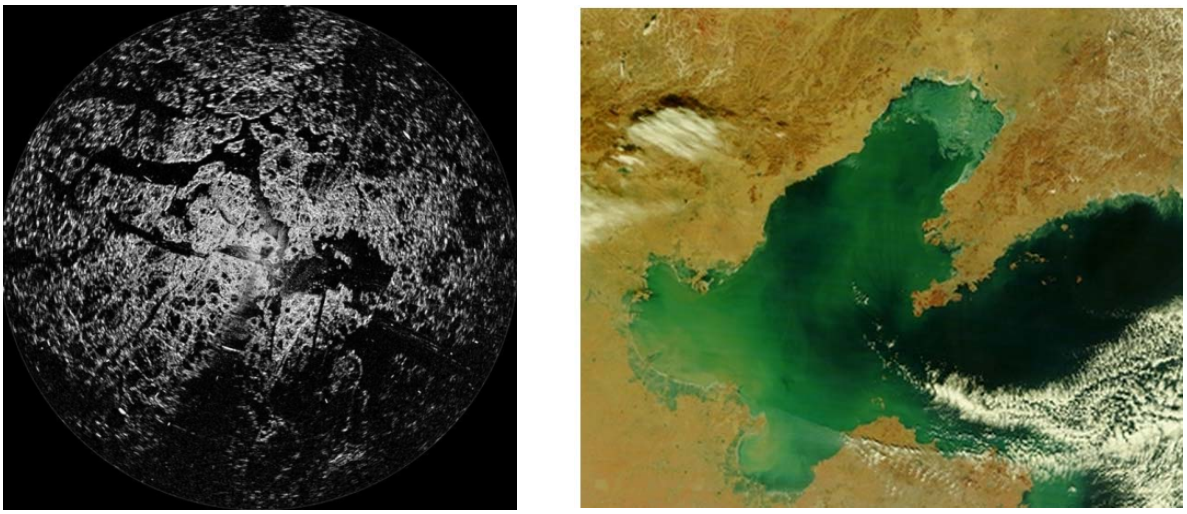
b)



c)

d)

Figure II-2 – Platform Radar (a), ice air reconnaissance (b), in-situ observations (c) and UAV (d).



a) b)

Figure II-3– Platform radar imagery (a), satellite imagery (b)

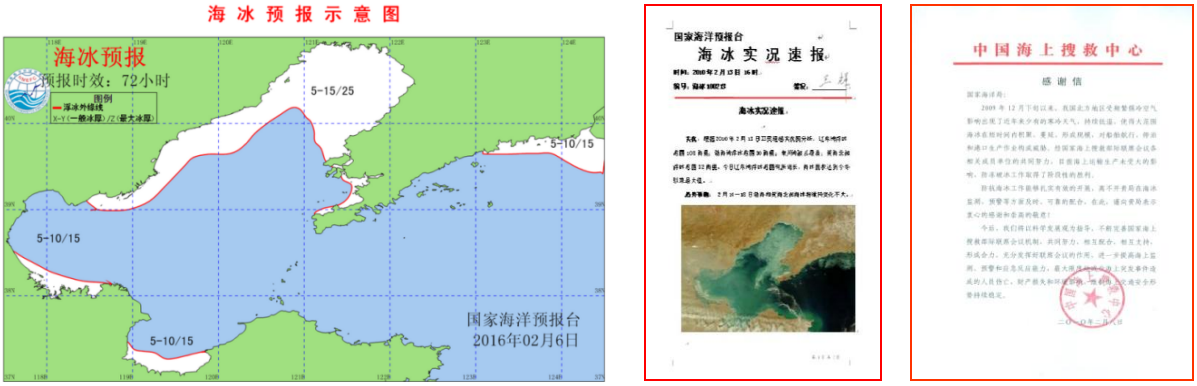


Figure II-4 – Sea ice thematic map bulletin for Bohai Sea on 6 February 2016

ANNEX III – Denmark / Greenland

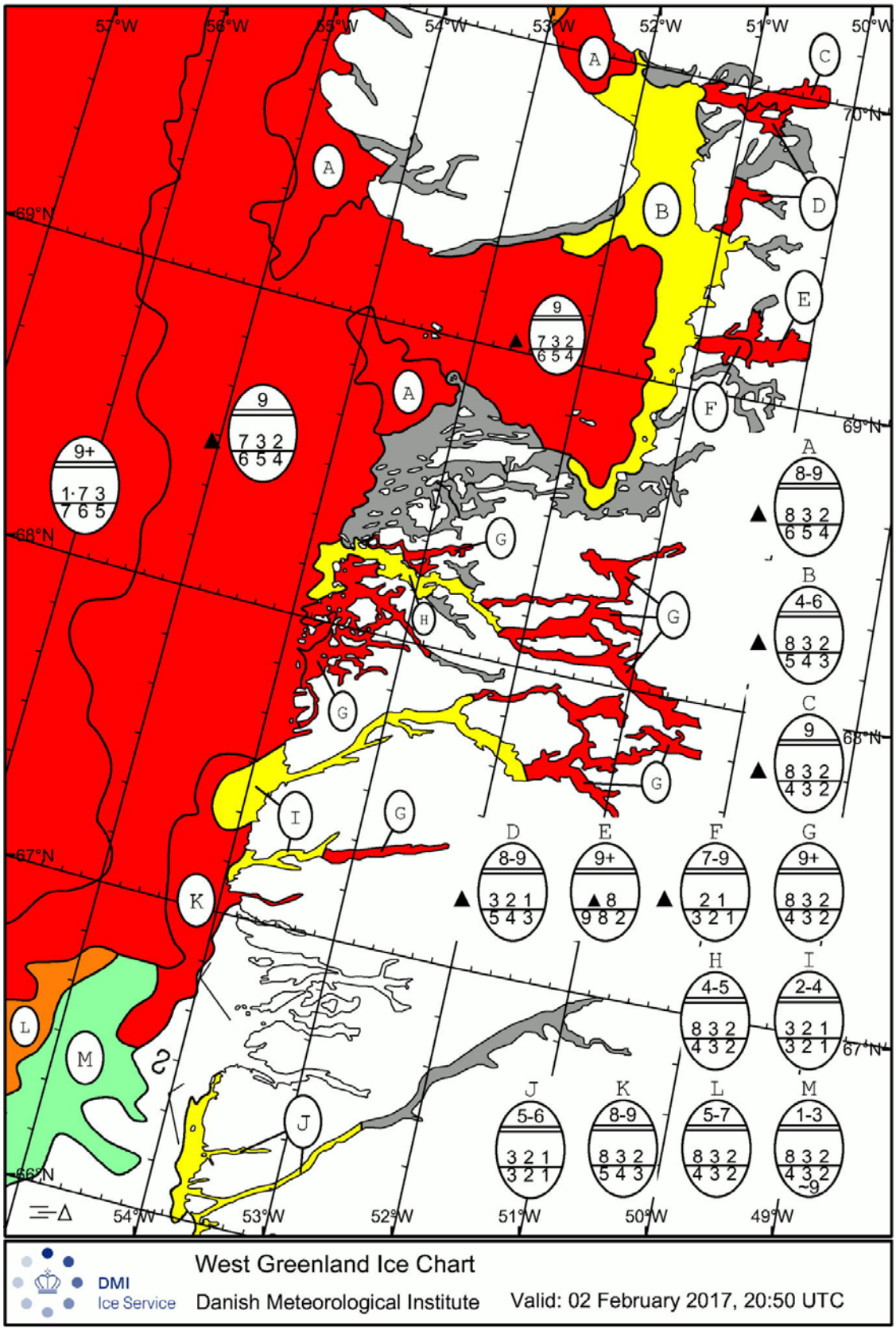


Figure III-1 – West Greenland ice chart

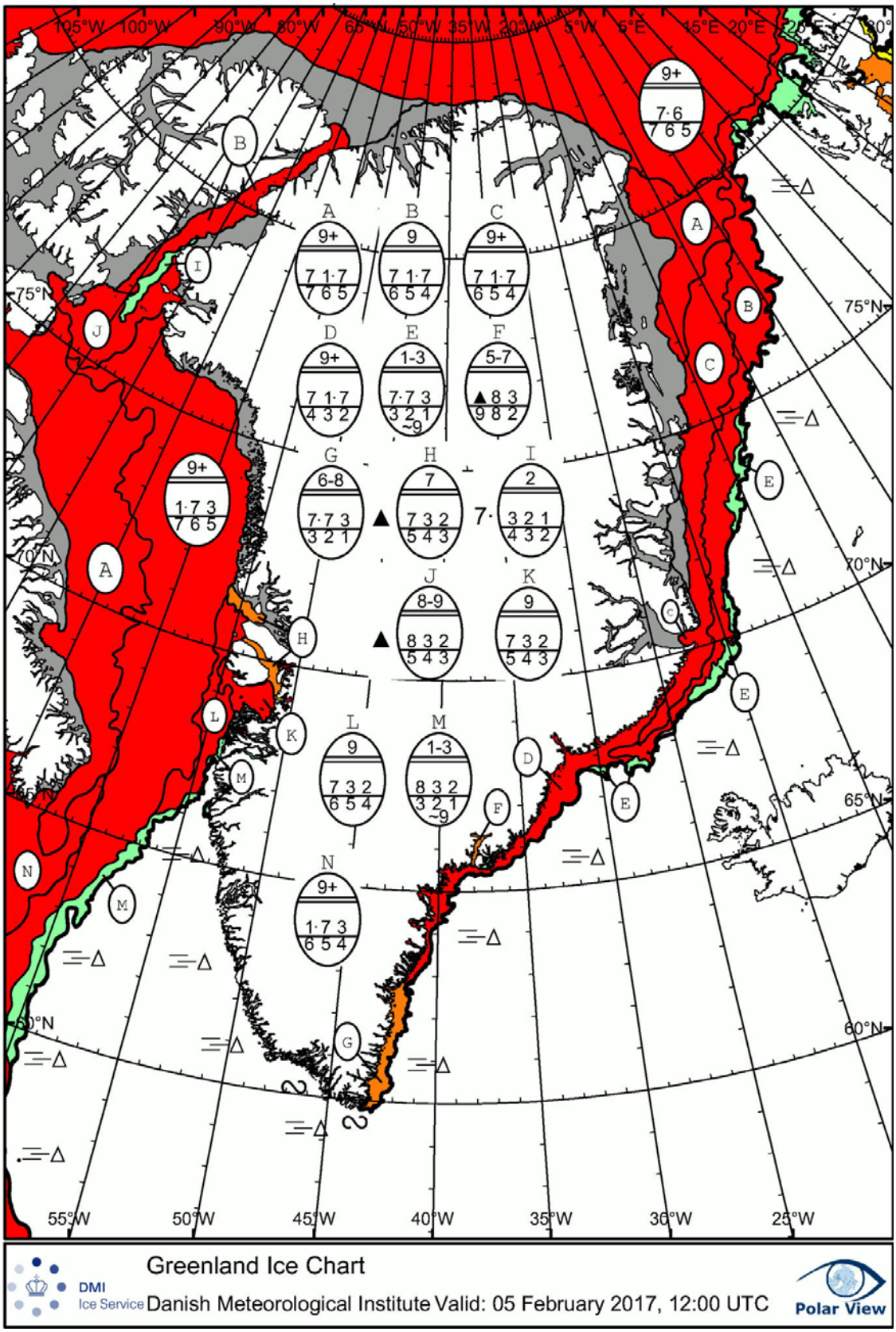


Figure III-2 – Greenland ice chart.

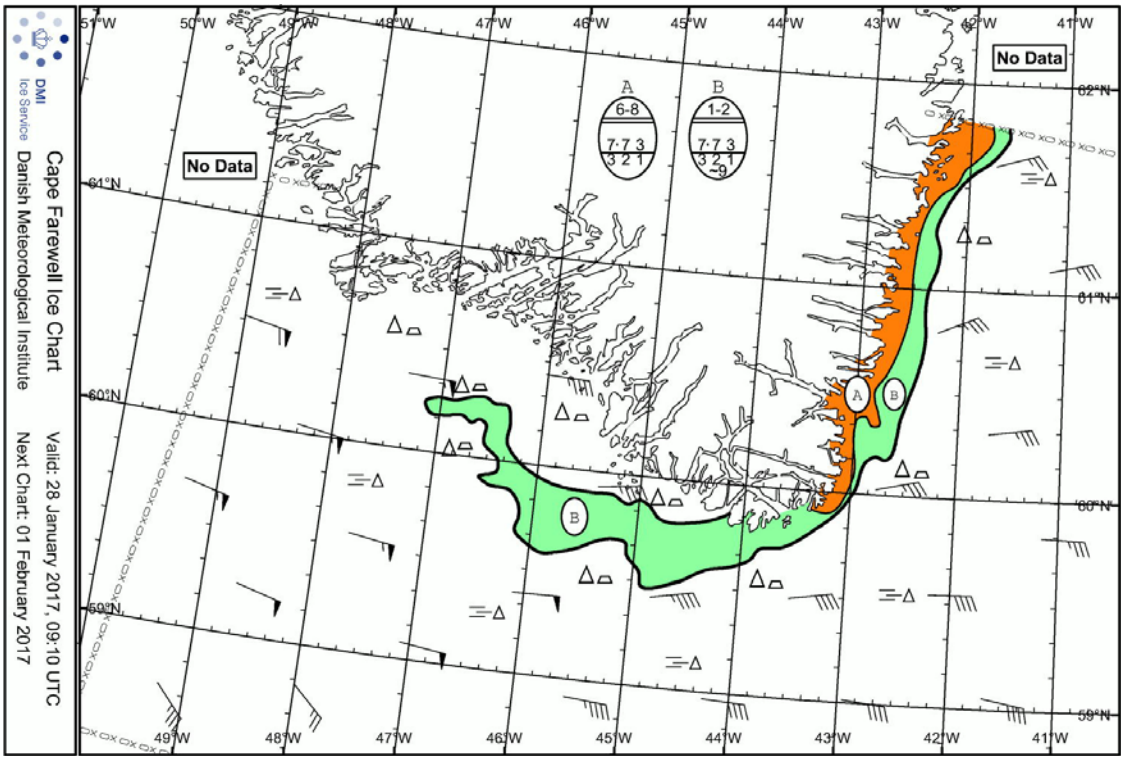


Figure III-3 – Cape Farewell ice chart.

Greenland Sea Areas

Tuesday the 7. February 2017.

There is storm warning for Aputiteeq, Kulusuk and Nunap Isuata Kitaa. There is gale warning for Daneborg, Kangikajik, Timmiarmiut, Nunap Isuata Kangia, Nunarsuit, Narsalik, Meqquitsoq, Attu and Kiatak. There is risk of severe ice accretion of Daneborg and Meqquitsoq. There is risk of ice accretion of Nunarsuit and Narsalik.

Synopsis /2100 UTC..

Forecast, valid to the 8. February 06 UTC.. Issued at 7.15 UTC..

A deep low, 960 hPa, east of Timmiarmiut, is moving slowly towards north. An associated front gives rain, sleet and snow to the eastern waters. Cold air with scattered snow showers is moving down over the western and southern waters from northwest and north.

Forecast for Daneborg

East 7 to 12 m/s. And in southwestern part northeast 4 to 9 m/s. Very poor visibility. Around noon, this evening and this night gale from east 10 to 15 m/s. Very poor visibility.

Significant wave height: 6 m. Swells: 5 m.

Old ice and medium first-year ice in the northern and western part, otherwise few icebergs and growlers.

Figure III-4 – Example of a forecast for a Greenland sea areas.

Figure III-5 – Example of an automated Greenland iceberg (target) map based on Sentinel 1 (HH+HV). Ships are not eliminated.

ANNEX IV - Estonia

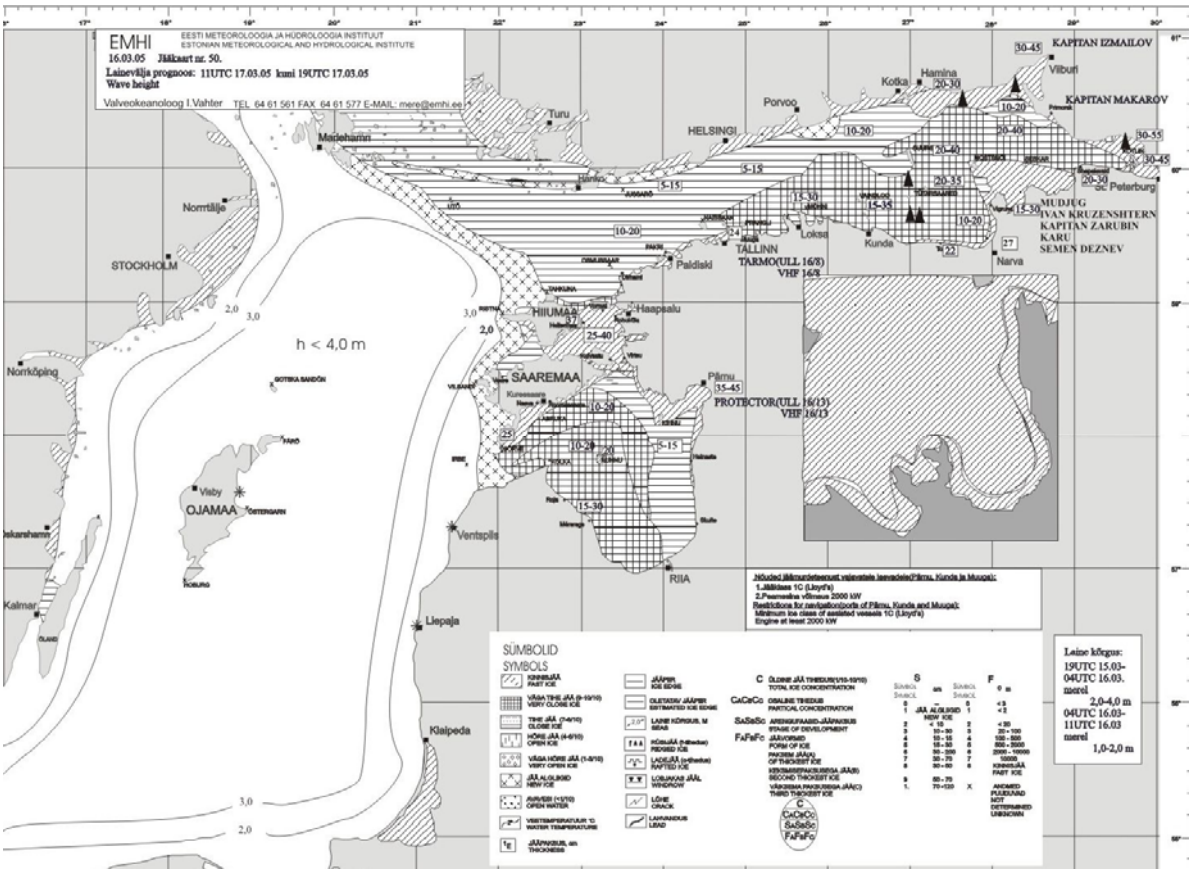


Figure IV-1 – Ice chart for the Baltic proper for 16 March 2005.

ANNEX V – Finland

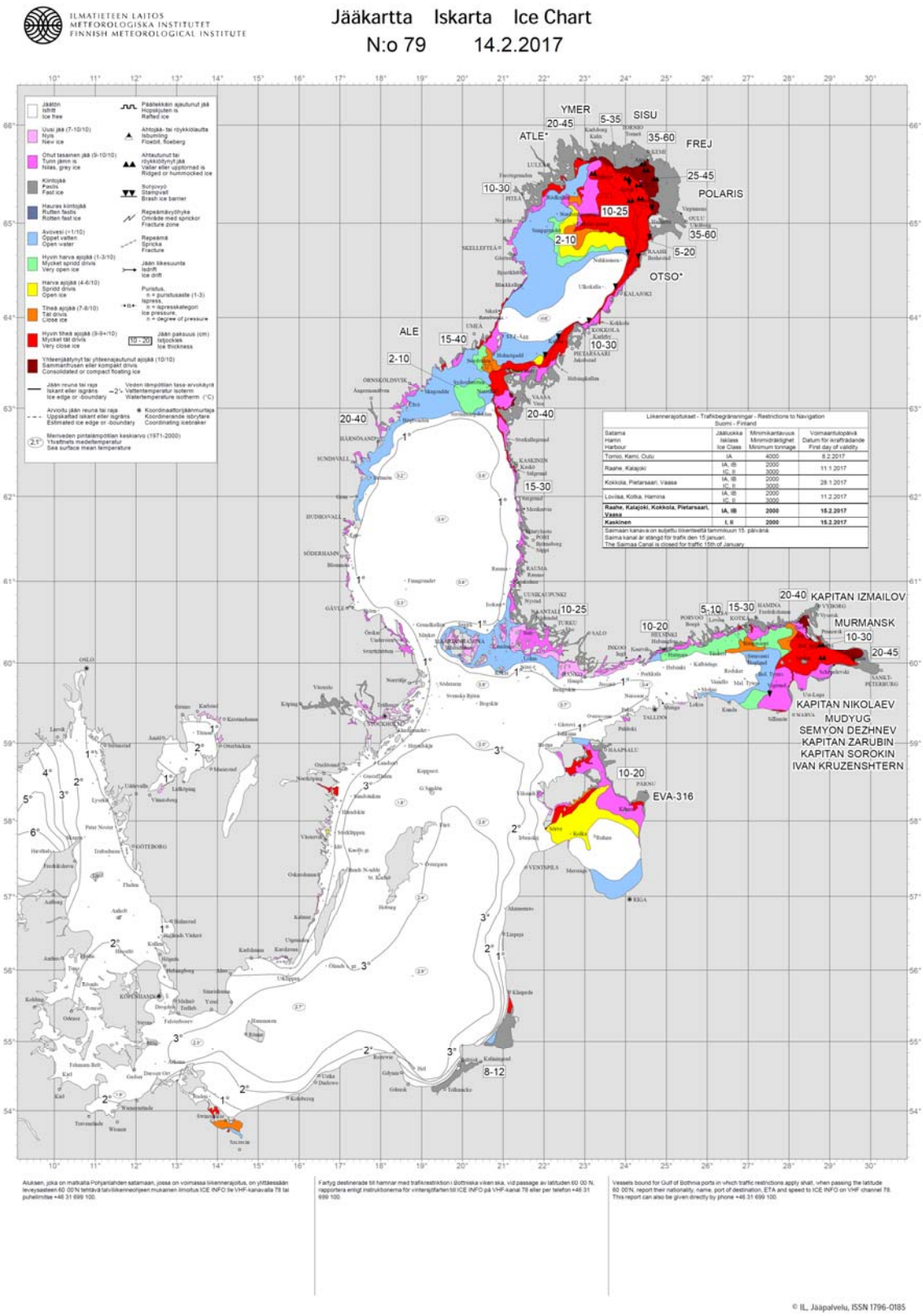


Figure V-1 – Example of Finnish ice chart on 14 February 2017

LIIKENNERAJOITUKSET – TRAFIKRESTRIKTIONER – RESTRICTIONS TO NAVIGATION

SUOMI – FINLAND – FINLAND

Satama Hamn Harbour	Minimi kantavuus Minimidräktighet Minimum tonnage	Jääluokka Isklass Ice Class	Voimaantulopäivä Datum för ikraftträdande First day of validity
Tornio, Kemi, Oulu	4000	IA	8.2.2017
Raahe, Kalajoki	2000 3000	IA, IB IC, II	11.1.2017
Kokkola, Pietarsaari, Vaasa	2000 3000	IA, IB IC, II	28.1.2017
Loviisa, Kotka, Hamina	2000 3000	IA, IB IC, II	11.2.2017
Raahe, Kalajoki, Kokkola, Pietarsaari, Vaasa	**2000**	**IA, IB**	**15.2.2017**
Kaskinen	**2000**	**I, II**	**15.2.2017**
Saimaan kanava on suljettu liikenteeltä tammikuun 15. päivä. Saima kanal är stängd för trafik den 15 januari. The Saimaa Canal was closed for traffic 15th of January.			

RUOTSI – SVERIGE - SWEDEN

Satama Hamn Harbour	Minimi kantavuus Minimidräktighet Minimum tonnage	Jääluokka Isklass Ice Class	Voimaantulopäivä Datum för ikraftträdande First day of validity
Karlsborg	4000	IA	11.2.2017
Luleå, Haraholmen	2000	IA	11.2.2017
Skelleftehamn	2000	I	15.1.2017
Holmsund - Örnsköldsvik	2000	I	23.1.2017
Ångermanälven	2000	I	23.1.2017
Härnösand - Skutskär	2000	I, II	23.1.2017
Mälaren	1300	I	13.2.2017
Vänern, Göta älv	1300 2000	I II	14.2.2017

VENÄJÄ – RYSSLAND - RUSSIA

Satama Hamn Harbour	Rajoitus Restriktion Restriction	Voimaantulopäivä Datum för ikraftträdande First day of validity
Saint-Petersburg	No barge towed by tug. Without ice class only with icebreaker.	10.1.2017
Vyborg	No barge towed by tug. Without ice class only with icebreaker.	10.1.2017
Vysotsk	No barge towed by tug. Without ice class only with icebreaker.	10.1.2017
Primorsk	No vessels without ice class. Ice class "Ice 1" only with icebreaker	13.1.2017
Ust'-Luga	**No barge towed by tug. Without ice class only with icebreaker.**	**16.2.2017**
Vyborg	**No vessels without ice class. Ice class "Ice 1" only with icebreaker.**	**21.2.2017**

VIRO – ESTLAND - ESTONIA

Satama Hamn Harbour	Minimi koneteho Minimimaskineffekt Minimum engine power	Jääluokka Isklass Ice Class	Voimaantulopäivä Datum för ikraftträdande First day of validity
Pärnu	1600 kW	1C (Lloyd's)	18.1.2017

PUOLA – POLEN - POLAND

Satama Hamn Harbour	Minimi koneteho Minimi maskineffekt Minimum engine power	Jääluokka Isklass Ice Class	Voimaantulopäivä Datum för ikraftträdande First day of validity
Świnjouście - Szczecin	1200 kW	II (PRS-L4)	17.1.2017

Figure V-2 – Restrictions to navigation supplement to FMI ice chart on 14 February 2017

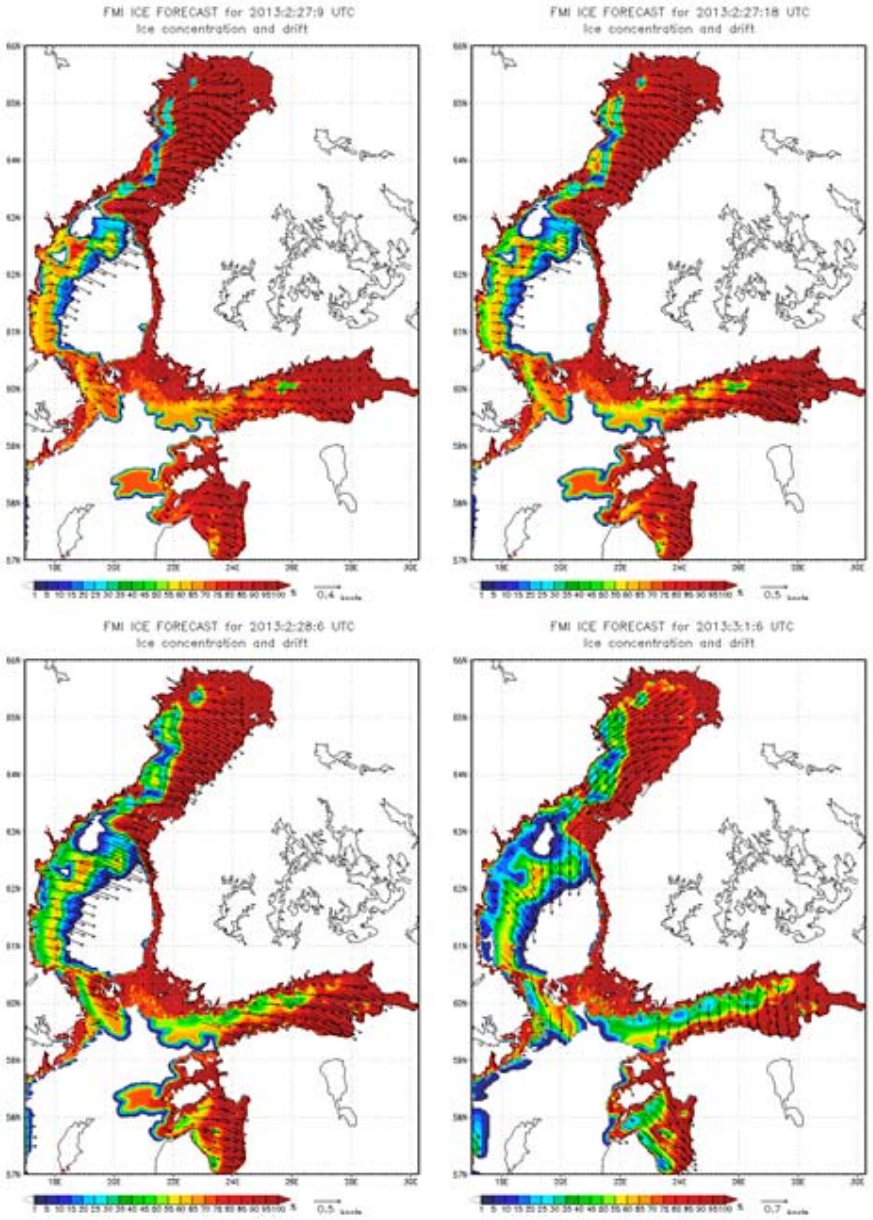


Figure V-3 – Ice concentration and drift forecast for 27th February – 1st of March 2013 (t+3h, +12h, +24h and 48h)

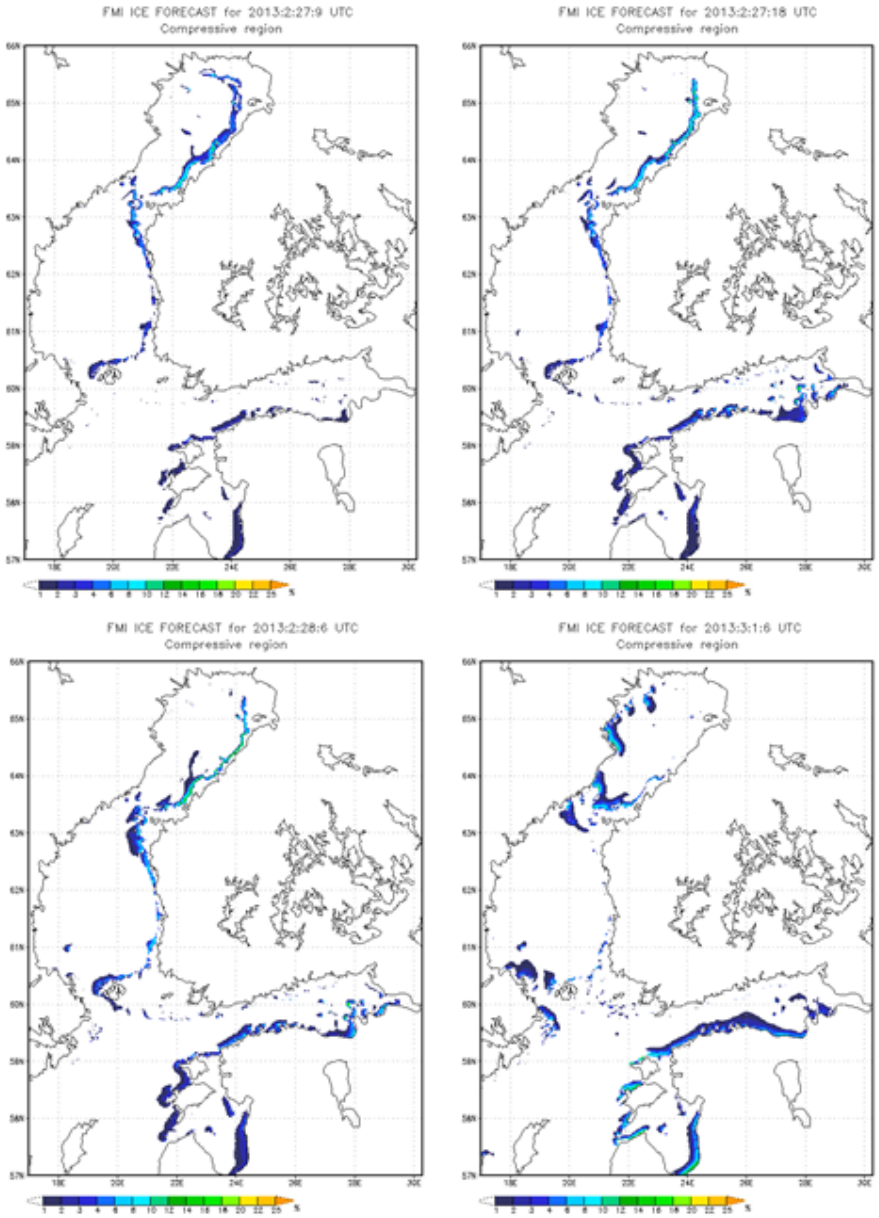


Figure V-4 – Ice compression regions forecast for 27th February – 1st of March 2013 (t+3h, +12h, +24h and 48h)

ANNEX VI – Germany

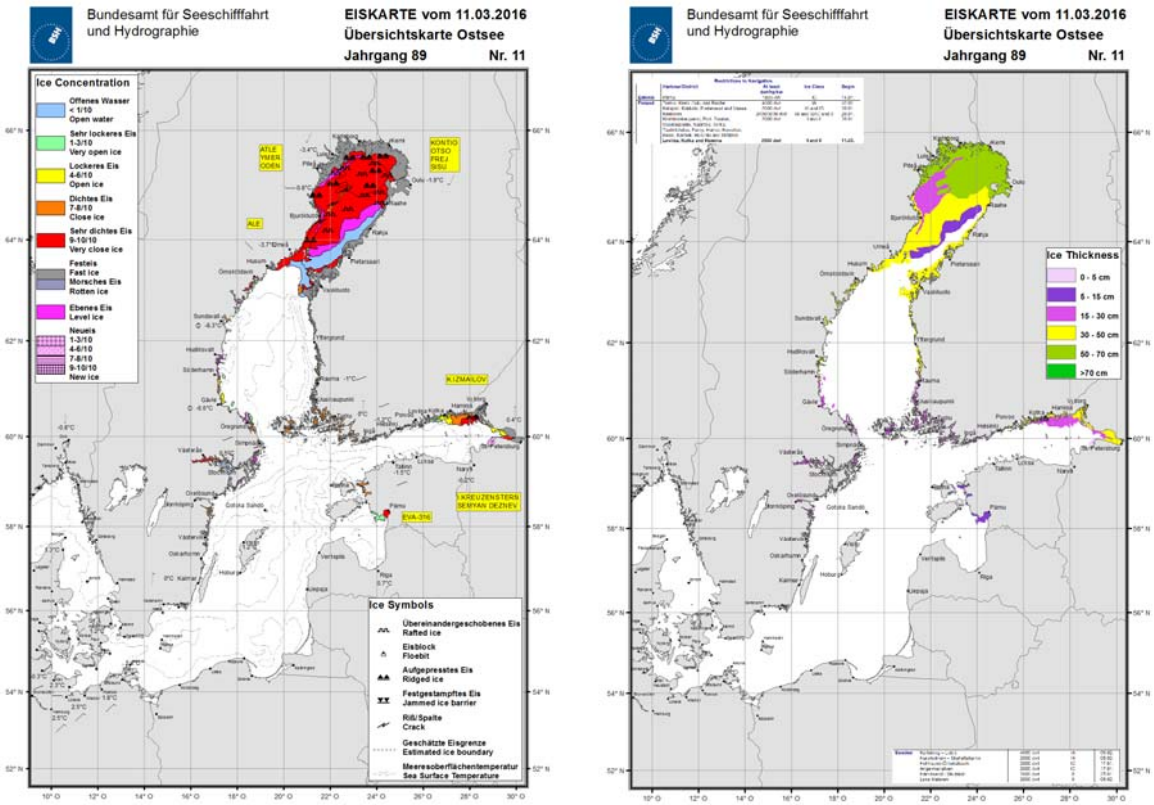


Figure VI-1 – Ice chart for the whole Baltic, March 13, 2016.

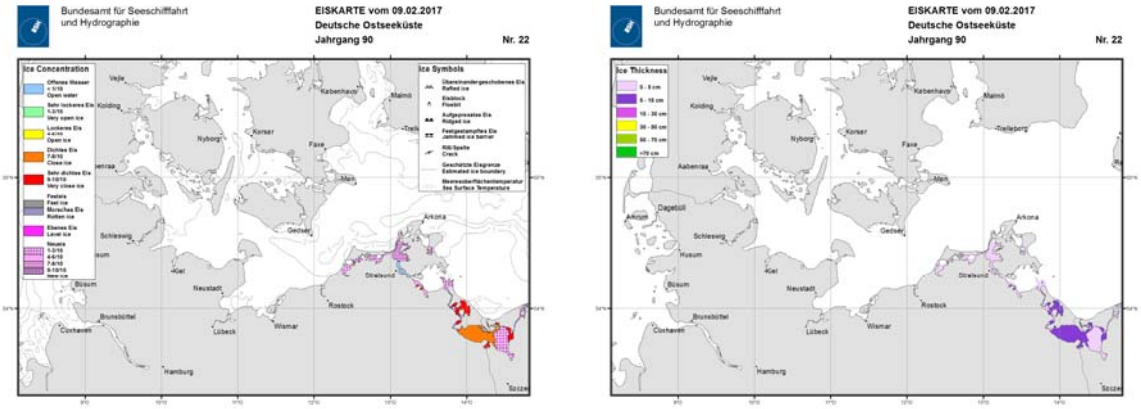


Figure VI-2 – German coast chart, February 9, 2017.

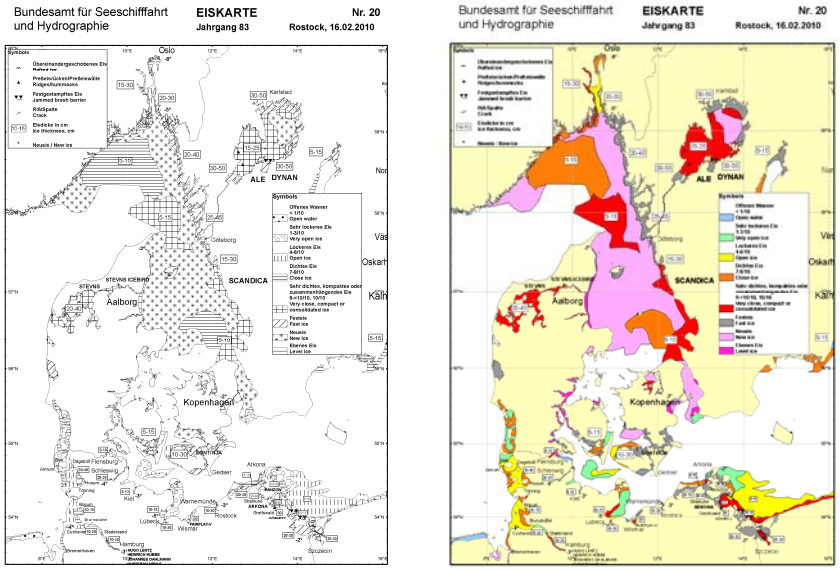


Figure VI-3 – Western Baltic Sea area and North Sea coast ice chart for 16 February 2010. The black and white version is for radio facsimile broadcast. Newer maps in color will look more similar to the actual ice charts of the whole Baltic and the German coast.

ANNEX VII – Japan

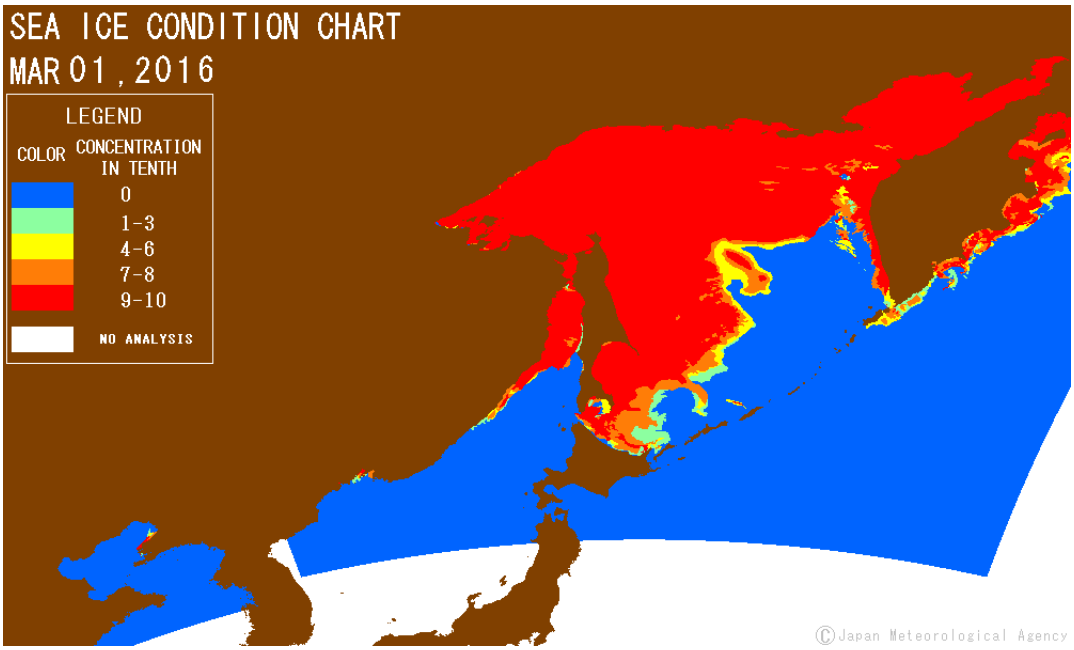


Figure VII-1 — Daily sea-ice condition chart for the Sea of Japan and the Sea of Okhotsk for 1 March 2016

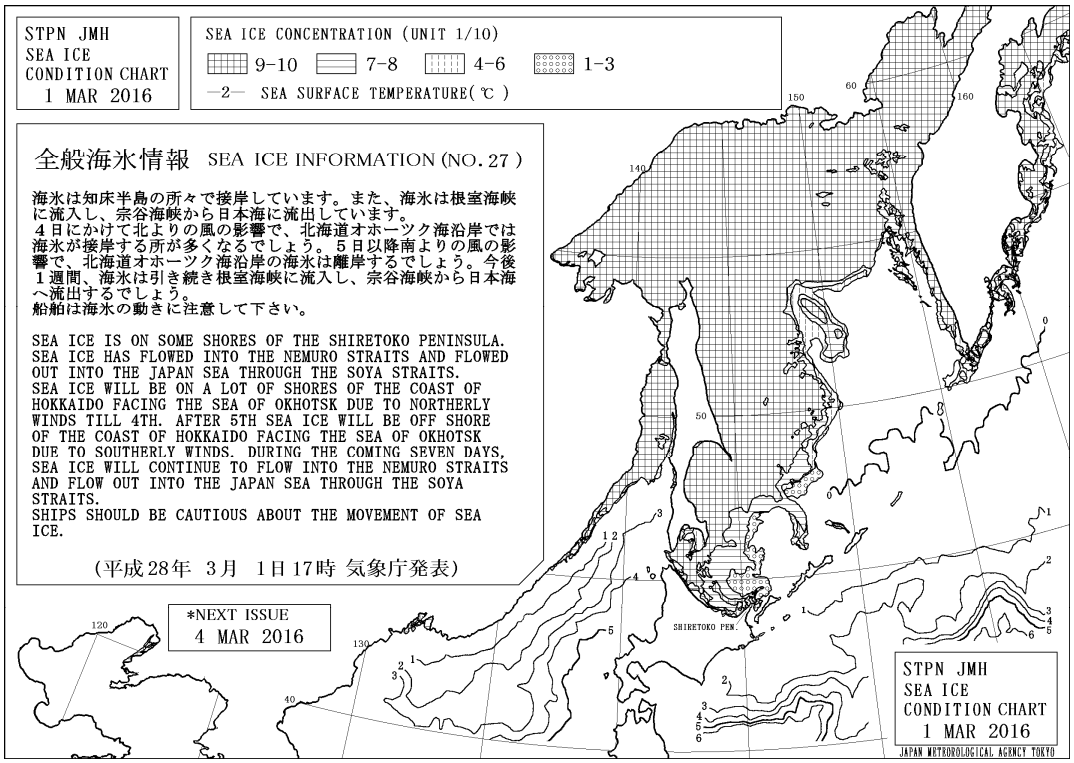


Figure VII-2 — Sea-ice condition chart for the Sea of Japan and the Sea of Okhotsk for 1 March 2016

北海道地方海氷情報　第 21 号

平成 28 年 3 月 1 日 16 時 40 分
札幌管区気象台発表

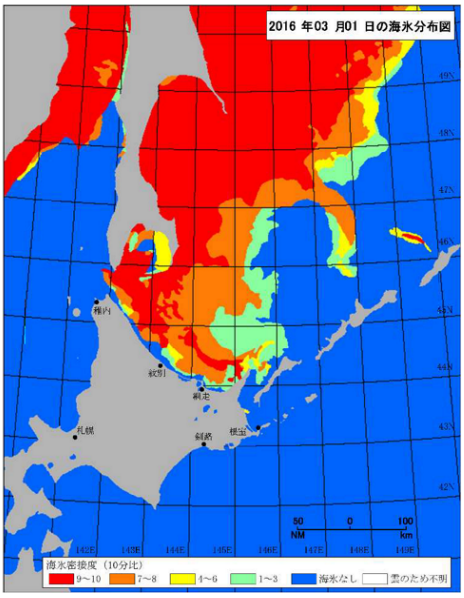
（見出し）
北海道オホーツク海側の海氷は、宗谷岬から知床岬の海岸 10 キロメートル以内にあります。期間の前半は接岸する範囲が広がりますが、期間の後半は海岸から離れる見込みです。

（本　文）
[概　況]
北海道オホーツク海側の海氷は、宗谷岬から知床岬の海岸 10 キロメートル以内にあり、知床半島では接岸している所があります。また、一部は宗谷海峡から日本海に流出し、根室海峡にも流入しています。

[今後 1 週間の予想]
2 日は冬型の気圧配置となり北よりの風となるでしょう。その後は高気圧に覆われますが、期間の後半は気圧の谷が通過するため、南よりの風となるでしょう。
このため、北海道オホーツク海側では、期間の前半は海氷の接岸する範囲が広がるでしょう。期間の後半は海岸から離れる見込みです。
海氷の一部は引き続き宗谷海峡から日本海に流出し、根室海峡に流入するでしょう。
付近を航行する船舶は海氷の動きに注意してください。

次の北海道地方海氷情報は、3 月 4 日（金）に発表する予定です。

札幌管区気象台ホームページ　海氷・流氷に関する情報
http://www.jma-net.go.jp/sapporo/kaiyou/seaice/seaice.html



海氷分布図に用いた資料：海上自衛隊、気象衛星による観測結果

Figure VII-3 — Local sea-ice information for the area around Hokkaido for 1 March 2016

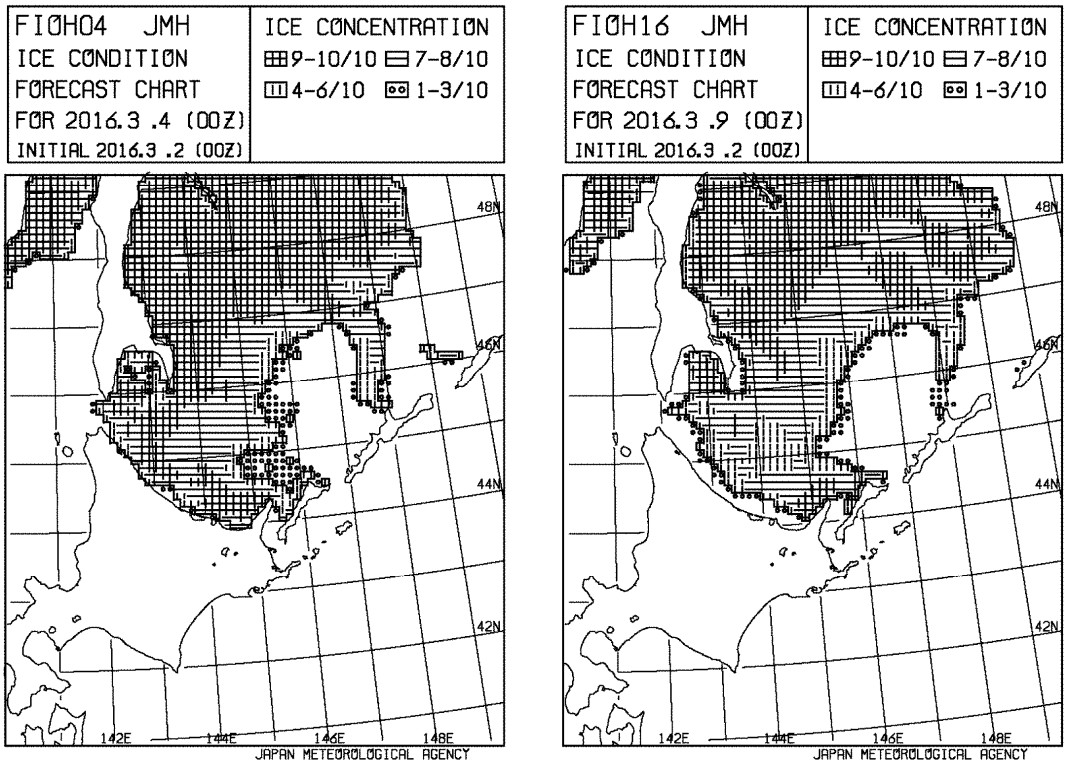


Figure VII-4 — Ice condition forecast charts for 4 and 9 March 2016 for the southern part of the Sea of Okhotsk (initial conditions for 2 March 2016)

ANNEX VIII – Norway

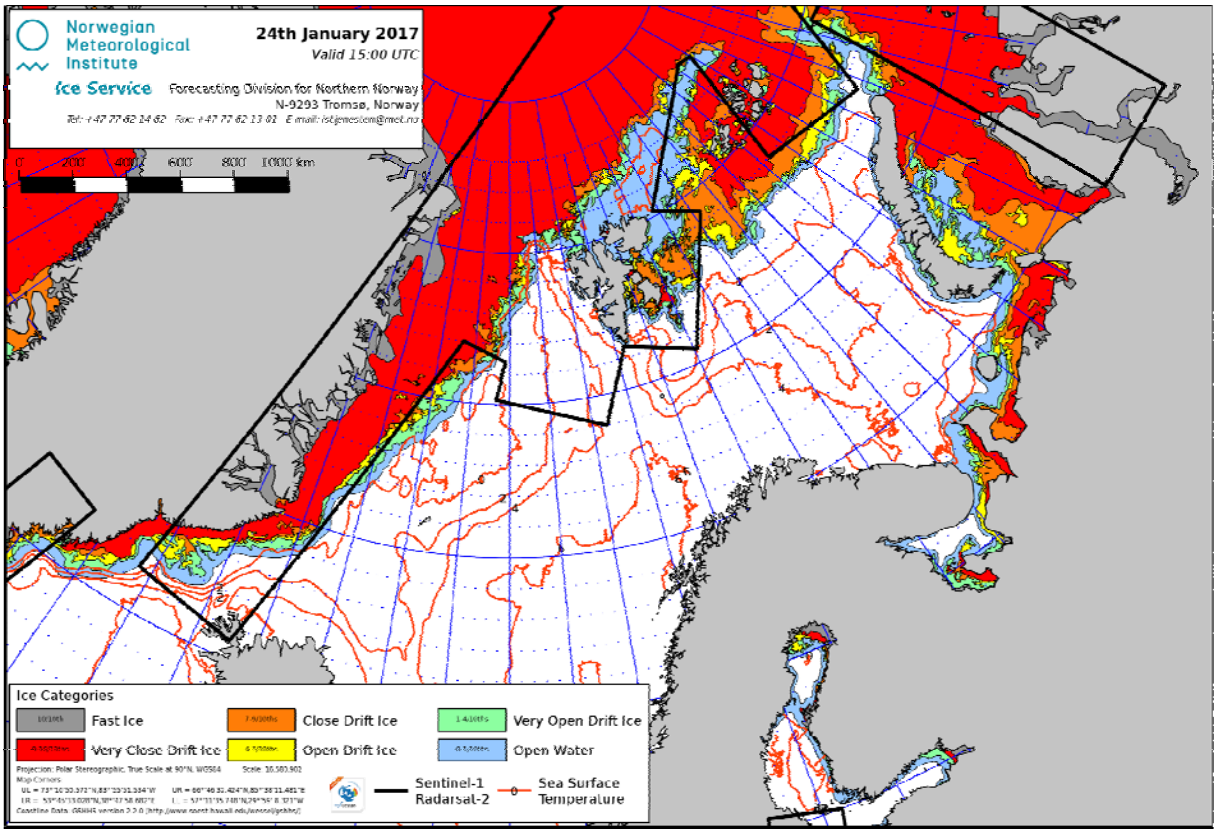


Figure VIII-1 – Daily ice chart for the Atlantic sector of the Arctic for 24 January 2017.

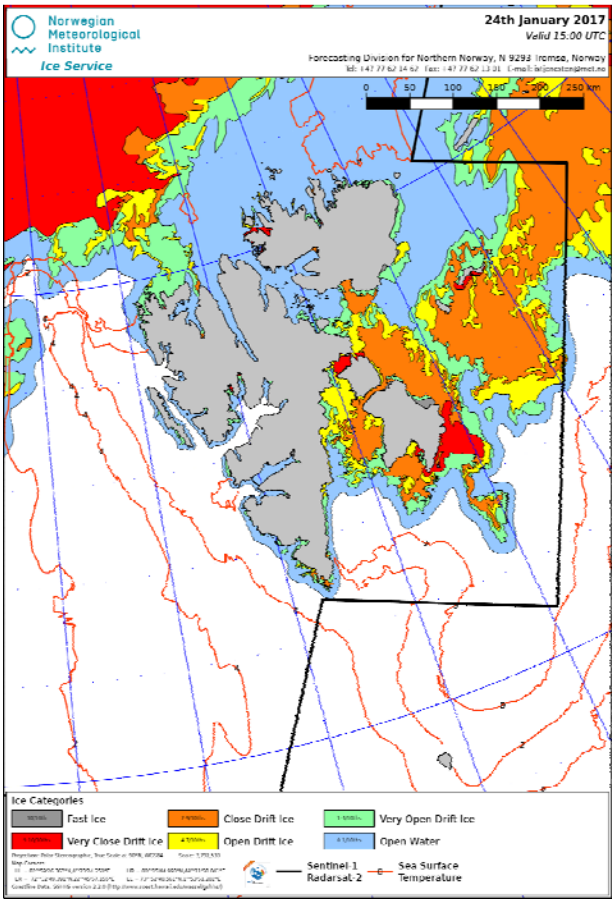


Figure VIII-2 – High-resolution ice chart for the Svalbard area for 24 January 2017.

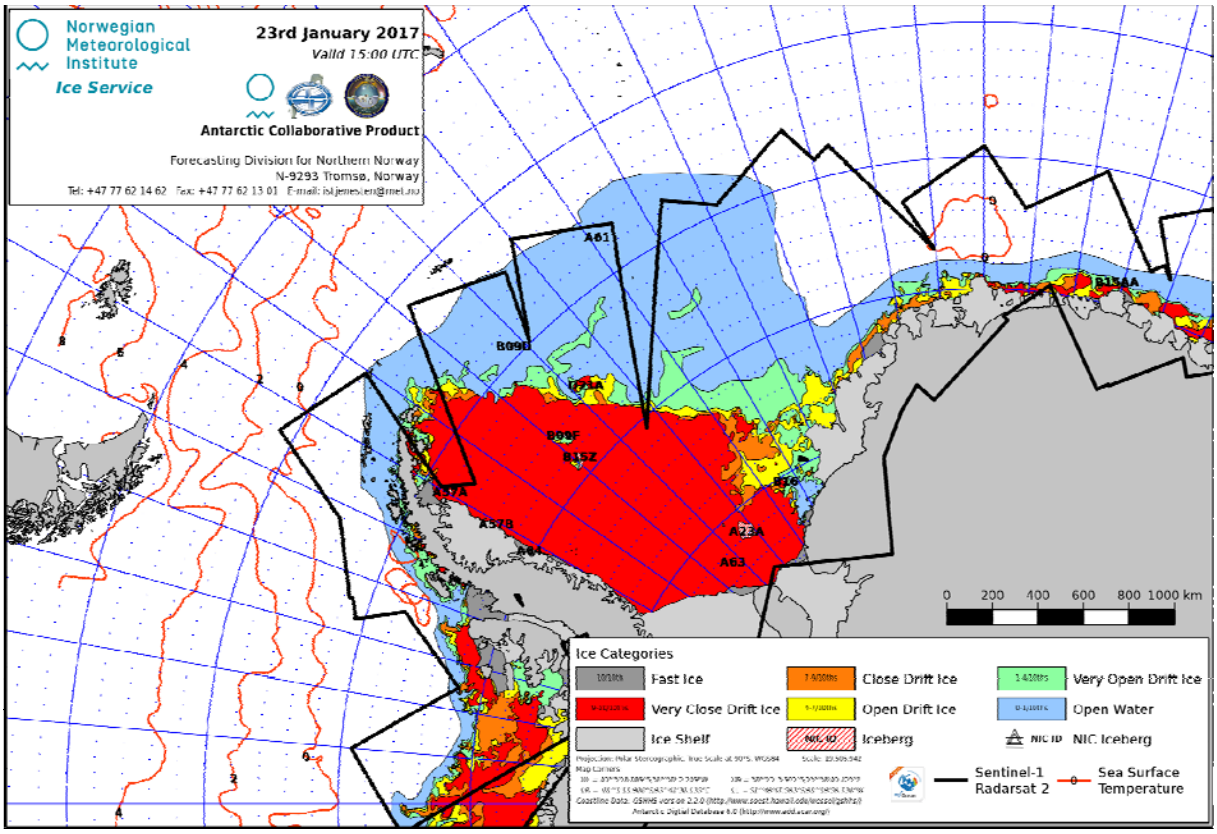


Figure VIII-3 – Weekly collaborative ice chart for the Weddell and Bellingshausen Seas sector of the Antarctic for 23 January 2017.

ANNEX IX – Poland

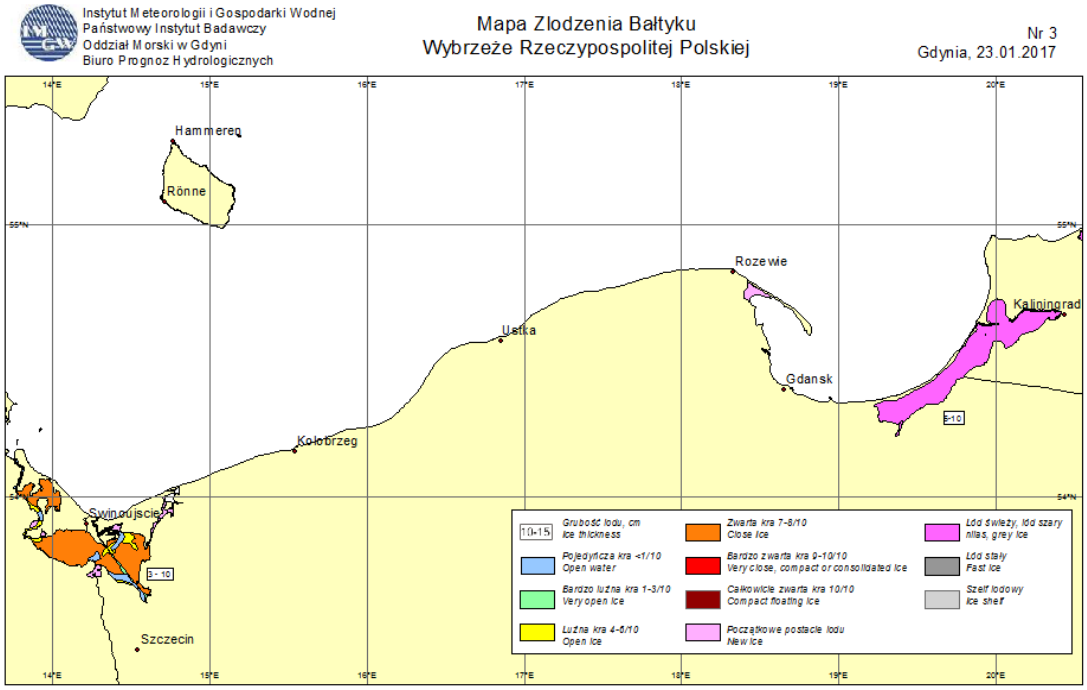


Figure IX-1 – Ice chart for the Polish Baltic coast on 23 January 2017

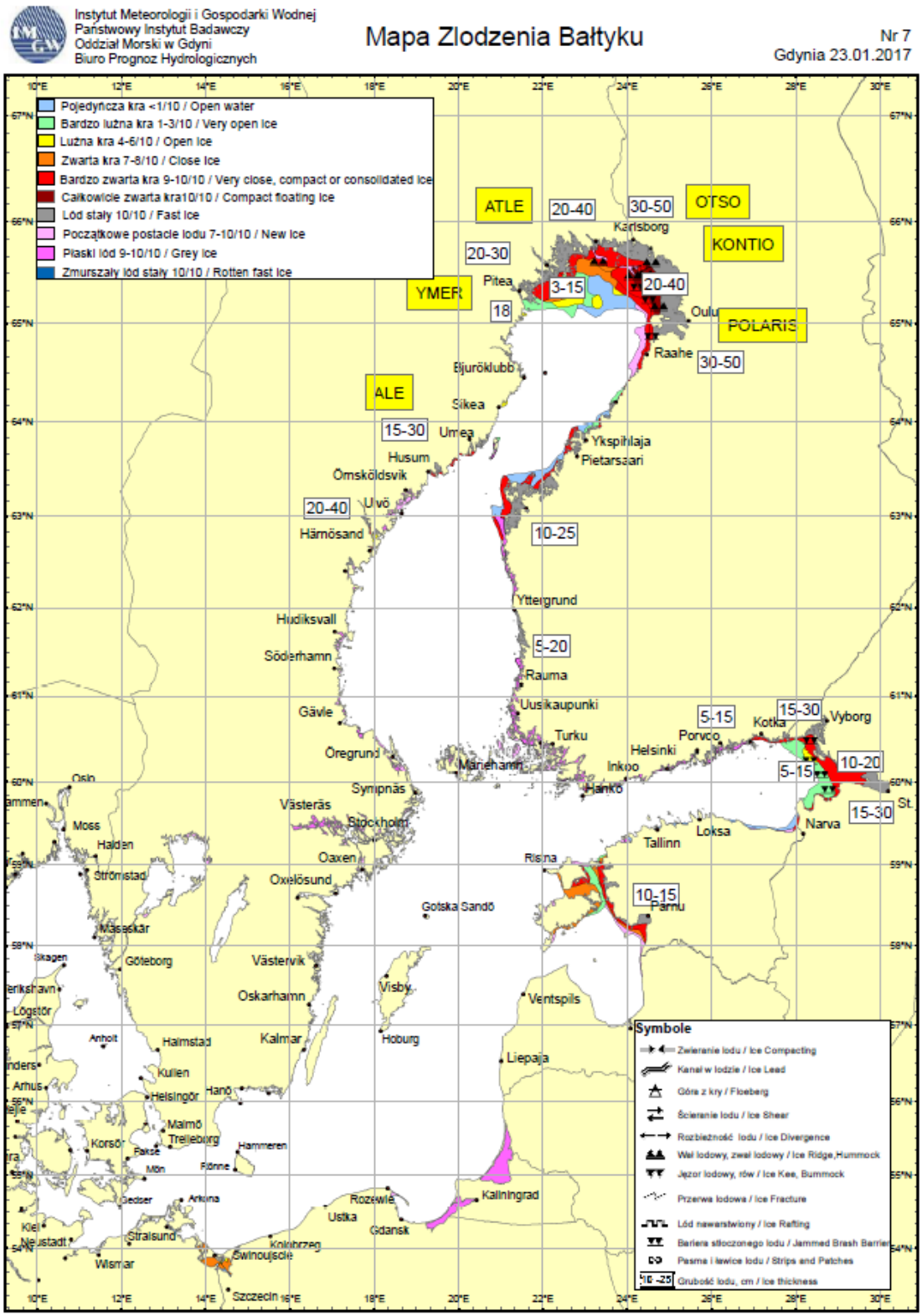


Figure IX-2 – Ice chart for the Baltic Sea on 23 January 2017

ANNEX X – Russian Federation

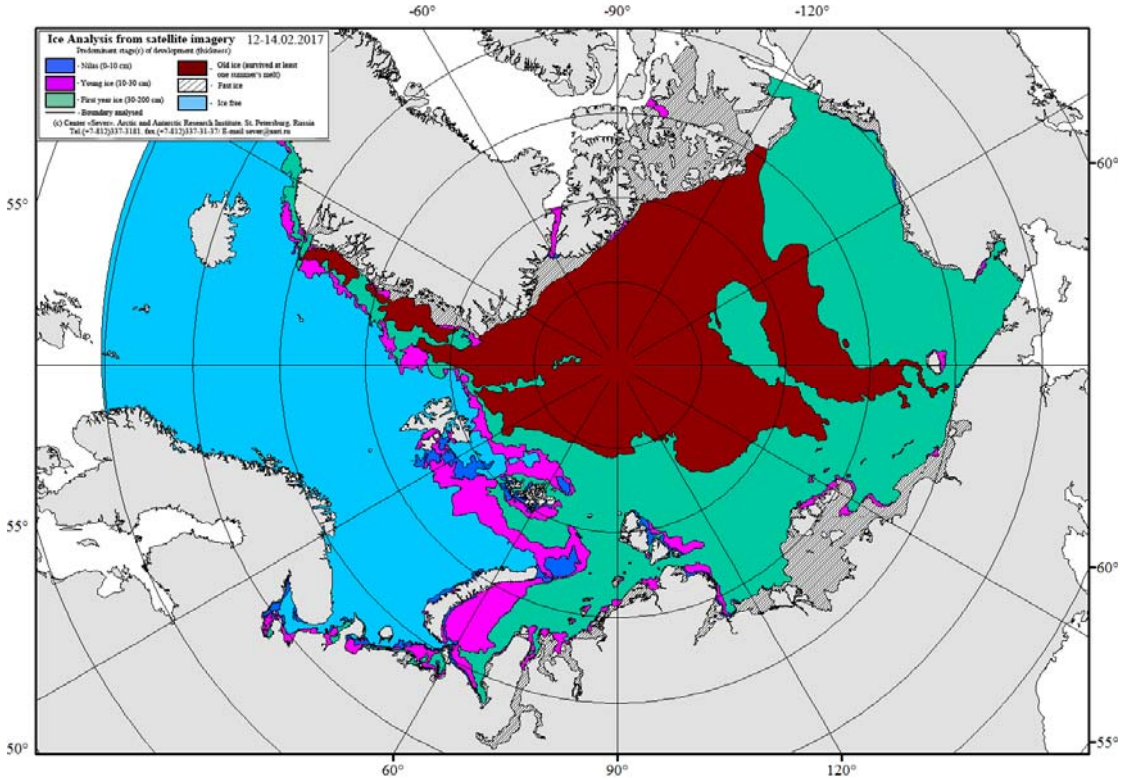


Figure X-1 – Common usage AARI ice chart for the Arctic Ocean on 12-14 February 2017.

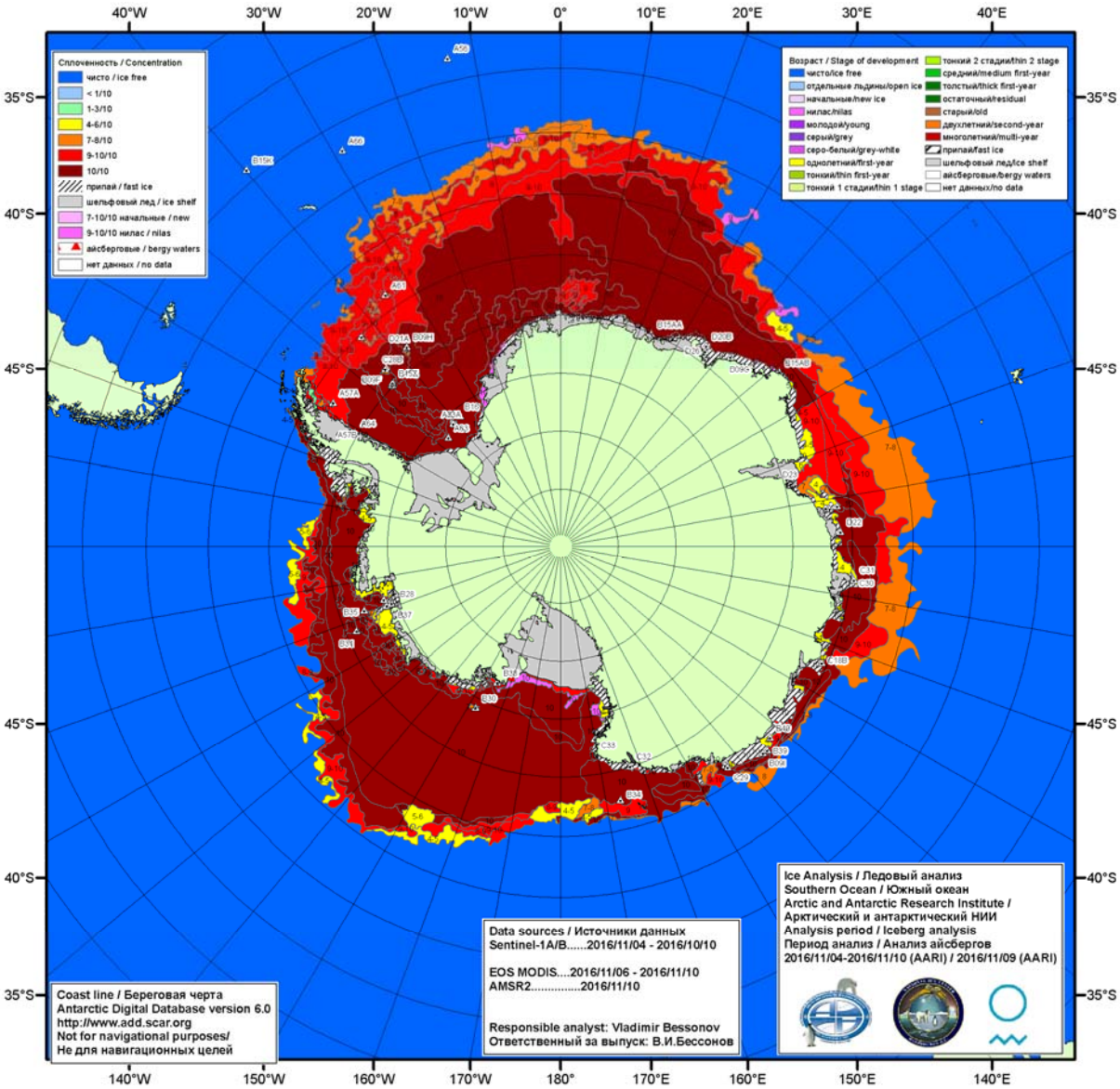


Figure X-2 – AARI Antarctic sea ice and iceberg analysis for 04-10 November 2016.

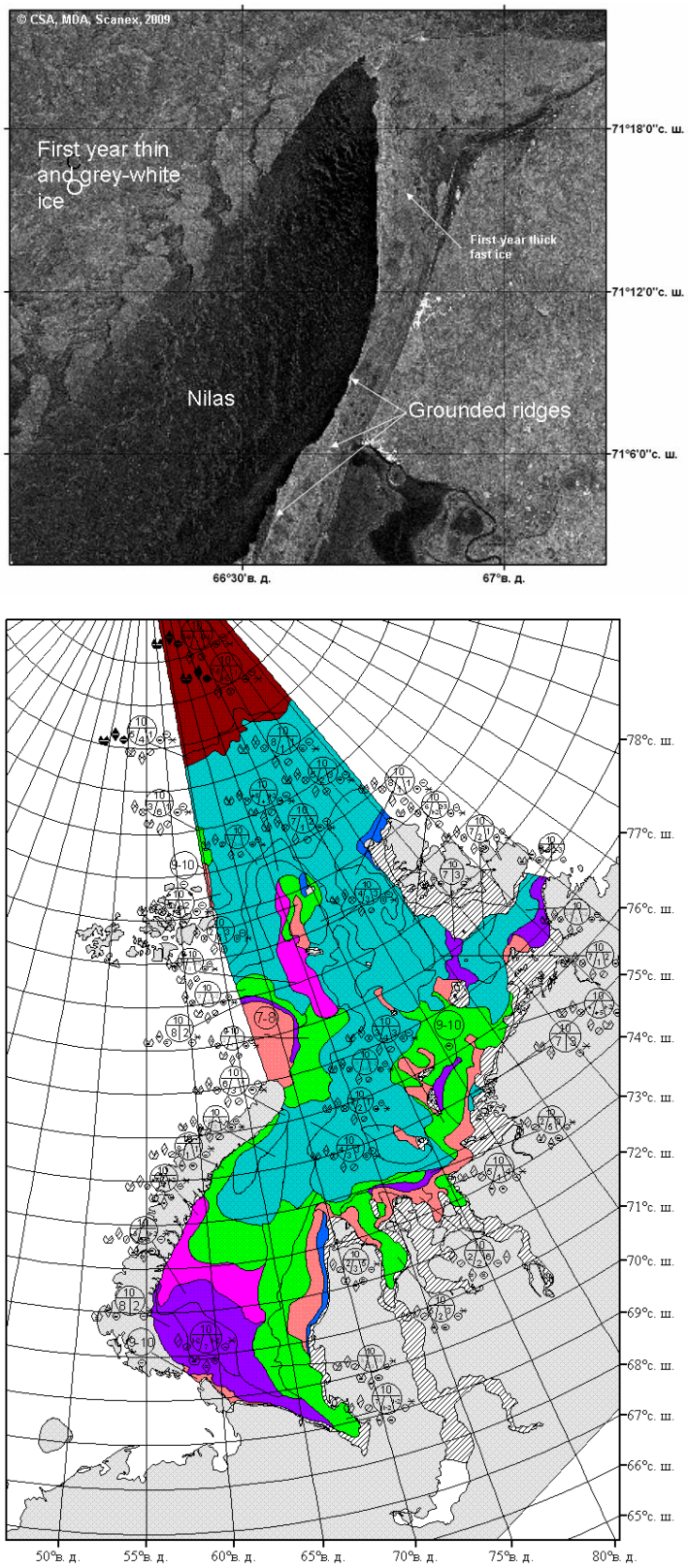


Figure X-3 – Background Radarsat-1 fine beam imagery for 5 February 2009 12:54 for the area near Yamal peninsula and detailed ice chart in Russian national symbology for the Kara Sea, 2-4 February 2009.

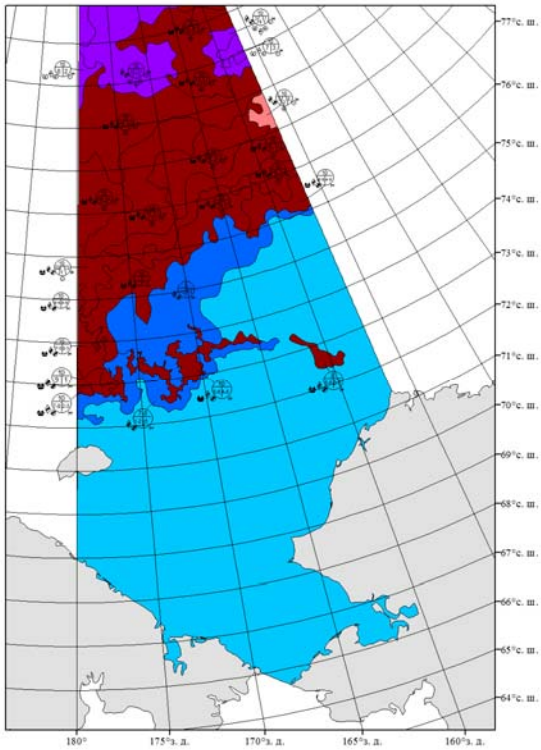


Figure X-4 – AARI ice chart in Russian national symbology for the Chukchi Sea for 3-4 October 2016

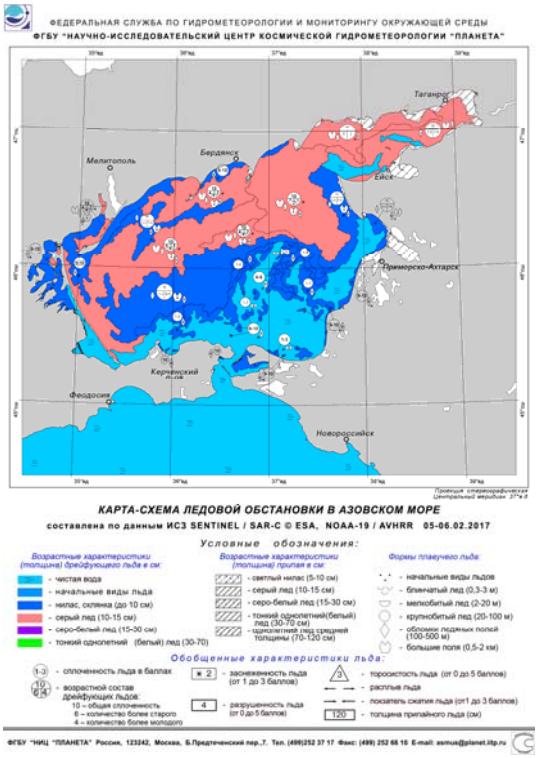


Figure X-5 – Planet ice chart in Russian national symbology for the Azov Sea for 5-6 February 2017.

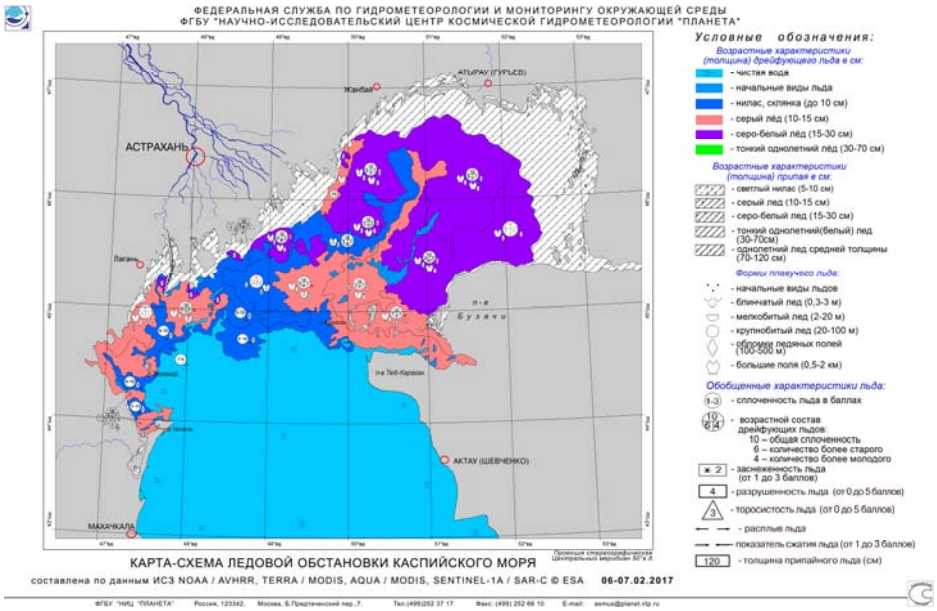


Figure X-6 – Planet ice chart in Russian national symbology for the Caspian Sea for 6-7 February 2017.

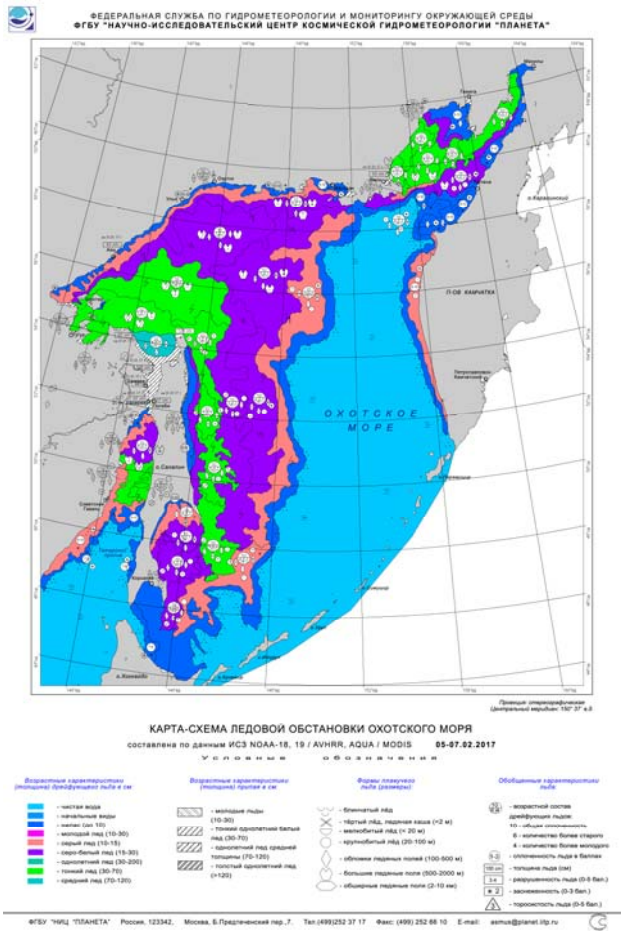


Figure X-7 – Planet ice chart in Russian national symbology for the Okhotsk Sea for 6-7 February 2017.

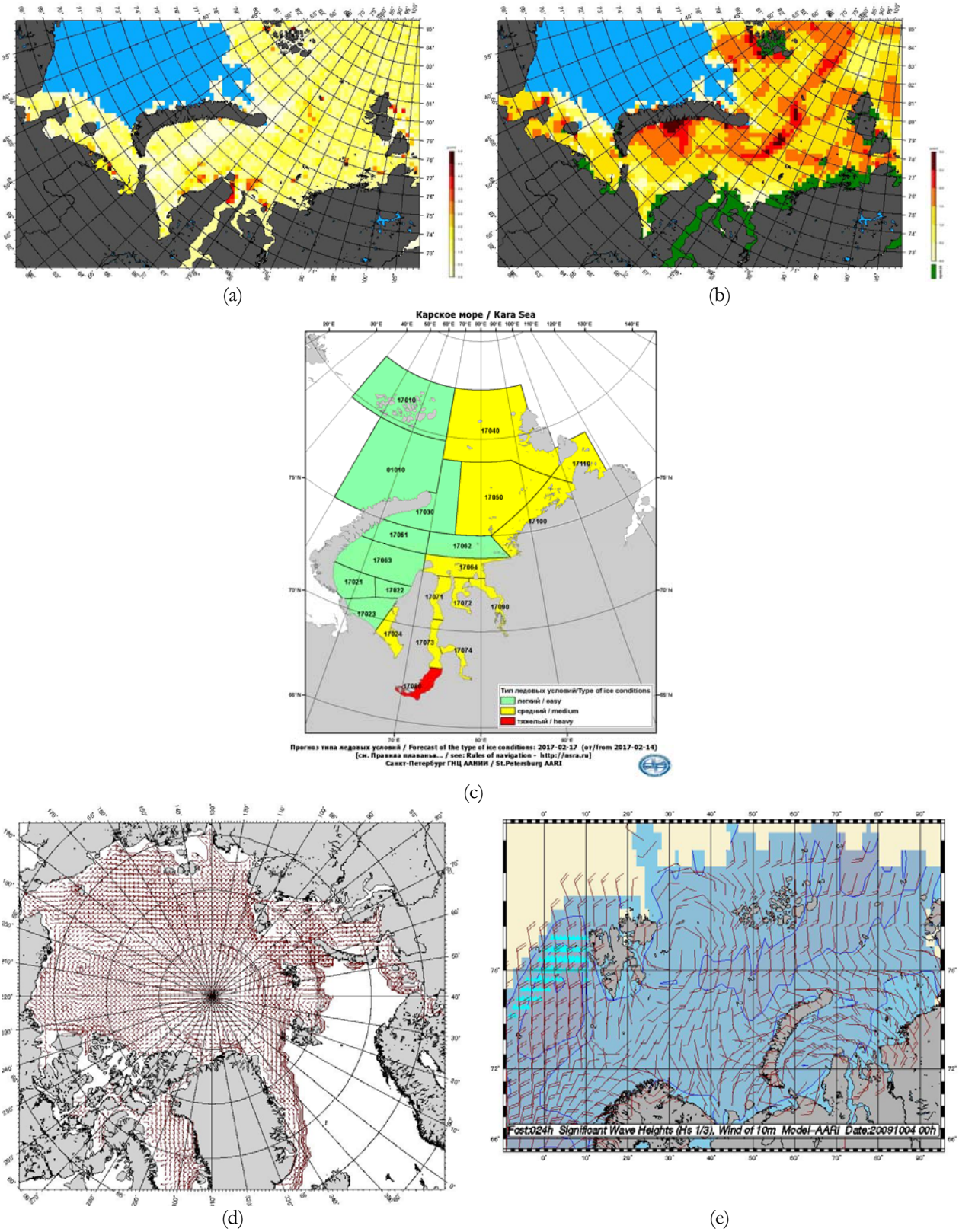


Figure X-8 – Short-term prognostic charts: 2010-02-05 +024h for the Barents-Kara Seas: hummocks concentration (a) and level of ice compacting (b); 2017-02-14 +72h: type of ice conditions (c); 2010-02-05 +024h for the Arctic Ocean: mean daily ice drift (d); 2009-10-03 +024h significant (3%) waves height, level of ice accretion and surface wind vectors for the Western Eurasian Arctic seas (e).

ANNEX XI – Sweden

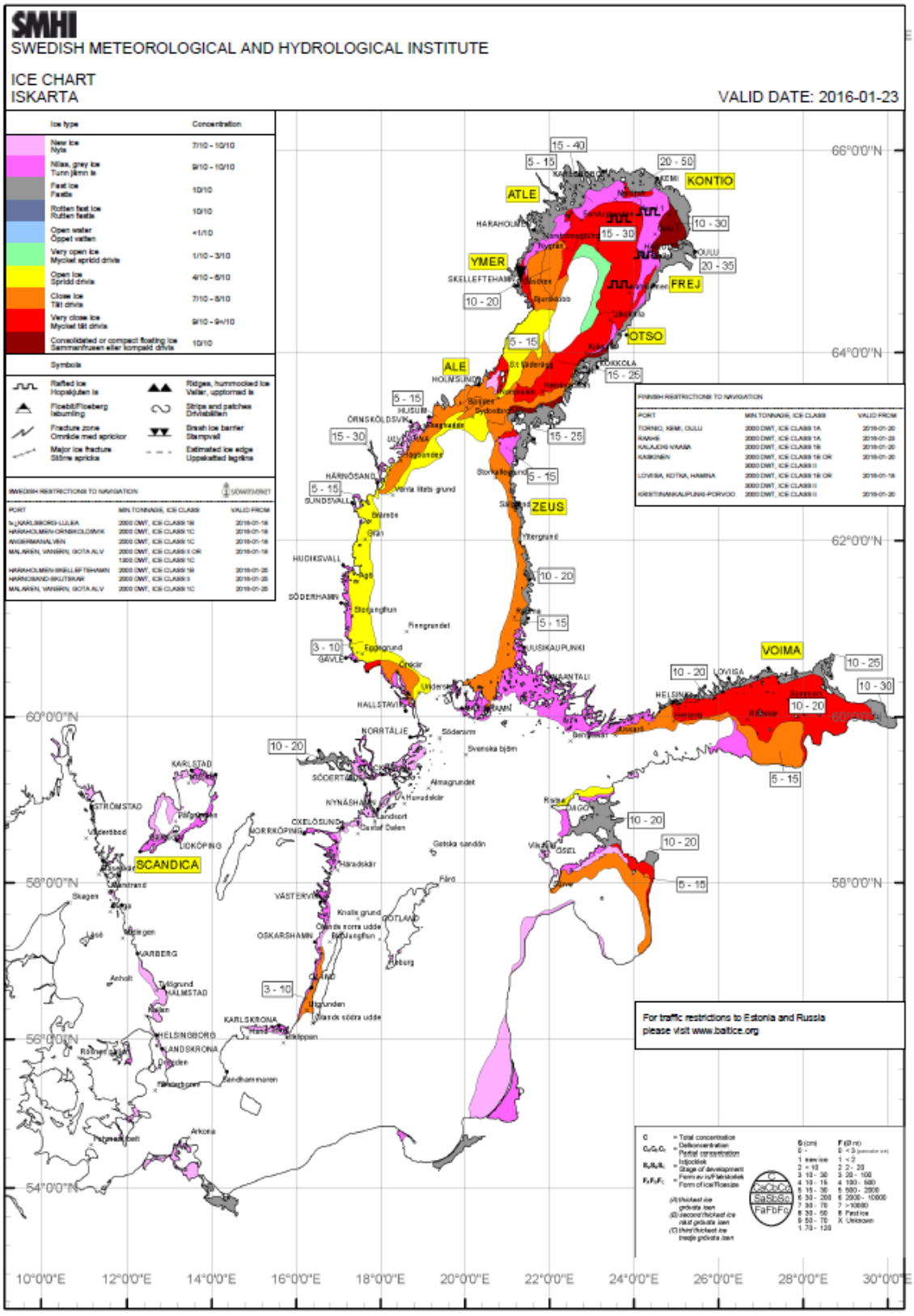


Figure XI -1 – Daily ice chart for the Baltic Sea, 23 January 2016

ANNEX XII - United States

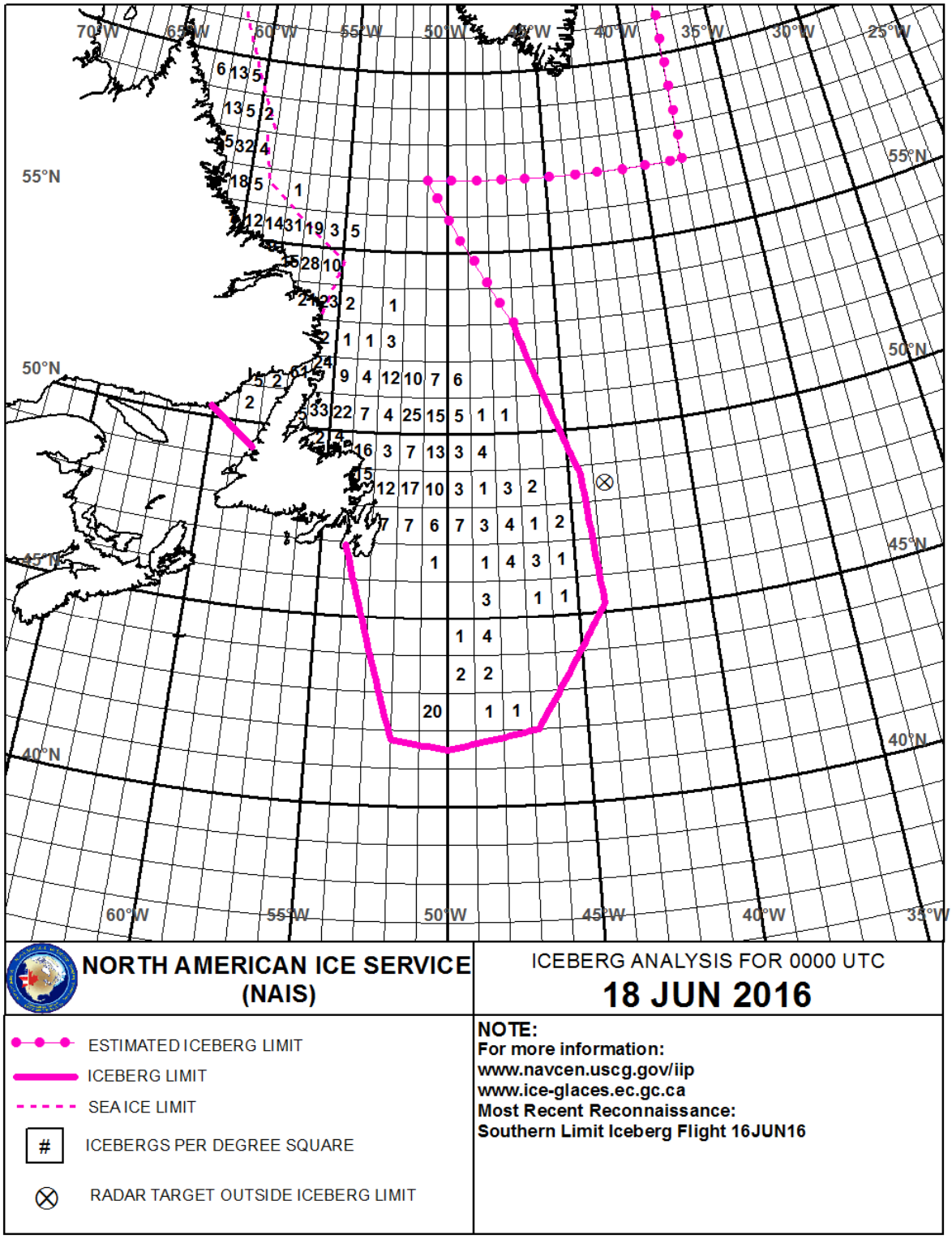


Figure XII-1 – NAIS Iceberg chart for 18 June 2016.

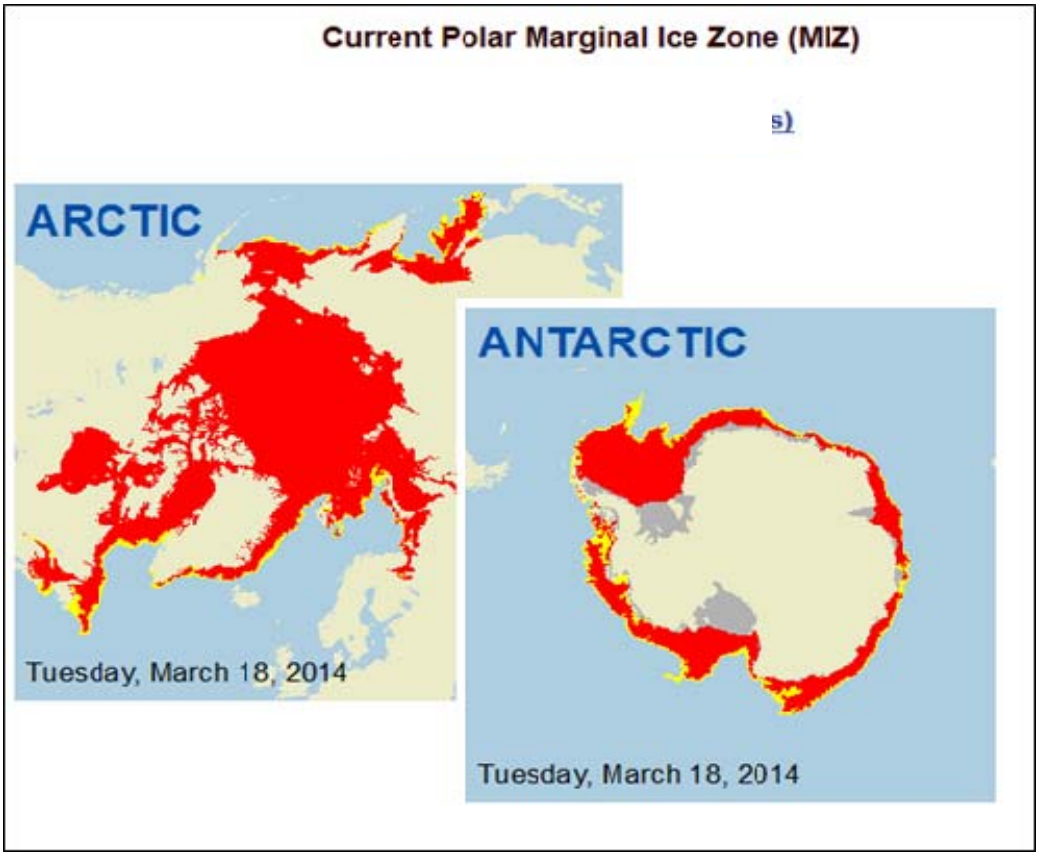


Figure XII-2 – Daily Ice Edge Products

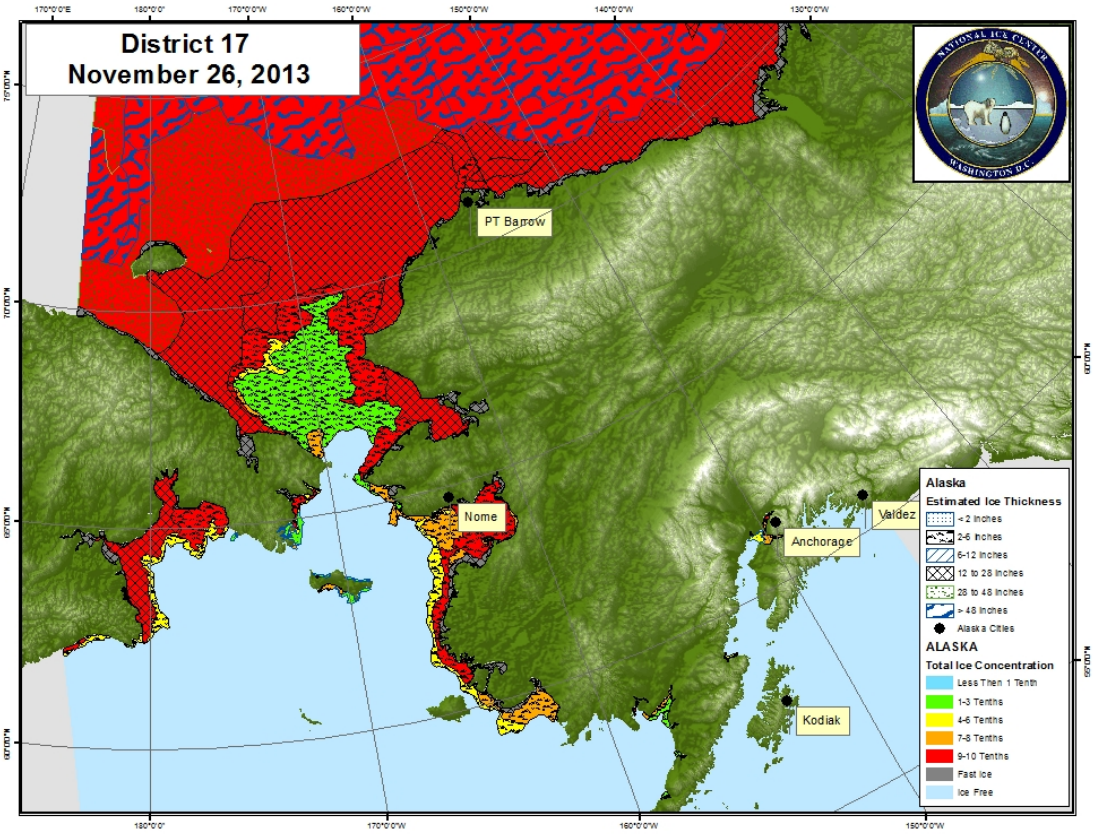


Figure XII-3 – Sample Arctic Maritime Awareness Briefing Aid

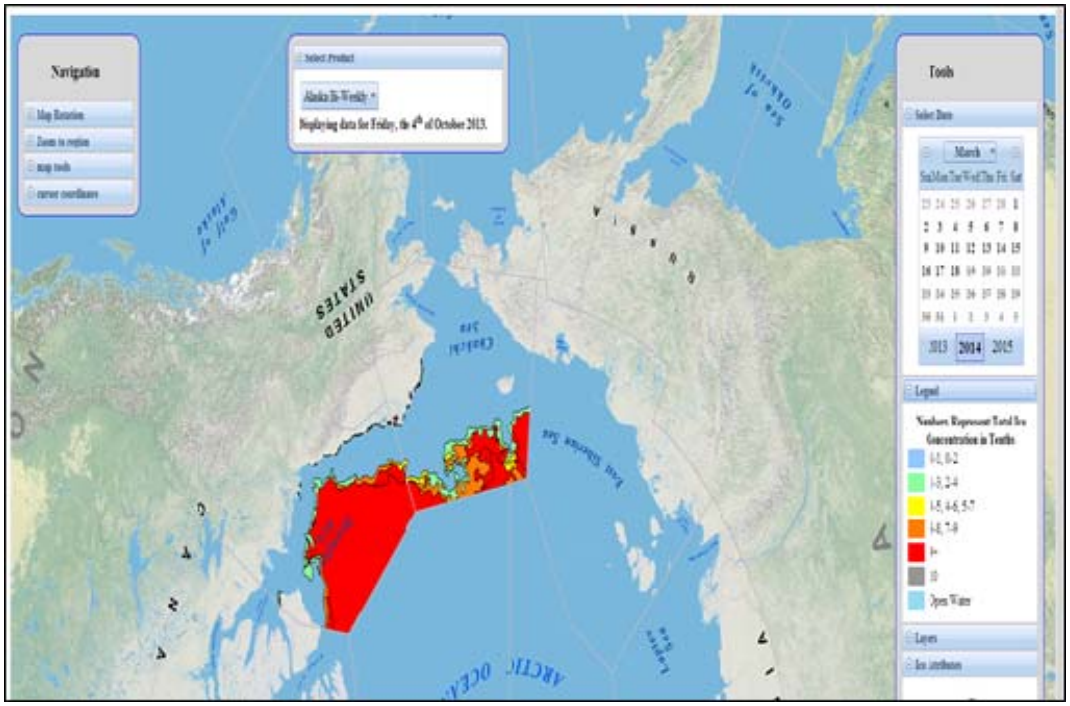


Figure XII-4 – Product on Demand on USNIC website.

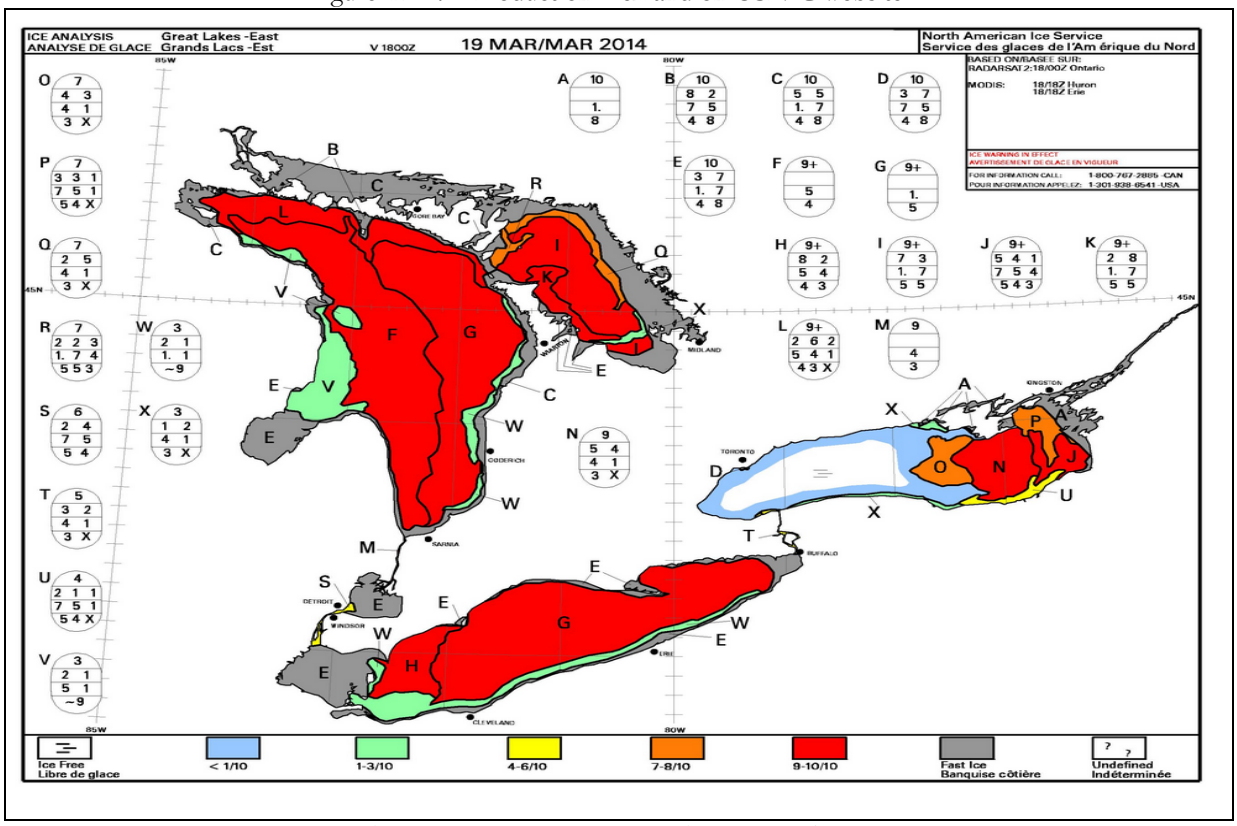


Figure XII-5 – NAIS Great Lakes Ice Products

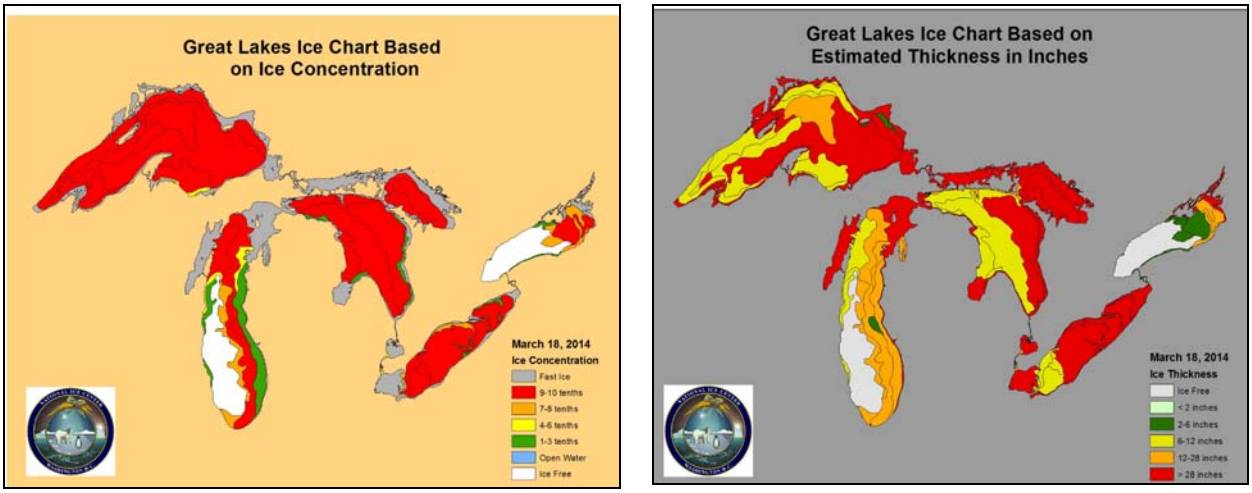


Figure XII-6 –. USNIC Great Lakes Ice Products

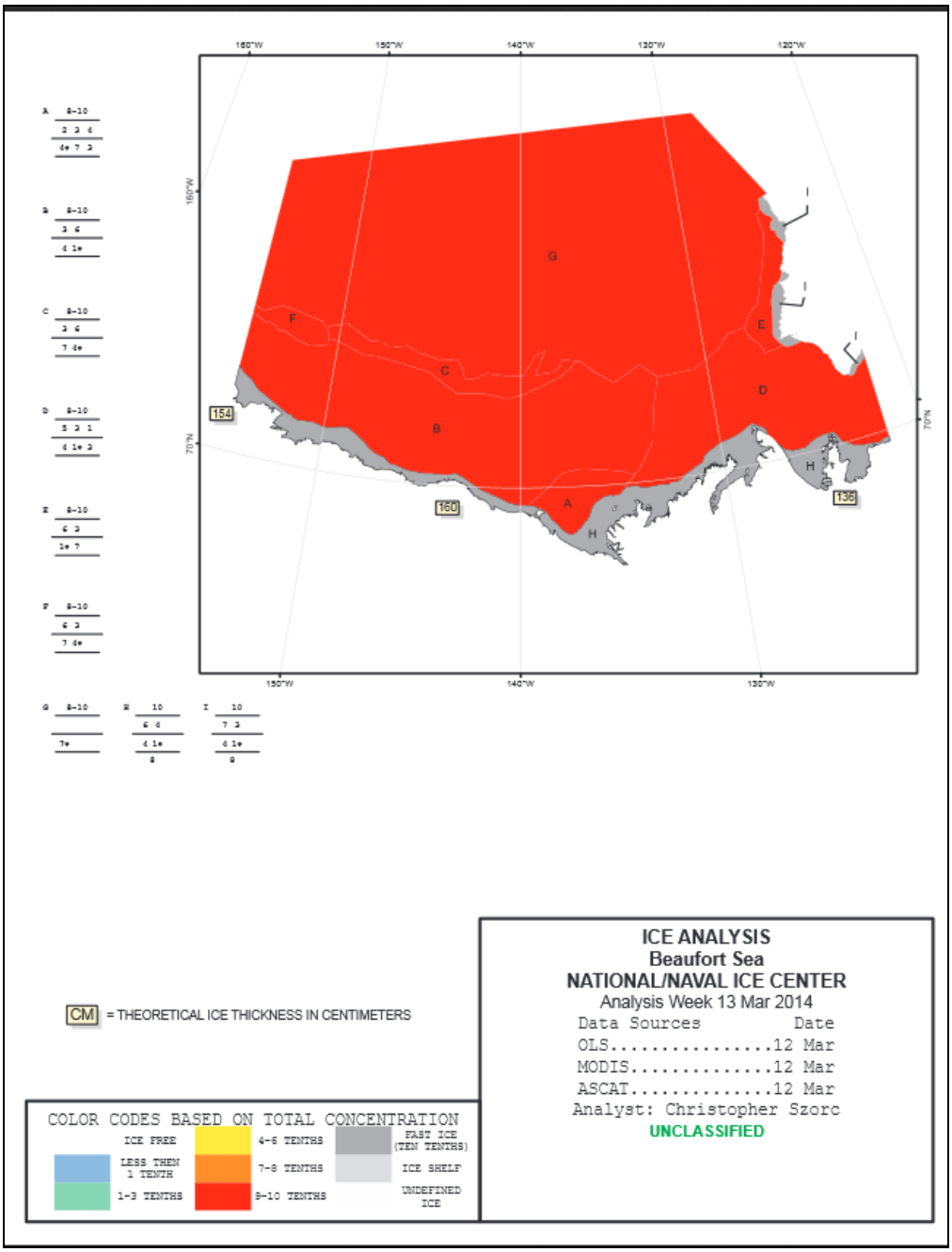


Figure XII-7 – Beaufort Sea Ice Analysis

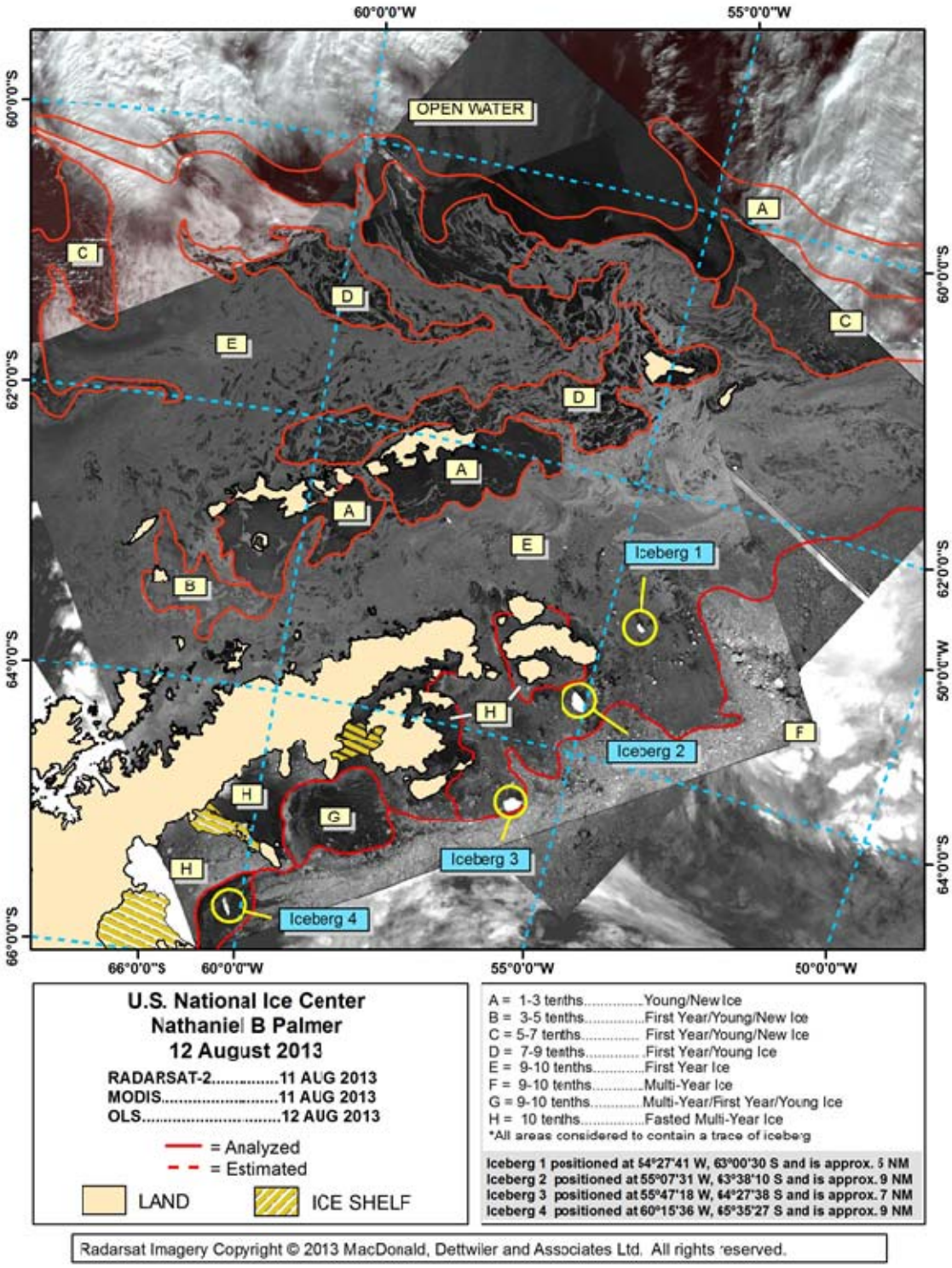


Figure XII-8 – Sample Annotated Imagery

ANNEX XIII – North American Ice Service

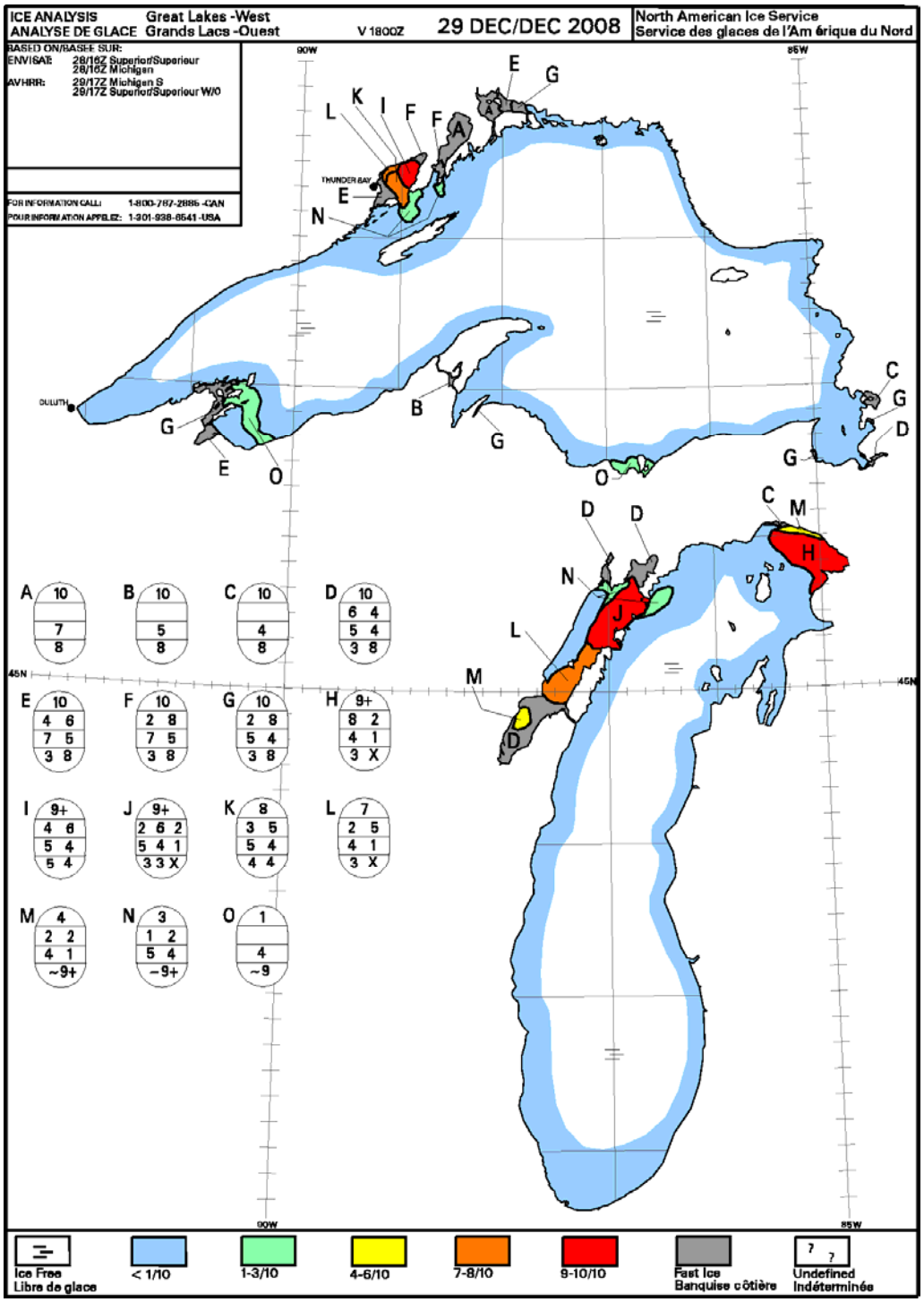


Figure XIII-1 Weekly ice chart for Great Lakes, 29 December 2008.

ANNEX XIV – Argentina

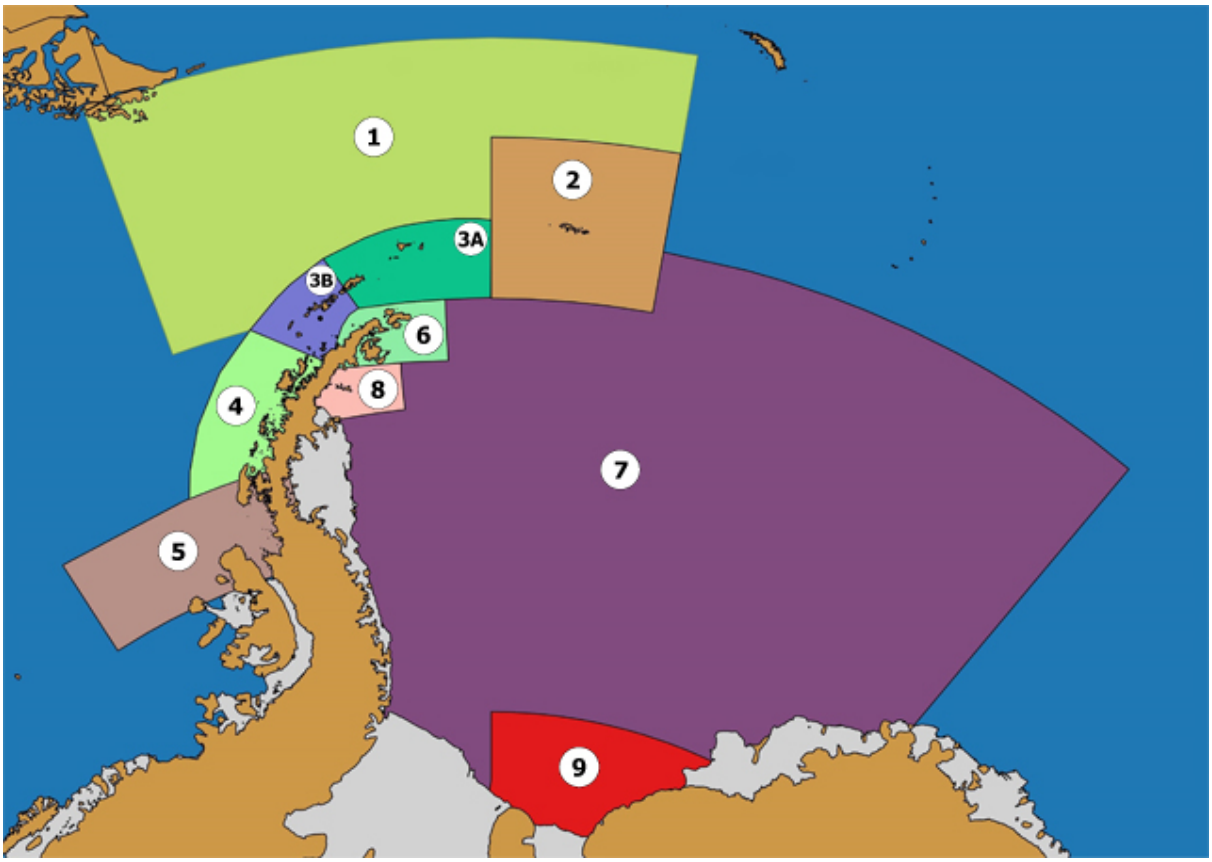


Figure XIV-1 – Antarctic Zones for Argentina Ice Chart production.

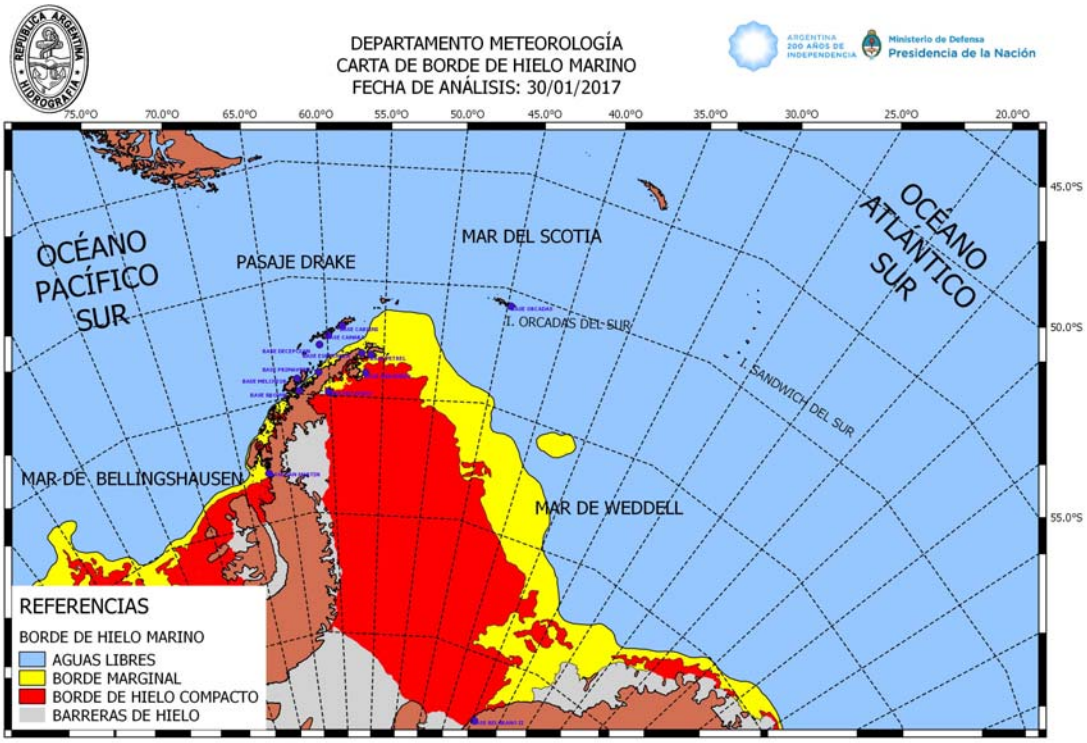


Figure XIV-2 – Sea Ice Edge Chart for January 30th 2017.

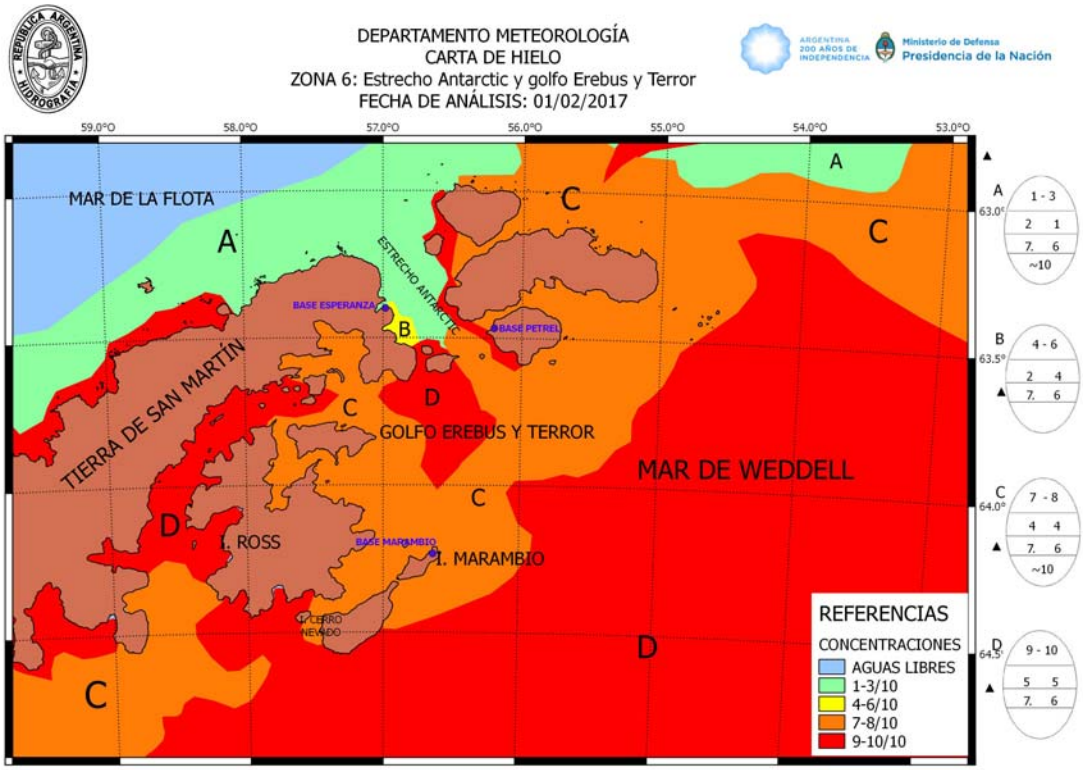


Figure XIV-3 – Ice Chart of Zone 6 for February 1st 2017.

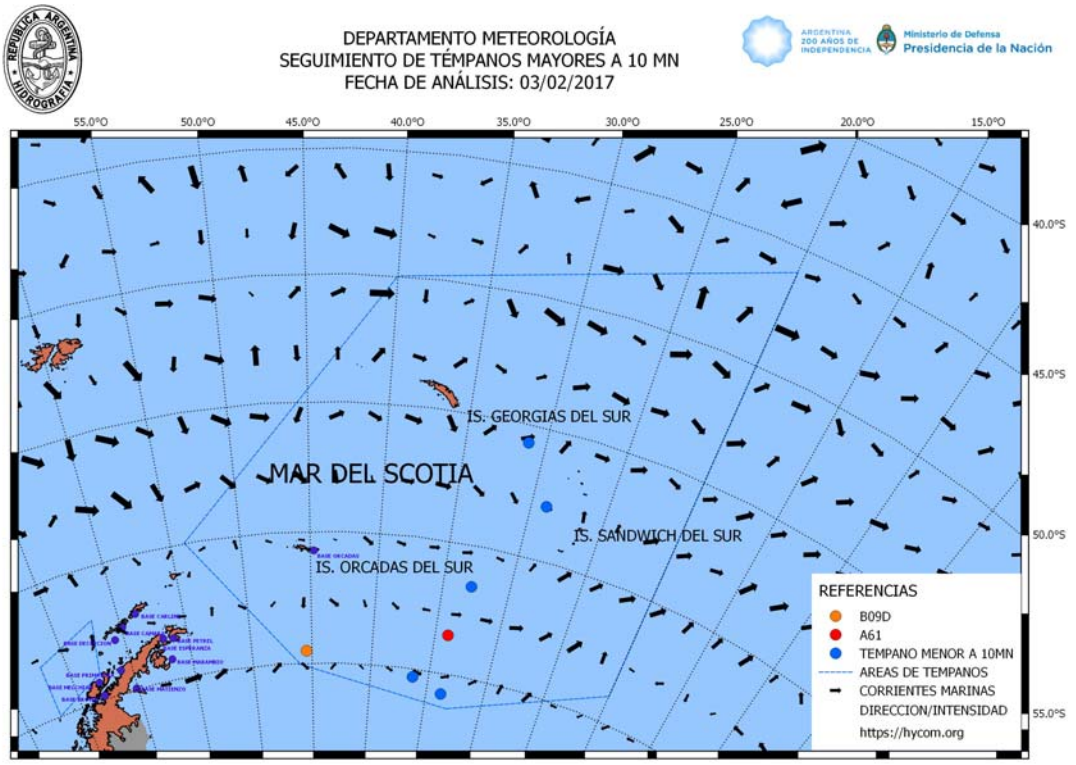


Figure XIV-4 – Icebergs Chart for February 3rd 2017.

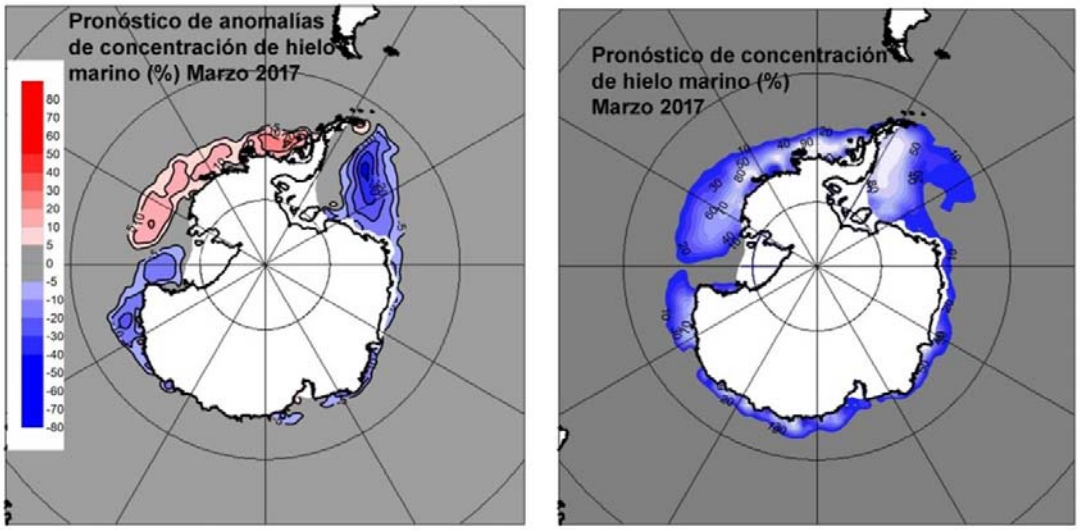


Figure XIV-5 – Sea Ice Concentration Forecast valid for March 2017. Left image: Sea Ice Concentration Anomalies Forecast. Right Image: Percentage of Sea Ice Concentration Forecast.

List of acronyms and other abbreviations

09 February 2017 revision

AARI	Arctic and Antarctic Research Institute
ACSYS	Arctic Climate System Study
AHI	Advanced Himawari Imager
AIRSS	Arctic Sea Ice Regime Shipping System
AMSR	Advanced Microwave Scanning Radiometer
APT	Automatic Picture Transmission
ATF	Antarctic Task Force (Argentina)
AVHRR	Advanced Very High Resolution Radiometer
BIM	Baltic Icebreaking Management
BSH	Bundesamt für Seeschiffahrt und Hydrographie (Germany)
BSIM	Baltic Sea Ice Meeting
BSIS	Baltic Sea Ice Services
CAA	Chinese Antarctic and Arctic Administration
CEADO	Argentine Centre of Oceanographic Data
CCG	Canadian Coast Guard
CDA	Command Data Acquisition (satellite communications)
CDC	Climate Data Centre
CIS	Canadian Ice Service
CliC	Climate and Cryosphere project
CLIVAR	Climate Variability and Predictability (WCRP)
CMM	former WMO Commission for Marine Meteorology
COADS	Comprehensive Ocean Atmosphere Data Set
COTS	Commercial Off-the-Shelf
COOBC	China Offshore Oil Bohai Corporation
DCRS	Danish Center for Remote Sensing
DMSP	Defense Meteorological Satellite Program (USA)
DMI	Danish Meteorological Institute
DNMI	Norwegian Meteorological Institute
EC	Executive Council
ECDIS	Electronic Chart Display Information System
ECMWF	European Centre for Medium-Range Weather Forecasting
EIS	European Ice Service
EMHI	Estonian Meteorological and Hydrological Institute
ENVISAT	Environmental Satellite
ERS	European Remote-Sensing Satellite
ESA	European Space Agency
ESDIM	Environmental Services, Data, and Information Management Programme
ETSI	JCOMM Expert Team on Sea Ice
EUMETSAT	European Organization for the Exploitation of Meteorological Satellites
FIMR	former Finnish Institute of Marine Research (now part of FMI)
FMI	Finnish Meteorological Institute
GCC-EWG	Gore-Chernomyrdin Commission Environmental Working Group
GCOS	Global Climate Observing System
GCW	Global Cryosphere Watch (WMO Program)
GDSIDB	Global Digital Sea Ice Data Bank
GIS	Geographic Information System
GLERL	Great Lakes Environmental Research Laboratory (USA)
GMDSS	Global Maritime Distress and Safety System
GMES	Global Monitoring of Environment and Security Programme
GTS	WMO WWW Global Telecommunications System
HRPT	Higher Resolution Picture Transmission
IABP	International Arctic Buoy Programme
IHO	International Hydrographic Organization

IICWG International Ice Charting Working Group
IIP International Ice Patrol
IMGW Institute of Meteorology and Water Management (Poland)
IMO Icelandic Meteorological Office
IMO International Maritime Organization
IOC Intergovernmental Oceanographic Commission (of UNESCO)
IPAB International Programme for Antarctic Buoys
IST Information Society Technology
IWICOS Weather, Sea ice and Ocean Service System
IUGG International Union of Geodesy and Geophysics
JCOMM Joint WMO/IOC Technical Commission for Oceanography and Marine Meteorology
JCG Japan Coast Guard
JDA Japan Defense Agency
JIWG Joint USA/Canada Ice Working Group
JMA Japan Meteorological Agency
HELMI forecast dynamic-thermodynamic numeric model for sea ice used at FIMR
LAC Local Area Coverage
LEGMA Latvian Environment, Geology and Meteorology Agency
LHMS Lithuanian Hydrometeorological Service
MANICE Manual of Standard Procedures for Observing and Reporting Ice Conditions (CIS)
MetOffice UK Meteorological Office
MODIS Moderate Resolution Imaging Spectrometer
NAIS North American Ice Service
NASA National Aeronautics and Space Administration (USA)
NAVOCEANO Naval Oceanographic Office (USA)
NAVTEX International system for reception of marine safety information
NCEP National Center for Environmental Prediction (USA)
NESDIS NOAA National Environmental Satellite Data Information Service
NGDC NOAA National Geophysical Data Center
NIC National Ice Center (USA)
NMEFC National Marine Environment Forecast Centre (China)
NOAA National Oceanographic and Atmospheric Administration (USA)
NPOESS National Polar Orbiting Environmental Satellite (USA)
NSIDC National Snow and Ice Data Center (USA)
NSR Northern Sea Route (Russia)
OLS Operational Linescale System
ONR Office of Naval Research (USA)
OTSR Optimum Track Ship Routing
PIPS Polar Ice Prediction System (USA)
PRIC Polar Research Institute of China
PSC University of Washington Polar Science Center
QC Quality Control
QMFO Qingdao Marine Forecasting Observatory
RADARSAT Satellite from Canada
RIZA Institute for Inland Water Management and Waste Water Treatment (the Netherlands)
SAR Synthetic Aperture Radar
SCC CLiC Science and Coordination Committee
SCG JCOMM Services Programme Area Coordination Group
SG Steering Group
SGSI former CMM Subgroup on Sea Ice
SIGRID Format for the archival and exchange of sea-ice data in digital form
SHN Naval Hydrographic Service (Argentina)
SIMS Sea Ice Mapping System
SMARA Argentine Navy Meteorological Service
SMHI Swedish Meteorological and Hydrological Institute
SMN Argentine National Meteorological Service
SOA State Ocean Administration (China)
SOLAS International Convention for the Safety of Life at Sea

SPA	JCOMM Services Programme Area
SSM/I	Special Sensor microwave Imager
SST	Sea Surface Temperature
SYKE	former Finnish Environmental Institute (now part of FMI)
TD	Technical Document
UN	United Nations
UNESCO	United Nations Educational, Scientific and Cultural Organization
USN	U.S. Navy
USCG	U.S. Coast Guard
VIIRS	Visible Infrared Imaging Radiometer Suite
WCP	World Climate Programme
WCRP	World Climate Research Programme
WDC	World Data Centre
WMO	World Meteorological Organization
WWW	World Weather Watch of WMO
XML	Extensible Markup Language

Sea-ice products by areas of the World Ocean available via the Ice Logistics Portal

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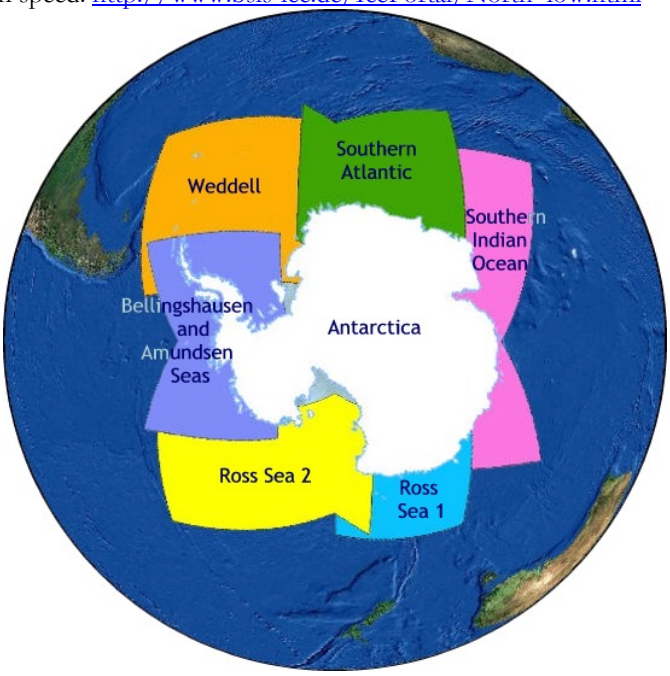
High connection speed: http://www.bsis-ice.de/IcePortal/displayNorthernMap90E.html
Low connection speed: http://www.bsis-ice.de/IcePortal/North_low.html



High connection speed: http://www.bsis-ice.de/IcePortal/displaySouthernMap.html
Low connection speed: http://www.bsis-ice.de/IcePortal/South_low.html

All available actual S411 charts: http://www.bsis-ice.de/IcePortal/ILP_S411.shtml