Homeland Security

United States Coast Guard

Report of the International Ice Patrol in the North Atlantic

2011 Season
Bulletin No. 97
CG-188-66

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Season of 2011

CG-188-66

Forwarded herewith is Bulletin No. 97 of the International Ice Patrol, describing the Patrol's services and ice conditions during the 2011 season. With only three icebergs crossing 48° N, this was one of the lightest seasons on record, and the fourth time in the last seven years that icebergs did not threaten transatlantic shipping lanes. Transatlantic shipping benefited by saving hundreds of miles per voyage compared to an average season transit. However, several fragments of an ice island that calved from the Petermann Glacier in Northern Greenland in August of 2010 drifted south along the Labrador Coast. The fragments contained billions of tons of ice but remained inshore and did not affect mariners on the Grand Banks. The fragments persisted through the end of the ice year in September, significantly affecting use of the Strait of Belle Isle for much of the navigation season. The Ice and Environmental Conditions section presents a discussion of the meteorological and oceanographic conditions that contributed to the light season.

During 2011, Ice Patrol vigilantly monitored the iceberg danger and issued daily products under the North American Ice Service (NAIS). Under the growing NAIS partnership, Ice Patrol and the Canadian Ice Service agreed to share responsibility for providing iceberg warnings to North Atlantic mariners according to the time of the year. Ice Patrol issued daily iceberg warnings from February to July while the Canadian Ice Service assumed responsibility for the remainder of the year. In previous years, the responsibility was divided according to geographic areas. The details are described in the Summary of Operations section and Appendix C.

Also in 2011, Ice Patrol contracted a study to assess the feasibility of using satellites for iceberg reconnaissance and conducted an operational assessment of available data as described in the Summary of Operations section. Additionally, the second ice reconnaissance detachment using the U.S. Coast Guard's HC-144A aircraft deployed to Newfoundland for evaluation of the platform for iceberg reconnaissance as described in the Iceberg Reconnaissance section.

On behalf of the dedicated men and women of the International Ice Patrol, I hope you enjoy reading this report on the 2011 season.

L. K. Mack
Commander, U. S. Coast Guard
Commander, International Ice Patrol

International Ice Patrol
2011 Annual Report

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Cover Photograph: Iceberg Reconnaissance crewmember deploys a Compact Air-Launched Ice Beacon on a Petermann Ice Island fragment.

Abbreviations and Acronyms

AIS	Automated Information System
AOR	Area of Responsibility
ATC	Aviation Training Center
BAPS	iceBerg Analysis and Prediction System
C-130J	Non-missionized C-130 long-range reconnaissance aircraft
CALIB	Compact Air-Launched Ice Beacon
CAMSLANT	Communications Area Master Station Atlantic
CCG	Canadian Coast Guard
CIS	Canadian Ice Service
D1	First Coast Guard District
ECAS	Air Station Elizabeth City
ELTA	Brand name of radar system on HC-130J
HC-130J	Missionized C-130 long-range reconnaissance aircraft
HC-144A	Medium-range Maritime Patrol Aircraft
HF	High Frequency
IIP	International Ice Patrol
IRD	Ice Reconnaissance Detachment
KT	Knot or Nautical Mile Per Hour
LAKI	Limit of All Known Ice
M	Meter
MB	Millibar
MCTS	Marine Communications and Traffic Service
M/V	Motor Vessel
NAFO	Northwest Atlantic Fisheries Organization
NAIS	North American Ice Service
NAO	North Atlantic Oscillation
NIC	National Ice Center
NM	Nautical Mile
NTIS	National Technical Information Service
NWS	National Weather Service
OPCEN	Operations Center
PAL	Provincial Aerospace Limited
RADAR	Radio Detection and Ranging (also radar)
RMS	Royal Mail Steamer
SOLAS	Safety of Life at Sea
SST	Sea Surface Temperature
TAC	Total Accumulated Ice Coverage
WOCE	World Ocean Circulation Experiment

Introduction

This is the 97th annual report of the International Ice Patrol (IIP). IIP was under the operational control of Commander, U.S. Coast Guard First District. The report contains information on IIP operations, environmental conditions, and iceberg conditions in the North Atlantic during 2011. The Ice Patrol was formed after the RMS *Titanic* sank on 15 April 1912. Since 1913, except for periods of World War, Ice Patrol has monitored the iceberg danger near the Grand Banks of Newfoundland and has broadcast the Iceberg Limit to mariners. The activities and responsibilities of IIP are delineated in U.S. Code, Title 46, Section 80302, and the International Convention for the Safety of Life at Sea (SOLAS), 1974.

IIP conducted aerial reconnaissance from St. John's, Newfoundland to search for icebergs in the North Atlantic and Labrador Sea. In addition to IIP reconnaissance data, Ice Patrol received iceberg reports from other aircraft and mariners in the North Atlantic. At the Operations Center (OPCEN) in New London, Connecticut, personnel analyzed iceberg and environmental data and used the iceBerg Analysis and Prediction System (BAPS) computer model to predict iceberg drift and deterioration. Based on the model's prediction, IIP produced a daily iceberg chart and text bulletin in 2011 under the North American Ice Service Collaborative Arrangement. In addition to these routine broadcasts, IIP responded to individual requests for iceberg information.

RADM Daniel A. Neptun was Commander, U.S. Coast Guard First District.

CDR Lisa K. Mack was Commander, International Ice Patrol.

For more information about the International Ice Patrol, including historical and current iceberg bulletins and charts, visit our website at www.navcen.uscg.gov/IIP.

INTERNATIONAL ICE PATROL

Summary of Operations

The International Ice Patrol (IIP) monitors iceberg danger near the Grand Banks of Newfoundland as mandated by the International Convention on the Safety of Life at Sea (SOLAS). In addition, participation in North American Ice Service (NAIS) initiatives in 2011 modified traditional IIP operations. The NAIS partnership, comprised of the Canadian Ice Service (CIS), the National Ice Center (NIC) and the IIP, was formed in 2003 to transform individual organizational strengths into a unified source of ice information and meet all marine ice information needs and obligations of the United States and Canadian governments.

On 01 February 2011, IIP released the first NAIS Iceberg Chart. Prior to this milestone in harmonization, IIP Iceberg Charts were produced only when the iceberg population posed a threat of collision near the Grand Banks of Newfoundland. CIS produced a daily Iceberg Chart for the Canadian Maritimes year-round. Now, the daily NAIS Iceberg Chart is produced year-round and incorporates the Canadian Maritimes as well as the Grand Banks. IIP prepares the chart from 01 February through 31 July. CIS generates the chart from 01 August until IIP resumes responsibility for product generation in February the following year. Implementation of the harmonized NAIS Iceberg Chart reduces redundancy between CIS and IIP, while improving efficiency and service to mariners.

The rapid organizational progression resulting from NAIS is striking when put into context of the historical evolution of IIP's Iceberg Chart. Initial steps towards the possibility of a joint chart started back in 1983 when CIS began using the iceBerg Analysis and Prediction System (BAPS) and IIP continued using the iceberg Data Management and Prediction System (DMPS). These two systems were nearly identical and served the needs of each individual ice center for many years. In 1998, IIP transitioned to BAPS, establishing a truly common production system between CIS and IIP. The respective databases at each ice center were synchronized in 2006, allowing seamless information sharing; significantly improving the transfer of icebergs as they passed south from CIS's traditional area of responsibility. In 2009, the charts produced by IIP and CIS had a common look, showing numbers per degree square to indicate the relative iceberg density. Finally, in 2011, the harmonized NAIS chart minimized duplication of effort because a chart produced by one ice center is then forwarded to the customer base of both respective services. Additionally, the numbers per degree square were standardized to include bergy bits and growlers. Future improvements will include harmonization of text products, distribution mechanisms and workflow.

Figure 1 portrays the importance of a harmonized Iceberg Chart. On the left are the IIP iceberg analysis chart (top) and the CIS iceberg analysis chart (bottom) for 14 May 2010. While the iceberg population generally appears the same, the message of the two products is completely different. The IIP product for 14 May was a weekly product intended to afford the mariner operating below 50 degrees North situational awareness of the iceberg distribution as it approached traditional trans-Atlantic shipping lanes. The CIS product for 14 May was a daily product with an actual Iceberg Limit designated. On the right side is the NAIS iceberg analysis chart for 01 June 2011 (chosen because the iceberg distribution was similar). The harmonized chart is then forwarded to the customers of both IIP and CIS, ensuring the most consistent and accurate information is provided to all mariners concerned with iceberg dangers in the Northwest Atlantic.

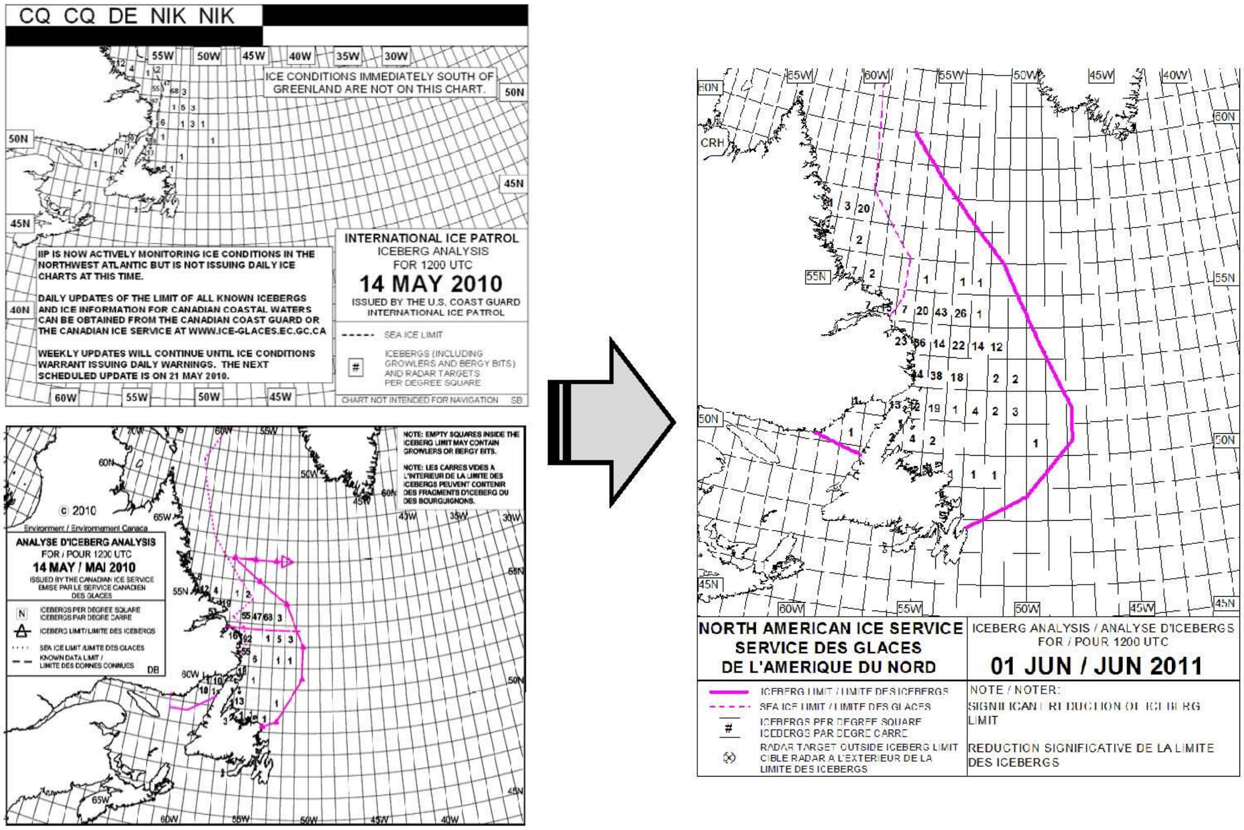


Figure 1. Harmonization of the IIP (top left) and CIS (bottom left) Iceberg Charts into the NAIS Iceberg Chart (right).

The harmonized chart required many adjustments to the standard procedures followed at each center. Terminology changes, including IIP's shift from the Limit of All Known Ice (LAKI) to an Iceberg Limit were required to accommodate the harmonized chart. This change was in stride with international standards of ice charting and was a critical shift to enable the harmonization. While much of the workflow and processes have been adjusted at CIS and IIP to accommodate the joint chart, additional harmonization with products is still pending (in particular, response to reports of icebergs outside the Iceberg Limit and distribution processes).

In support of the harmonized chart, IIP actively monitored the iceberg danger in the region generally bounded by 40°N - 60°N and 39°W - 57°W as well as the Strait of Belle Isle. Reconnaissance efforts were coordinated between CIS and IIP on a case-by-case basis. Because the iceberg distribution was fairly compact, reconnaissance flights were typically separated in time.

Products and Broadcasts

In 2011, IIP transmitted 242 scheduled NAIS Bulletins with 99.1% of scheduled NAIS Bulletins reaching SafetyNET (a satellite-based worldwide maritime safety information broadcast service of high seas weather warnings, NAVAREA navigational warnings, radionavigation warnings and ice reports) on time (prior to or at 1200Z). However, NAIS Bulletins over Simplex Teletype Over Radio (SITOR) service via Communications Station Boston were temporarily interrupted in August 2011. Changing the verbiage of the subject of the Bulletin from IIP to NAIS prevented the Automated Broadcast Environment (ABE) used by Communications Area Master Station Atlantic (CAMSLANT) from identifying the messages for delivery. This omission has been corrected, but future changes to the Bulletin format should be vetted through message handling providers to prevent this occurrence. Broadcasts via SITOR have been on time since the correction, but the delivery rate throughout the season was reduced to 90% as a result of the error. Navigational Telex (NAVTEX) warnings contained an abbreviated version of the NAIS Bulletin and were delivered 100% on time through the duration of the season.

Sometimes IIP will receive a report of an iceberg or stationary radar target near or beyond the published Iceberg Limit, which challenges the accuracy of the NAIS products and is a threat to safe navigation. When IIP receives such a report, an unscheduled safety broadcast is transmitted to mariners reporting the location and type of object (iceberg or radar target) sighted or detected. During the 2011 Ice Season, IIP sent two unscheduled safety broadcasts for two icebergs sighted outside the published Iceberg Limit. Both of these reports required a revision of the Iceberg Limit. As a result of these revisions, the Iceberg Limit accuracy for the 2011 Ice Season was 99.1%.

Information Reports

A critical factor contributing to IIP’s successful safety record is the support received from the maritime community. This support is measured by the volume of voluntary information reports IIP receives from the maritime community each year. These reports are sent in response to a long-standing IIP request for information on weather conditions, sea surface temperatures, and iceberg sightings from any vessel transiting within or near the Grand Banks of Newfoundland. Receiving on-scene and near real-time information helps ensure the accuracy of IIP products.

These reports are generated by various land, sea, air, and space platforms including: merchant ships and Canadian Coast Guard vessels operating within or near the Grand Banks of Newfoundland, IIP reconnaissance flights, commercial aerial reconnaissance contracted by the Canadian Ice Service (CIS) and provided by Provincial Aerospace Limited (PAL), and satellite data processed by the Centre for Cold Ocean Resource Engineering (C-CORE), a research and development company specializing in remote sensing and ice engineering that is based in St John’s, Newfoundland. **Figure 2, Column 1** provides the breakdown of the sources for information reports received during the 2011 Ice Year by percentage. All ships that provided reports directly to IIP are listed in Appendix B. Automated reports from passing ships made to other research or government entities are not quantified by IIP directly, but are essential for feeding model data that is critical to IIP’s product accuracy.

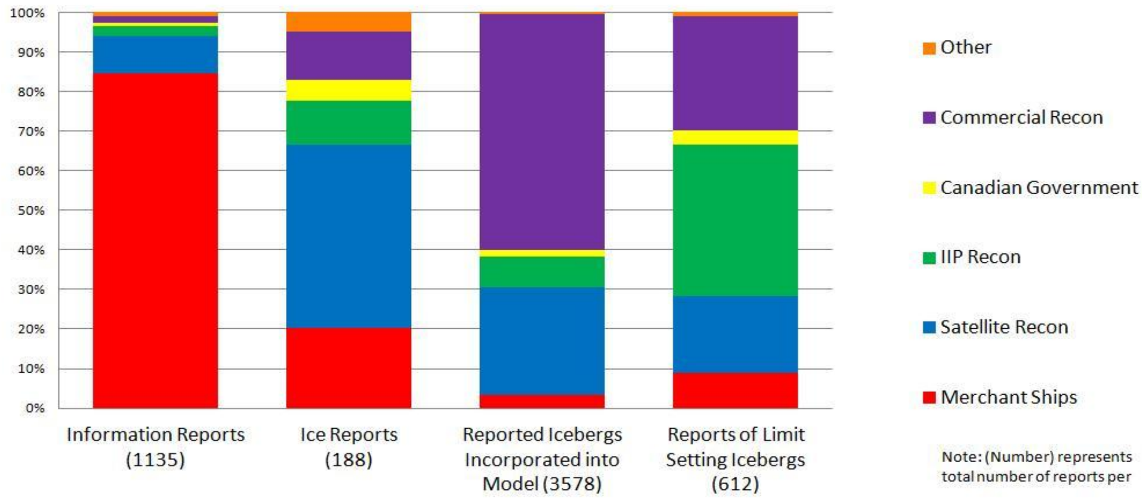


Figure 2. Percentage of information reports, reports containing ice, icebergs incorporated into the model and reports of limit setting icebergs by reporting source in 2011.

The IIP Operations Center received, analyzed, and processed 1,135 information reports, approximately 35% more than the previous year's information report tally. The increase since 2010 can be partially attributed to the correction of an error in the Service Code 42 message reporting process, a mechanism for mariners to provide reports over INMARSAT free of charge.

Of the 1135 information reports received by IIP, 188 (16.6%) reports contained ice information, including icebergs, growlers, and/or stationary radar targets. The percentage of information reports and information reports containing ice by reporting source is illustrated in **Figure 2, Columns 1 and 2**. Satellite reconnaissance was responsible for the greatest number of reports containing ice with 87 (46.2%). Merchant ships tallied the second highest number with 38 (20.2%) ice reports. IIP aerial reconnaissance flights provided 21 (11.7%) and commercial reconnaissance primarily from Provincial Aerospace Limited (PAL) provided 23 (12.2%) ice reports. The Canadian Government, including Canadian Coast Guard vessels, Canadian Forces aircraft, and the light house operators, combined to deliver 10 (4.9%) ice reports. Various other sources, including scientific research vessels, fishing vessels, and one passenger vessel combined to relay the remaining 9 (4.7%) ice reports.

The information reports with ice contained 5108 icebergs, growlers, bergy bits or radar targets, 3578 of which were incorporated (added or re-sighted) into the IceBerg Analysis and Prediction System (BAPS), the application that runs the iceberg drift and deterioration model. All ice reports received at the IIP Operations Center are evaluated for accuracy and viability, accounting for the disparity between objects reported vice those incorporated into the model. Several factors are considered during this evaluation, including atmospheric and oceanographic conditions, recent reconnaissance in the area, method of detection, and any other amplifying information relayed with the ice report. This standard is applied to all ice reports, even IIP's own reconnaissance, to ensure that accurate ice products are being broadcast to the maritime community. The percentage of updates to BAPS by reporting source is portrayed in **Figure 2, Column 3.** Commercial and satellite reconnaissance provided the majority of the information incorporated into BAPS this year, 60 and 27 percent, respectively.

Icebergs used to establish the limit are of critical importance because they define the boundary for ice-free ship navigation. As a result, the majority of IIP's reconnaissance missions focus on this boundary. IIP flights accounted for 38.1% of all limit-setting iceberg sightings or detections as shown in **Figure 2, Column 4.** Commercial and satellite reconnaissance also made significant contributions to sightings of limit-setting icebergs, 29 and 19 percent.

Satellite Reconnaissance Research

IIP contracted Science Applications, Inc. (SAIC) to conduct a study to assess the feasibility of using satellites to conduct iceberg reconnaissance. The intent of the study was to evaluate which satellites might be able to detect icebergs now, in 2015, and by 2020. Cost estimates for the IIP's coverage requirements were documented for the three best satellite candidates (Radarsat-2, TerraSAR-X and COSMO-SkyMed).

Findings from the report show that none of the current satellite providers can fully meet the spatial and temporal requirements. The primary shortcoming is that the satellites available today cannot meet the IIP requirement of 95% probability of detection for small icebergs, particularly in higher wind states. Distinguishing between icebergs and vessels is also a significant challenge. Cost estimates show that acquisition of satellite Synthetic Aperture Radar (SAR) data for iceberg reconnaissance is competitive with aerial reconnaissance.

Ideally, satellites could continually saturate the IIP area of responsibility at a resolution high enough to detect small icebergs with greater than 95% probably of detection. Unfortunately, there are not enough SAR satellites to accomplish this. There is a trade-off between image resolution and footprint coverage that must be optimized. In addition, in the region IIP is interested in, there is a high level of competition for SAR imagery from other users.

In step with the recommendations from the space-borne reconnaissance study, and in pursuit of documenting what is currently available from satellites, a significant focus was put on satellites in 2011. **Figure 3** schematically shows the process followed to acquire satellite information for incorporation into IIP daily operations.

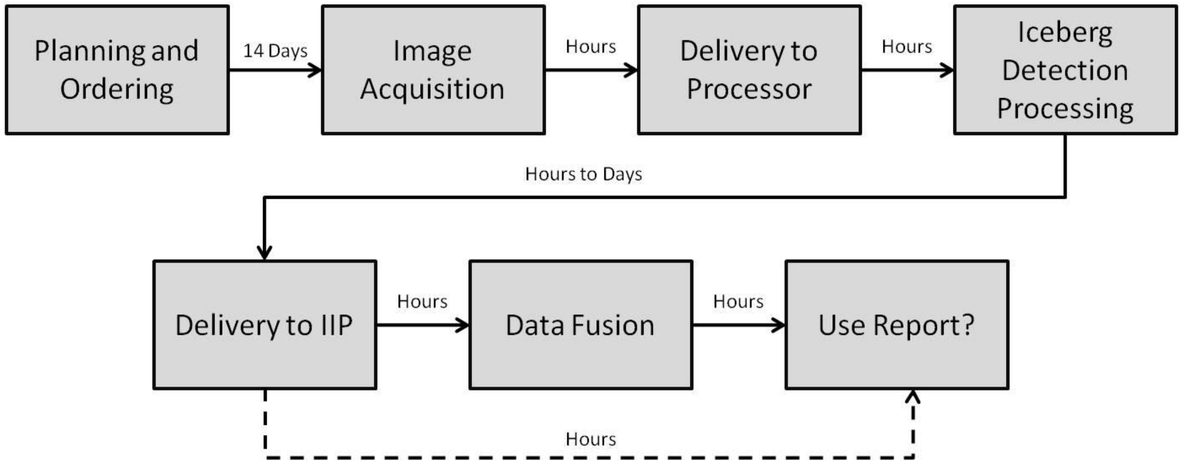


Figure 3. Satellite ordering and use flow chart.

The planning process starts at least two weeks prior to the scheduled image acquisition. A specialized software package (used by C-CORE, NIC and CIS) displays available images for ordering. Since IIP does not have the organic capability to accomplish this, C-CORE assisted in providing a list of available images in the area of interest.

Through the support of PolarView (the European Space Agency funded earth observation program focused on the use of satellites for the Arctic and the Antarctic regions) and C-CORE, IIP ordered 81 Radarsat-2 (RSA2) images for acquisition and processing. These images were used operationally, as well as to conduct an assessment of the reliability of satellite reconnaissance. NIC further supplemented this image tally by funding 100 TerraSAR-X (TSX) images. Thanks to the funding by PolarView and NIC, images were plentiful. Processing the imagery by C-CORE ended up being the funding shortfall (80 images funded by PolarView). To supplement the number of images available for processing, IIP contracted C-CORE to complete 50 additional images at a cost of approximately $420/image (contracted processing was to assist in an assessment of current SAR capabilities, images were not used operationally due to time latency). In addition to these two primary sources, IIP received SAR derived iceberg products from images ordered by CIS, the offshore oil industry and the Canadian Government. All together, IIP received 109 satellite messages from three different satellites, Radarsat-1 (RSA1), RSA2, and TSX, using various modes of search.

Considering the retreat of the sea ice edge and the southward motion of icebergs, IIP's Oceanographer assisted the Ice Information Officer in ordering images where icebergs were likely to be in the next two weeks. These orders were provided to C-CORE for submission. Early in the season, many orders were not executed due to competition with other users. C-CORE negotiated to maximize the acquisition of higher priority images desired by IIP (coincident or underflight).

Once an image is acquired, the information relevant for icebergs must be extracted. Currently, the most efficient and systematic method available to accomplish this task is through C-CORE's Iceberg Detection Software (IDS). This program scans the image to identify potential targets. Once potential targets are identified, basic statistical comparisons are done with a database of ships and iceberg targets to determine what type of contact it is most likely to be. C-CORE applied its IDS and quality checked results before providing iceberg information to IIP.

The output from C-CORE is a coded message that is directly ingested to BAPS. When possible, the IIP watchstander would evaluate other sources of vessel information to minimize potentially improperly classified targets (icebergs classified as ships). At this point, the IIP watchstander considers the iceberg population in the model and the quality of the image based on parameters reported by C-CORE. All, some, or none of the targets will then be incorporated (added or re-sighted) into the model. The dotted line between “Delivery to IIP” and “Use Report?” steps indicates the ideal end-state where satellite availability and resolution reliably differentiates ships from icebergs based on imagery alone.

These messages contained 1861 reports of icebergs, 36.4% of the total icebergs reported in 2011. These reports were analyzed and processed, with assistance from Maritime Intelligence Fusion Center Atlantic (MIFC LANT) and ship information reports IIP received from other sources, allowing IIP to add or re-sight 1379 icebergs, showing a presumed accuracy rate of 74.1%. Of the 1379 icebergs used, 119 of them were used to set the Iceberg Limit, and accounted for 19.4% of the total limit-setting bergs.

Efforts were made to ground-truth the SAR derived products with coincident IIP reconnaissance flights (5 events were scheduled). Due to inclement weather restraints and plane casualties, IIP was unable to conduct any of the planned simultaneous underflights. IIP will continue to pursue underflights when operationally possible. Additional innovative means of quantifying the reliability of iceberg detection by satellites are being pursued by comparing images from different satellites acquired coincidently (at the same time and area). This data is further being compared with vessel position information.

Historical Perspective

To determine the severity of the Ice Season, IIP uses two traditional measurements. The first measurement is the number of icebergs crossing south of 48°N. This number includes icebergs initially sighted or detected south of 48°N as well as those originally sighted or detected further north of that latitude and drifted south, as modeled by BAPS. The second measurement is season length, measured in the number of days daily products were issued. Now that IIP issues daily products year-round, season length will be measured by the number of days there were icebergs (modeled or sighted) south of 48°N.

In 2011, only 3 icebergs (not including bergy bits or growlers) were modeled to have drifted south of 48°N (none were sighted or detected). These modeled icebergs were only present from 02 – 27 May, a period of 25 days. This is the fifth time since 1983 (1999, 2005, 2006, 2010, and 2011) that icebergs did not reach the Grand Banks. The time period from 1983 through the present day represents IIP’s modern aerial reconnaissance era when using aircraft equipped with radars for iceberg detection became standard.

Canadian Support

Support to IIP by the Canadian Government was elevated to increased levels this year resulting from the Iceberg Chart Harmonization. CIS continued to share valuable reconnaissance data, including iceberg and information reports from Canadian Coast Guard and Canadian Forces assets, environmental data from the Canadian Meteorological Centre, and their sea ice and iceberg expertise.

IIP also appreciated the critical support from PAL who continued to share valuable ice observation data. Their reconnaissance flights for CIS and the Canadian Department of Fisheries and Oceans provided critical information on the iceberg population.

IIP thanks C-CORE for continuing to provide satellite-derived iceberg data and for their ongoing efforts to improve their iceberg detection capabilities.

Iceberg Reconnaissance and Oceanographic Operations

Ice Reconnaissance Detachment

The Ice Reconnaissance Detachment (IRD) is a sub-unit under Commander, International Ice Patrol which is partnered with Coast Guard Air Station Elizabeth City (ECAS). During the 2011 Ice Season, seven IRDs deployed to observe and report icebergs, sea ice, and oceanographic conditions on and near the Grand Banks of Newfoundland. All observations were transmitted to the IIP OPCEN in New London, CT where they were entered into BAPS and processed. IIP's ice products were created and distributed to mariners operating in IIP's area of responsibility as described in the **Summary of Operations** chapter.

Throughout the 2011 Ice Season, IRDs operated out of IIP's base of operations in St. John's, Newfoundland for a total of 55 days conducting 18 iceberg patrols. The Pre-Season IRD departed on 07 February to conduct training and official meetings with IIP partners in Elizabeth City, North Carolina and St. John's, Newfoundland. The deployment also determined the early season iceberg distribution. The last IRD was conducted in mid-July, concluding the 2011 IIP deployments to Newfoundland. There were 11 patrols cancelled due to weather and 8 patrols cancelled due to maintenance. A summary of 2011 IRD operations is provided in **Table 1**.

IRD	Deployed Days	Iceberg Patrols	Transit Flights	Logistics Flights	Flight Hours
Pre	12	2	3	2	35.9
1	Cancelled				
2	9	3	2	0	30.5
3	Cancelled				
4	9	3	2	2	34.4
5	Cancelled				
6	9	4	4	0	49.6
7	Cancelled				
8	7	2	2	0	23
9	Cancelled				
10	6	2	2	2	35.9
11	5	2	2	0	23.2
TOTAL	**55**	**18**	**17**	**6**	**232.5**

Table 1. Summary of IRD operations.

Aerial Iceberg Reconnaissance

Due to the consistent inclement environmental conditions in IIP's AOR, detecting and classifying targets is an ongoing challenge for IRDs. It is for this reason that the use of radar is critical to IIP operations. In times of reduced visibility, IIP relies heavily on the detection and classification capability of the ELTA-2022 radar as the primary means of conducting iceberg reconnaissance. In no-visibility conditions, the IRD relies on ELTA's imaging capability as the primary means of classifying targets.

The majority of 2011 aerial iceberg reconnaissance operations were conducted using HC-130J, long-range reconnaissance aircraft with cold weather capabilities provided by ECAS. In addition to the HC-130J, the IIP used the HC-144A medium-range reconnaissance aircraft. IRD 6 employed an HC-144A provided by Coast Guard Aviation Training Center (ATC) Mobile. In preparation for conducting more IRDs from the HC-144A platform, an HC-144A appendix summarizing IRD operations from the HC-144A is under development and will be included in the 2012 IRD Standard Operating Procedures.

The HC-130J aircraft is equipped with the ELTA-2022 360° X-Band Radar capable of detecting and classifying surface targets and the APN-241 Weather Radar capable of detecting surface targets but not classifying them. The HC-130J is also equipped with an Automated Information System (AIS) receiver as an integrated component of the HC-130J mission system to assist in target discrimination. The HC-144A aircraft is equipped with a Telephonics APS-143 360° Radar capable of detecting and classifying surface targets, and is also equipped with an AIS receiver in a similar configuration as the HC-130J to assist in target discrimination.

The IIP conducted 18 patrols with 125.8 patrol hours, experiencing only 3.6 hours of mission system down time and no visual only patrols. This number means that the IRD patrolled without a mission system for only 2.8% of actual patrol time. This is consistent with the 2010 ice season and a marked improvement from the 2009 season in which 68% of IIP patrols were visual only patrols.

The availability of 360° coverage provided by the ELTA radar allowed IIP to use 25 NM track spacing (**Figure 4**). This is an increase of 5 NM from 20 NM track spacing as a result of the HC-130J Ice Patrol Suitability Test Report of 20 February 2009 which determined that the ELTA detects iceberg sized targets with greater than 95% cumulative probability of detection with 25 NM track spacing. IIP maintained 25 NM track spacing throughout the season in an effort to maintain the integrity of patrols as further data analysis and probability of detection testing of the ELTA-2022 radar is conducted.

In 2011, IRDs detected a total of 549 icebergs. Icebergs are detected three different ways: (1) combination of radar and visual, (2) radar only, and (3) visual only. Nearly 48% of the icebergs were detected by the first method. The remaining icebergs were either detected by radar only (37%) or by visual only (15%) (**Figure 5**). Icebergs can be detected by visual only on both visual only patrols (patrols with visibility but no working radar) and radar and visual patrols (patrols with visibility and a working radar).

2011 Flight Hours

In addition to the 18 iceberg patrols flown during the 2011 Ice Season, 17 transit flights were conducted from ECAS and ATC Mobile to and from St. John's, Newfoundland. Three of those transit flights were conducted during the Pre-Season IRD to conduct training and meetings at ECAS in preparation for the Ice Season. Due to the range and speed limitations of the HC-144A, four transit flights were conducted during IRD 6: (1)

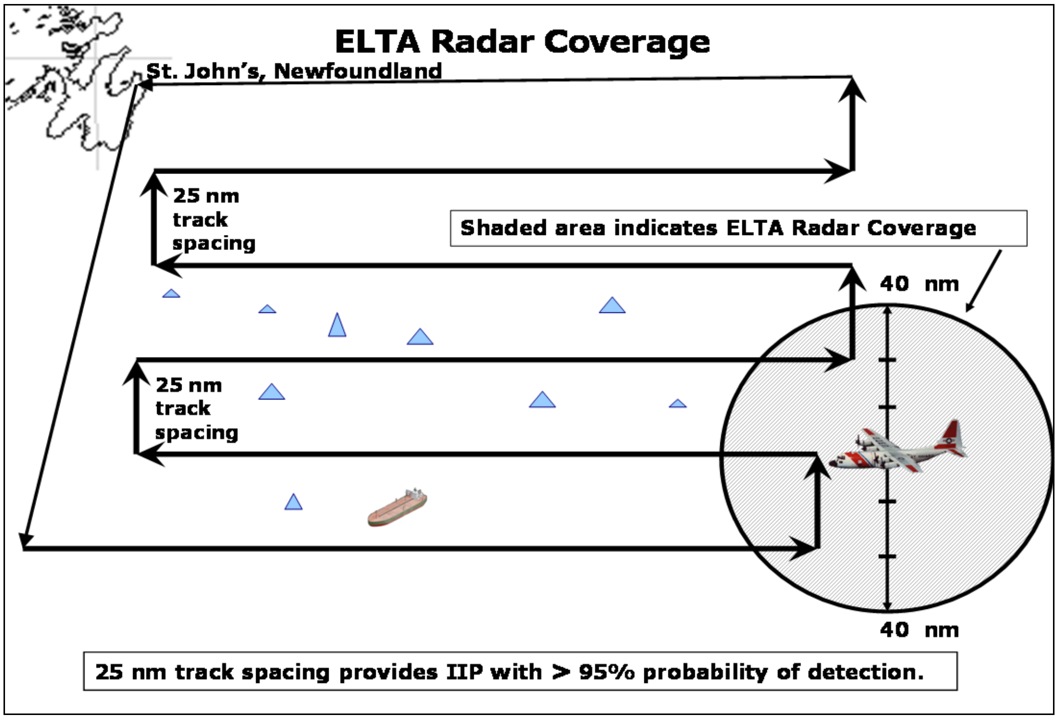


Figure 4. Radar reconnaissance plan.

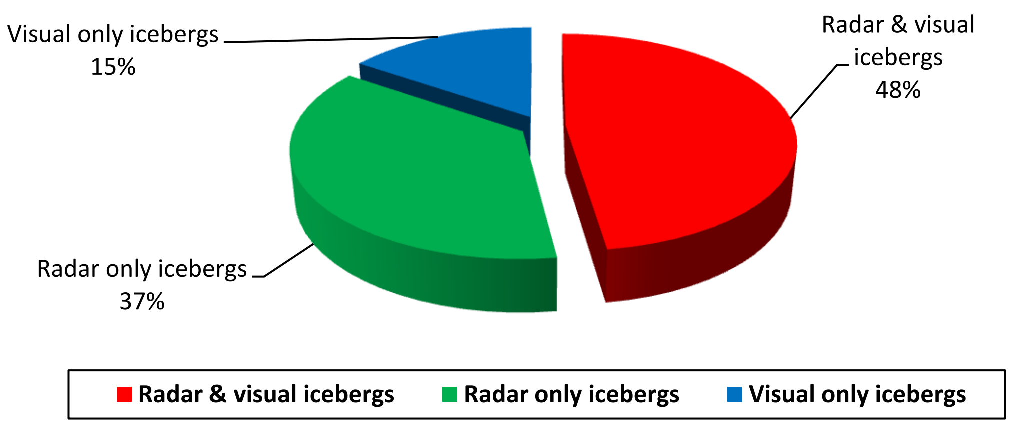


Figure 5. Breakdown of icebergs by detection method.

Mobile to Groton via ECAS to pick up cold weather gear, (2) Groton to St John's, and (3) and (4) were the return flights. The numbers depicted in **Figure 6** are the breakdown of the 232.5 flight hours used during the 2011 Ice Season for IIP operations. The flight hours are broken down into three categories; transit hours, patrol hours, and logistics hours. This is a change from recent IIP Annual Reports that used five categories of flight hours. The main reason for the change was to show only flight hours the IIP used. Specifically excluded from this year's report are research hours and D1 patrol hours because research hours are nearly synonymous with patrol hours and D1 patrol hours do not relate to the IIP mission. Transit hours are hours which were a direct result of the aircraft transiting to and from specific locations in support of the IIP Mission. Patrol hours are those which were used patrolling for icebergs in the IIP's OPAREA. Logistics hours are classified as aircraft hours which were used to support the overall mission of the IIP, but do not fall into the previous two categories. Logistics hours are generally used to transport parts for an aircraft which has been designated for use in the execution of the IIP mission. A comparison of flight hours to number of icebergs that drifted south of 48°N from 2002 to 2011 is shown in **Figure 7**. For the second year in a row, First Coast Guard District (D1) did not request that IIP conduct Northwest Atlantic Fisheries Organization (NAFO) sightings coincident to iceberg patrols.

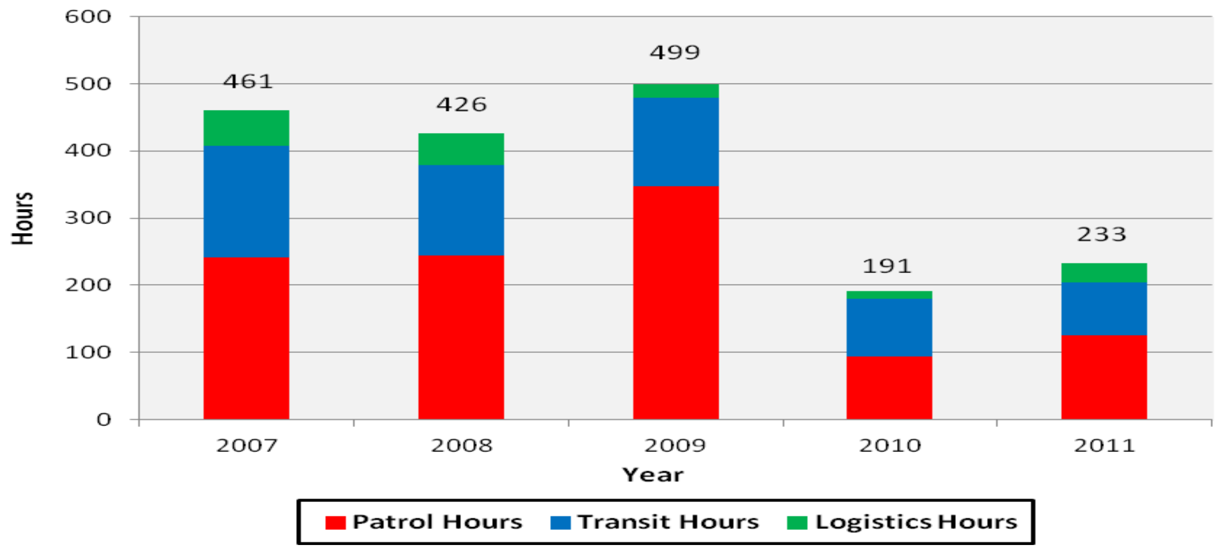


Figure 6. Summary of flight hours (2007-2011).

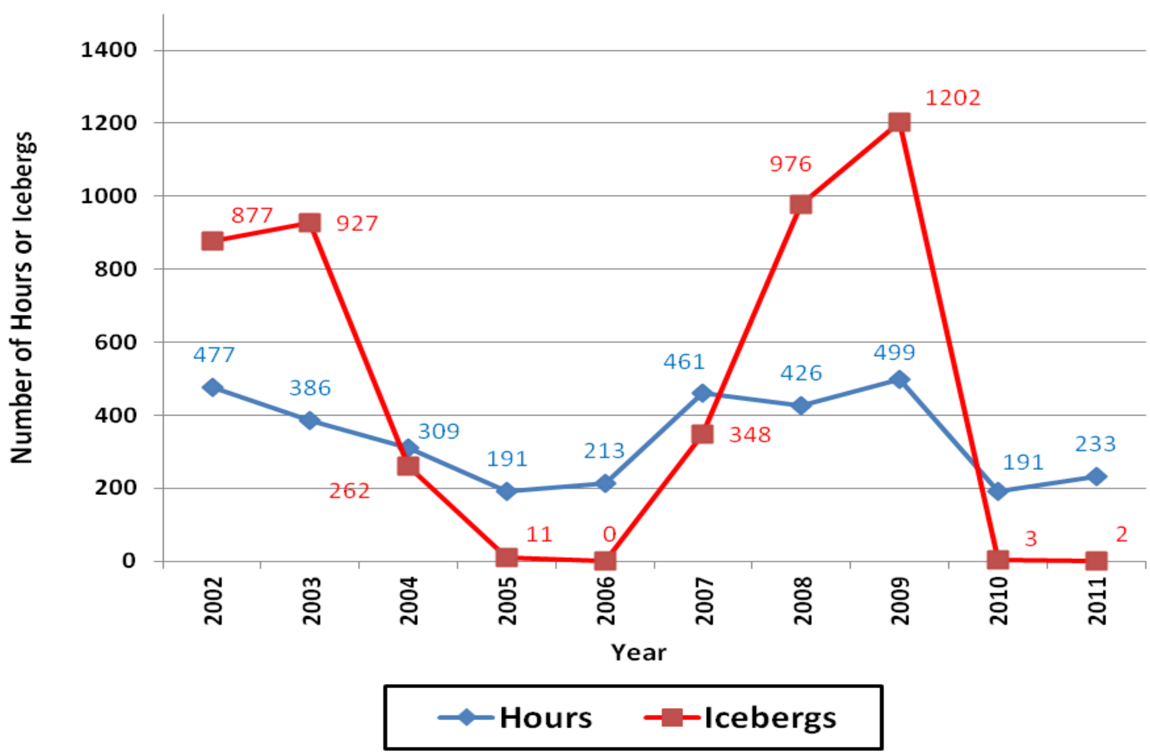


Figure 7. Flight hours versus icebergs south of 48°N (2002-2011).

Reconnaissance Challenges

The Grand Banks are a productive fishing ground frequented by fishing vessels, ranging from 20 to over 70 meters in length. Even in low sea states, determining whether an ambiguous radar contact is an iceberg or a stationary vessel is particularly difficult. These contacts (small vessels and ice) often present similar radar returns and cannot easily be differentiated. Therefore, when a radar image does not present distinguishing features, the IRD classifies the contact as a radar target (RT) in hopes of being able to identify it on a subsequent pass or patrol. In the 2011 Ice Season, the IIP did not classify any radar targets.

In addition, the oil industry continues to develop the Grand Banks region for its oil reserves and new exploration is conducted daily. The escalated exploration and drilling have increased air and surface traffic in IIP's OPAREA, further complicating target identification. However, this difficulty is mitigated by information reports provided by this traffic. Reports from ships, aircraft, and drilling platforms greatly aid IIP in the creation of an Iceberg Limit that is as accurate and reliable as possible.

Oceanographic Operations

Throughout the iceberg season, IIP deploys drifting buoys on and near the Grand Banks of Newfoundland. The drifters provide near real-time ocean current information that is used to modify the historical current database within BAPS. This improves the accuracy of the iceberg drifts calculated by the model. The drifters also provide sea surface temperature (SST) information that is incorporated into an SST analysis product developed by the U. S. Navy. BAPS uses this product to estimate iceberg deterioration. Both the current data and other environmental data described in the Summary of Operations chapter are used by BAPS to forecast the drift and deterioration of icebergs on and near the Grand Banks of Newfoundland.

IIP uses two types of drifters based on the World Ocean Surface Experiment/Surface Velocity Program (WOCE/SVP) design. The types differ only in the location of the holey sock drogue. The first has a drogue centered at 50m, and the second at 15m. The drifters with drogues at 50m are deployed in the deep waters of the North Atlantic, most frequently in the offshore branch of the Labrador Current. This current brings icebergs southward along the edge of the continental shelf into the shipping lanes. The drifting buoys with the drogue centered at 15m, the standard WOCE/SVP drogue depth, are used to measure the currents in the shallower waters on the Grand Banks and in the inshore branch of the Labrador Current.

IIP uses its reconnaissance aircraft and ships of opportunity to deploy the drifting buoys. Air-deployments are conducted during reconnaissance missions using an air-drop package that is prepared by IIP and ECAS personnel. Air deployments are much more expensive than ship deployments because of lost reconnaissance time and the cost of the air-drop package, so they are conducted in areas where few ships transit. Ship deployments are conducted on or near the Grand Banks through a cooperative arrangement with CCG vessels operating out of St. John's, NL.

In 2011, IIP deployed nine WOCE/SVP drifting buoys and one Compact Air Launched Ice Beacon (CALIB). Three buoys were air-deployed from the IIP reconnaissance aircraft. An additional six buoys were deployed from vessels; four 15m and one 50m buoys were deployed from CCG vessels and one 50m buoy was deployed from the U.S. Coast Guard Cutter *Eagle*. The CALIB was air-deployed from the IIP reconnaissance aircraft in an attempt to track a Peterman Ice Island fragment. The air-deployment of the CALIB was carried out successfully, however, the CALIB was observed sliding into a deep, water filled crack on the ice island and no signal was received after deployment. The three air-deployed WOCE/SVP drifting buoys were deployed on the Grand Banks of Newfoundland in the offshore branches of the Labrador Current.

While the CALIB failed to provide any data, all nine WOCE/SVP buoys functioned properly and transmitted oceanographic data for sufficient durations; in fact, we continue to monitor one of these buoys in support of the Canadian Ice Service (CIS). The other four WOCE/SVP buoys have lost their effectiveness as related to the monitoring of currents in the area of the Grand Banks of Newfoundland: three have drifted well out of the effective area while one was caught in fishing gear and carried away by a vessel to shore. **Figure 8** shows 2007-2011 air and ship WOCE/SVP drifting buoy deployments. **Figure 9** depicts composite drift tracks for the WOCE/SVP drifting buoys deployed in 2011. Detailed WOCE/SVP drifting buoy information is provided in IIP's 2011 WOCE/SVP Buoy Track Atlas, available upon request from IIP.

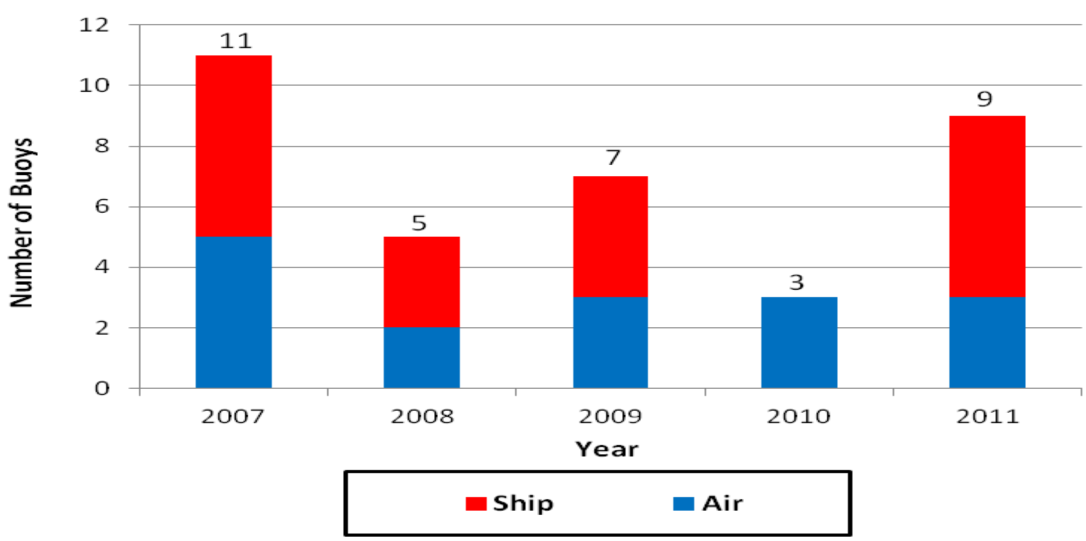


Figure 8. WOCE/SVP drifting buoy deployments (2007-2011).

Commemorative Wreath Drops

In conjunction with reconnaissance operations, IIP deployed several wreaths in 2011 to commemorate the sinking of the RMS *Titanic* and those lives lost in the execution of the Greenland Patrol. Three wreaths commemorating the 99th anniversary of the sinking of the *Titanic* were deployed on IRD 4. This year, the IIP held a memorial ceremony in honor of the Greenland Patrol at the USCG Academy in New London, Connecticut. The wreath used for this ceremony was later deployed during IRD 8.

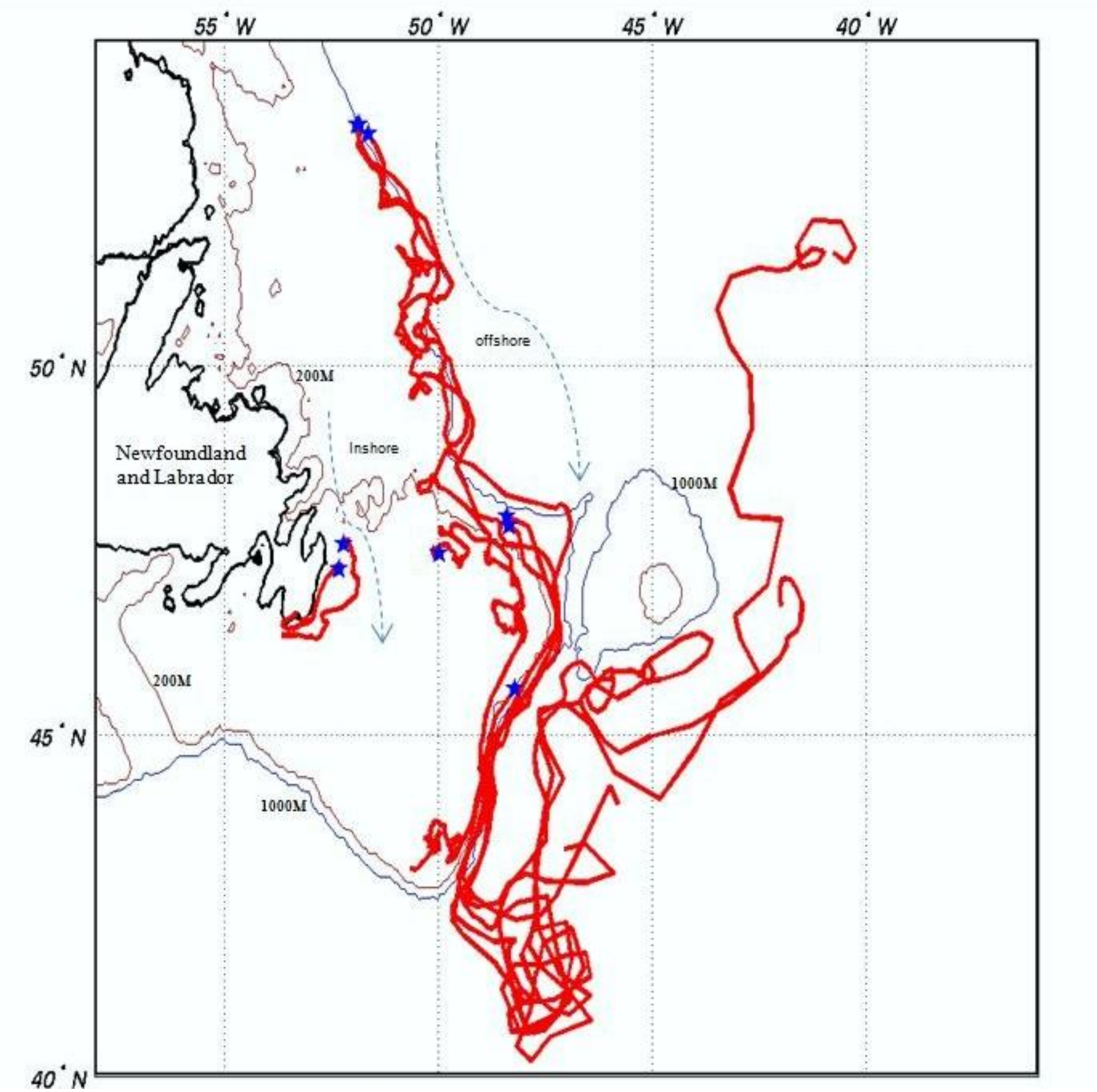


Figure 9. Composite buoy tracks. Blue stars indicate WOCE/SVP buoy deployment positions. Red tracks indicate individual WOCE/SVP buoy paths.

Ice and Environmental Conditions

Introduction

For the second year in a row, extraordinarily warm air temperatures in Labrador and southern Baffin Island dominated ice and environmental conditions during the winter. During the ice year (October 2010 – September 2011), no icebergs were detected south of 48^{o} N, although three icebergs were estimated by the IIP iceberg drift model to have moved south of 48^{o} N.

This section describes the progression of the ice year and the accompanying environmental conditions. The following month-by-month narrative begins in December 2010 as new ice began forming in the bays along the Labrador coast (**Figure 10**) and concludes in September 2011.

The narrative draws from several sources, including sea-ice and iceberg analyses provided by the Canadian Ice Service (CIS) and the U. S. National Ice Center (NIC); sea-surface temperature (SST) anomaly plots provided by the National Oceanic and Atmospheric Administration's National Weather Service (NOAA/NWS, 2011a); and summaries of the iceberg data collected by the International Ice Patrol (IIP).

The progress of the ice year is compared to observations from the historical record. The sea-ice historical data are derived from the *Sea Ice Climatic Atlas, East Coast of Canada, 1981-2010* (CIS, 2011a). The average number of icebergs estimated to have drifted south of 48°N for each month was calculated using 111 years (1900 through 2010) of IIP records (**Appendix D**). Sea-level pressure data are from the National Centers for Environmental Prediction/National Center for Atmospheric Research (NCEP/NCAR) Reanalysis dataset (Kalnay et al., 1996) and the United Kingdom's Meteorological Office (Met Office, 2011).

Pre-season Predictions

On 2 December 2010 CIS issued the pre-season sea-ice forecast for east Newfoundland waters (CIS, 2010). It predicted below average sea-ice extent and thickness at the peak of the season and a faster-than-normal retreat. This outlook was based on the seasonal temperature forecast that predicted normal to above-normal temperatures along the Labrador coast and over Newfoundland waters during January and February. The forecast was for the southern ice edge of the main ice pack to:

- enter the northern reaches of the Strait of Belle Isle by 1 January
- arrive in the vicinity of Fogo Island in the first week of February
- reach Cape Bonavista during the last week of February
- begin a faster-than-normal retreat in early March.

From 11-25 October 2010, CIS conducted a census of the iceberg population off the southern coast of Baffin Island. It was based on radar images from two satellites, RADARSAT-1 and 2 (Desjardins, 2010). The resulting iceberg count was 100, very few of

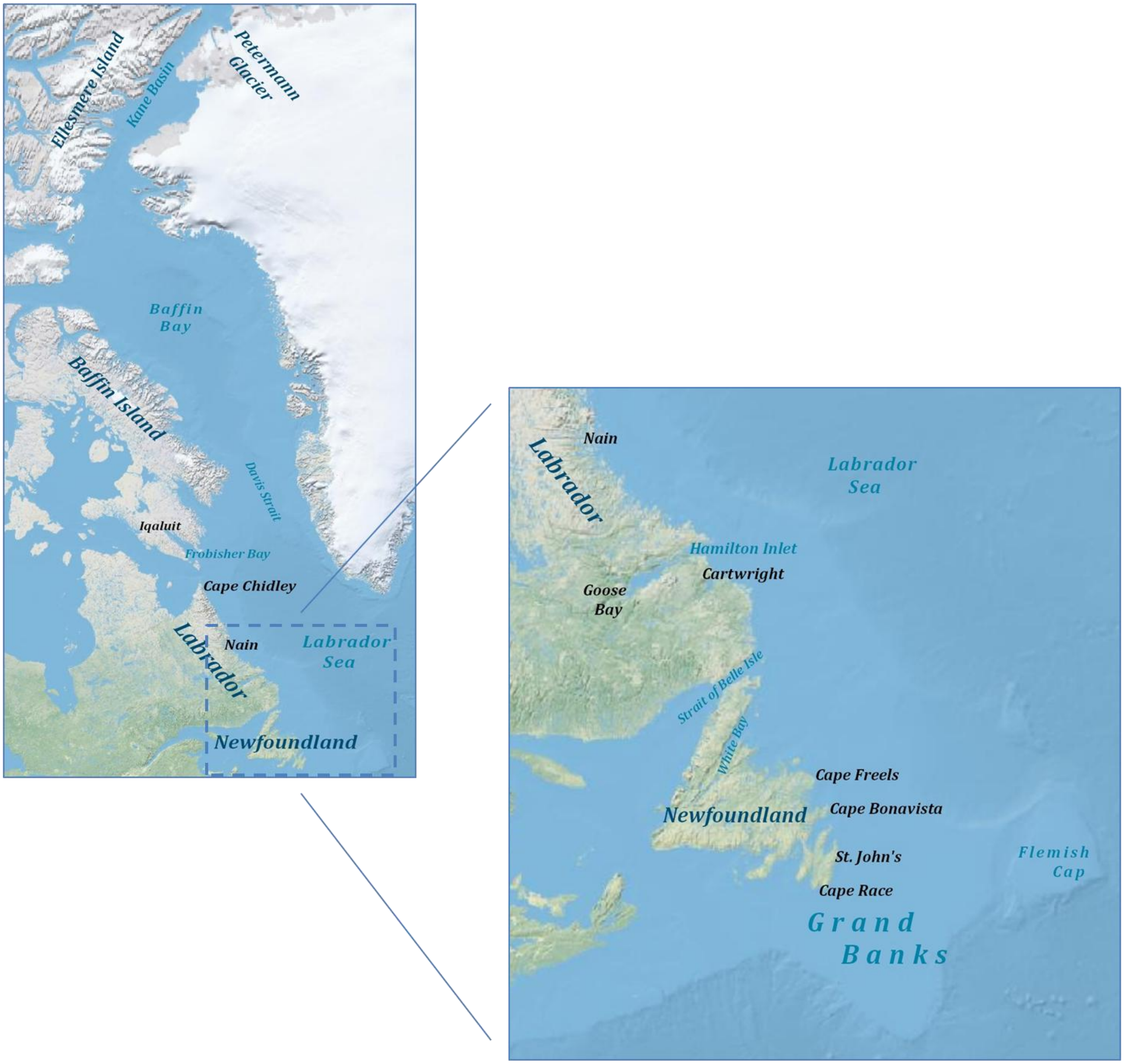


Figure 10. IIP OPAREA

which were in the deep offshore waters. The October 2010 count broke the previous year's record for the lowest CIS fall iceberg count in the survey's eleven-year history. Based on the forecast of less-than-normal sea-ice extent on the Grand Banks, warmer-than-normal SST off the northern Labrador coast, and the scant iceberg population observed in October, Desjardins (2010) predicted a season with fewer than 500 icebergs passing south of 48°N. He also noted that it was likely that fragments from the Petermann Ice Island would arrive in the vicinity of Newfoundland during the summer and fall months.

Petermann Ice Island

By far, the largest single contributor to the iceberg population seen near Labrador and Newfoundland in 2011 was the ice island calved from the Petermann Glacier (**Figure 11**) on 5 August 2010 (CIS, 2011b). When it left the Petermann Fjord, the ice island was approximately 82 nm^2 (~280 km^2), more than four times the size of Manhattan Island, NY. Over the following year, ice-island fragments scattered along 1800 nm of Canada's east coast, from the Kane Basin, which is between Ellesmere Island and Greenland, to White Bay on Newfoundland's northern coast. During the spring and summer, two major Petermann Ice Island (PII) fragments, designated PII-A and PII-B-b, moved southward along the Labrador Coast eventually reaching the northern Newfoundland coast. Along the way they calved hundreds of fragments that interfered with marine traffic along the Canadian east coast and through the Strait of Belle Isle. Many of the larger fragments were tracked by CIS (CIS, 2011b).

Figure 11. Image from the Moderate Resolution Imaging Spectroradiometer (MODIS) on NASA's Aqua satellite acquired on 5 August. 2011. (http://www.nasa.gov/topics/earth/features/petermann-calve.html) Red circle indicates Petermann Ice Island.

December 2010

Persistent onshore winds (**Figure 12**) and warmer-than-normal SST in the central Labrador Sea (**Figure 13**) combined to bring record-breaking warmth to southern Baffin Island and northern Labrador (**Figure 14**). Iqaluit, NU observed a monthly average air temperature anomaly of 14.3°C above normal, while Nain, NL was 9.9°C above normal (Environment Canada, 2011a).

The warm conditions dramatically slowed sea-ice development during the month. By month's end, about three weeks later than normal (CIS,2011c), new ice began forming in the bays along Labrador's coast. Meanwhile, the southern edge of the main ice pack reached the entrance of Frobisher Bay in southern Baffin Island, over 600 nm north of its normal position for the date.

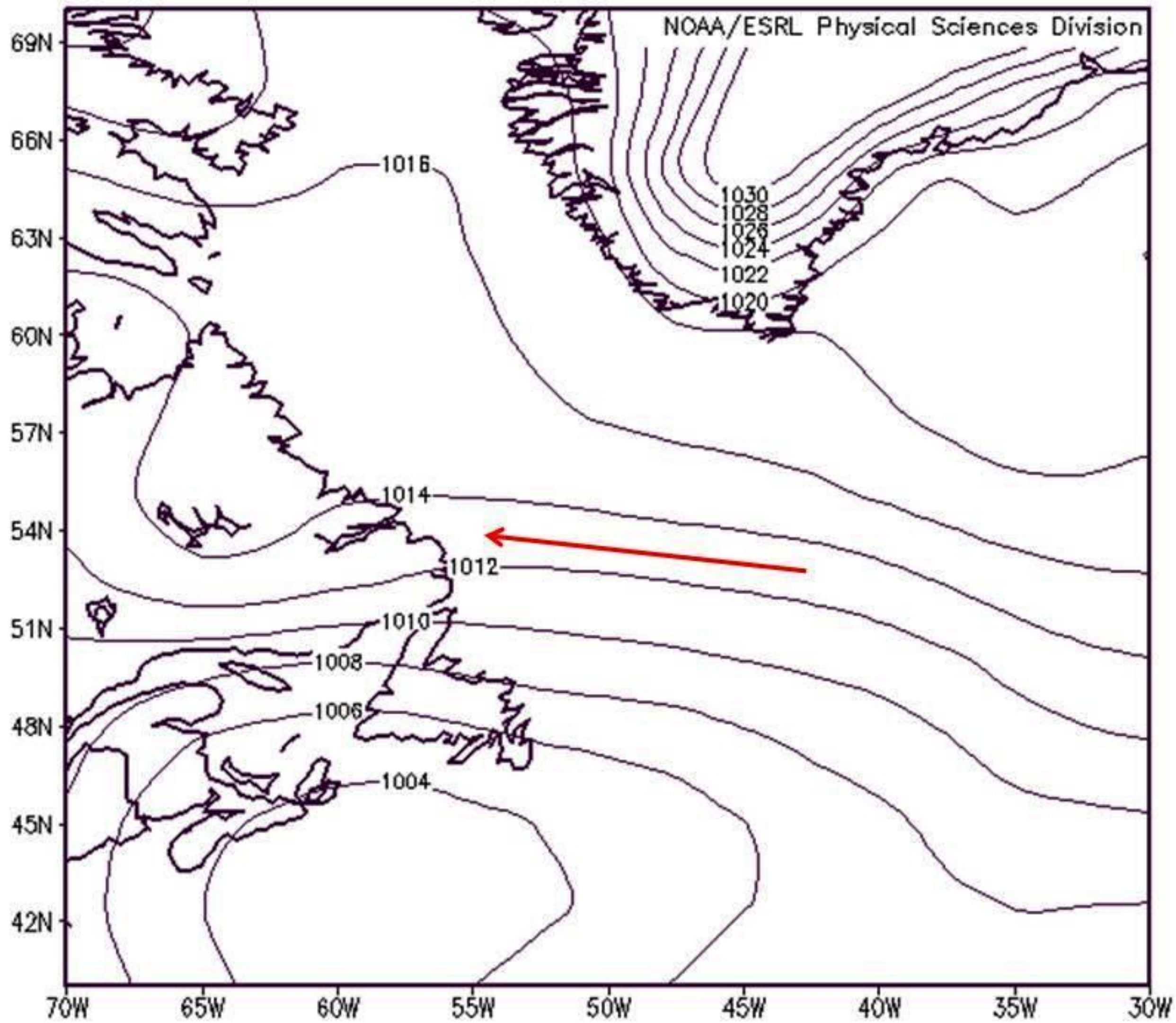


Figure 12. Mean sea-level pressure for 1 to 31 December 2010. Image provided by the NOAA/ESRL Physical Sciences Division, Boulder Colorado (http://www.esrl.noaa.gov/psd/). Red arrow indicates approximate wind direction.

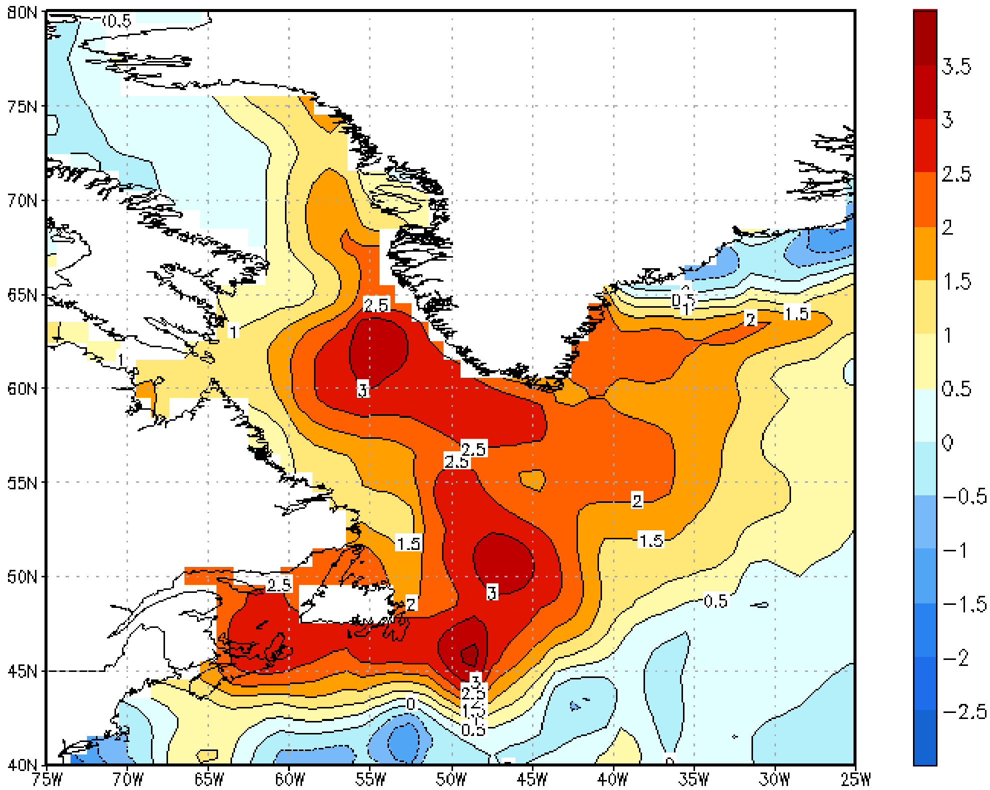


Figure 13. Mean SST anomaly for December 2010 in degrees C. (NOAA/NWS, 2011a).

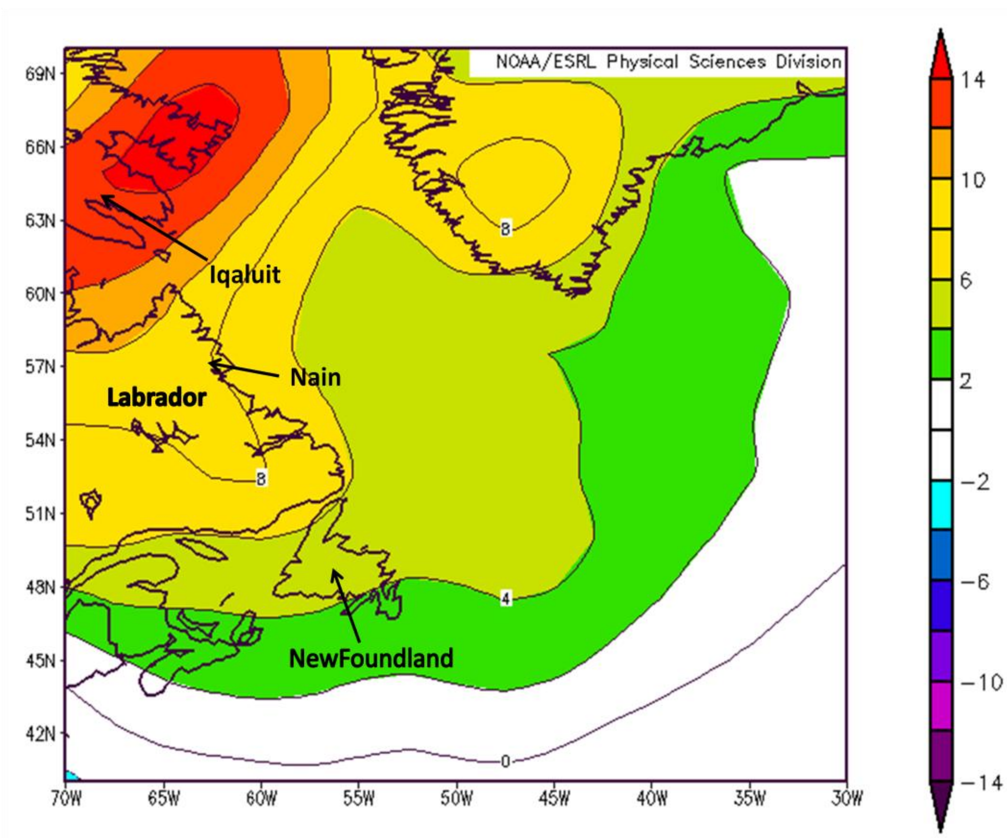


Figure 14. Air temperature anomaly for 1 to 31 December 2010. Image provided by the NOAA/ESRL Physical Sciences Division, Boulder Colorado (http://www.esrl.noaa.gov/psd/)

January 2011

Unusually warm air and SST conditions persisted along the Labrador coast in January. Average air temperatures for the month were from 7.8° C to 8.8° C above normal in Nain, Goose Bay, and Cartwright. Adjacent to the coast the SST anomaly was about 1° C -2° C above normal, while in the central Labrador Sea it was 3° C above normal (NOAA/NWS, 2011a).

At the end of the month, about seven weeks later than normal, the leading edge of the main ice pack reached Cape Chidley, the northernmost point of Labrador. In most years, the main pack reaches the Strait of Belle Isle in January prompting the Canadian Coast Guard (CCG) to recommend that the strait not be used by transatlantic shipping until the ice departs. The mild sea-ice conditions in 2011 made this recommendation unnecessary.

Late in the month, a strong blocking high pressure system set up in the eastern North Atlantic. Tracks of the storms leaving North America were forced northward along the Labrador Coast toward Davis Strait. On 25 January a particularly intense storm (**Figure 15**) brought strong winds and high seas to the region. Without the normal protective sea-ice cover, icebergs in the region were exposed to greater-than-normal deterioration.

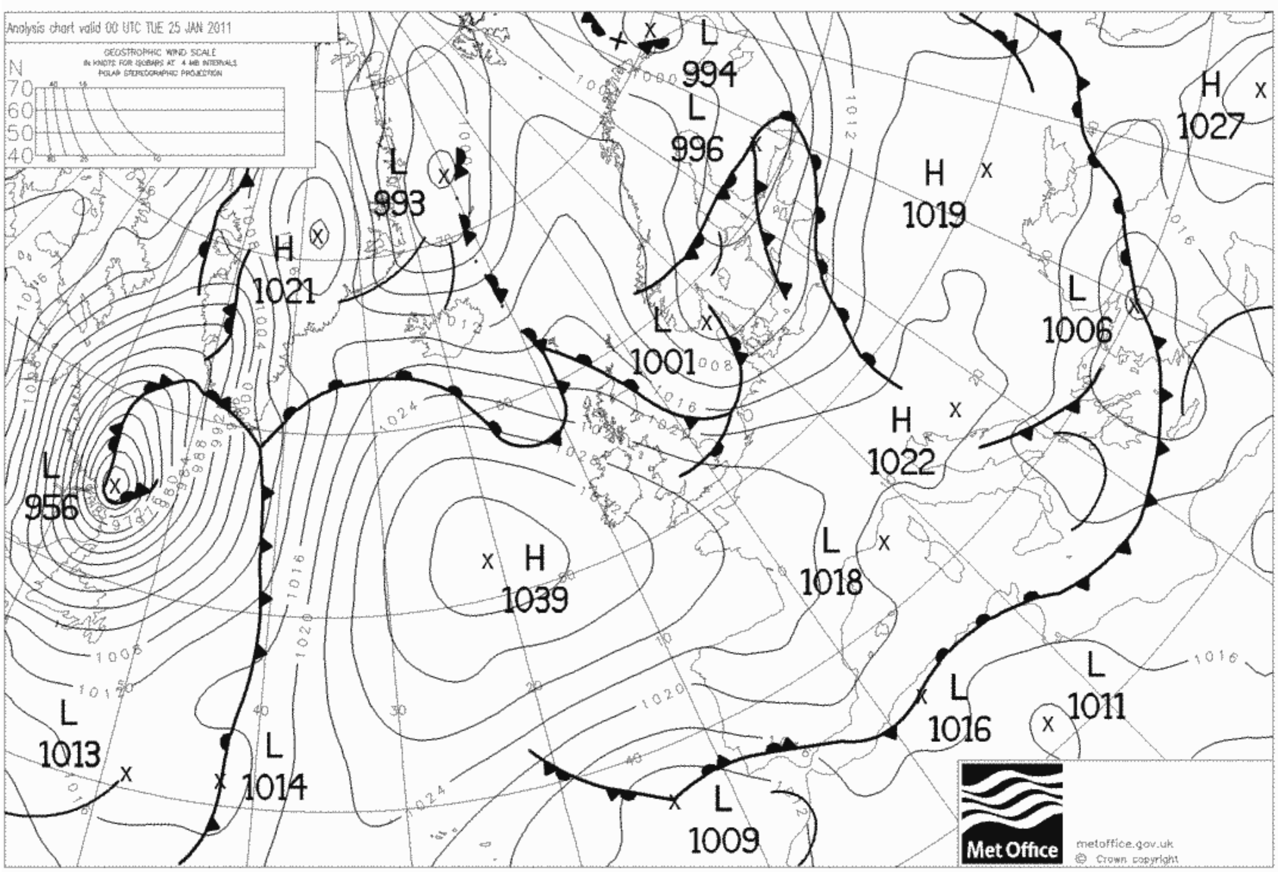


Figure 15. Sea-level pressure for 25 January 2011. (Met Office, 2011)

February 2011

During February, air temperatures in Newfoundland and Labrador returned to near-normal conditions. St John's, Cartwright, and Goose Bay recorded monthly average air values within a degree of normal.

On 5 February, about five weeks later than normal, the southern ice edge moved into the Strait of Belle Isle where it lingered for most of the month. By month's end the ice edge starting moving southward along Newfoundland's northern peninsula. At this time the sea ice extent in eastern Newfoundland waters was far less than normal (**Figure 16**).

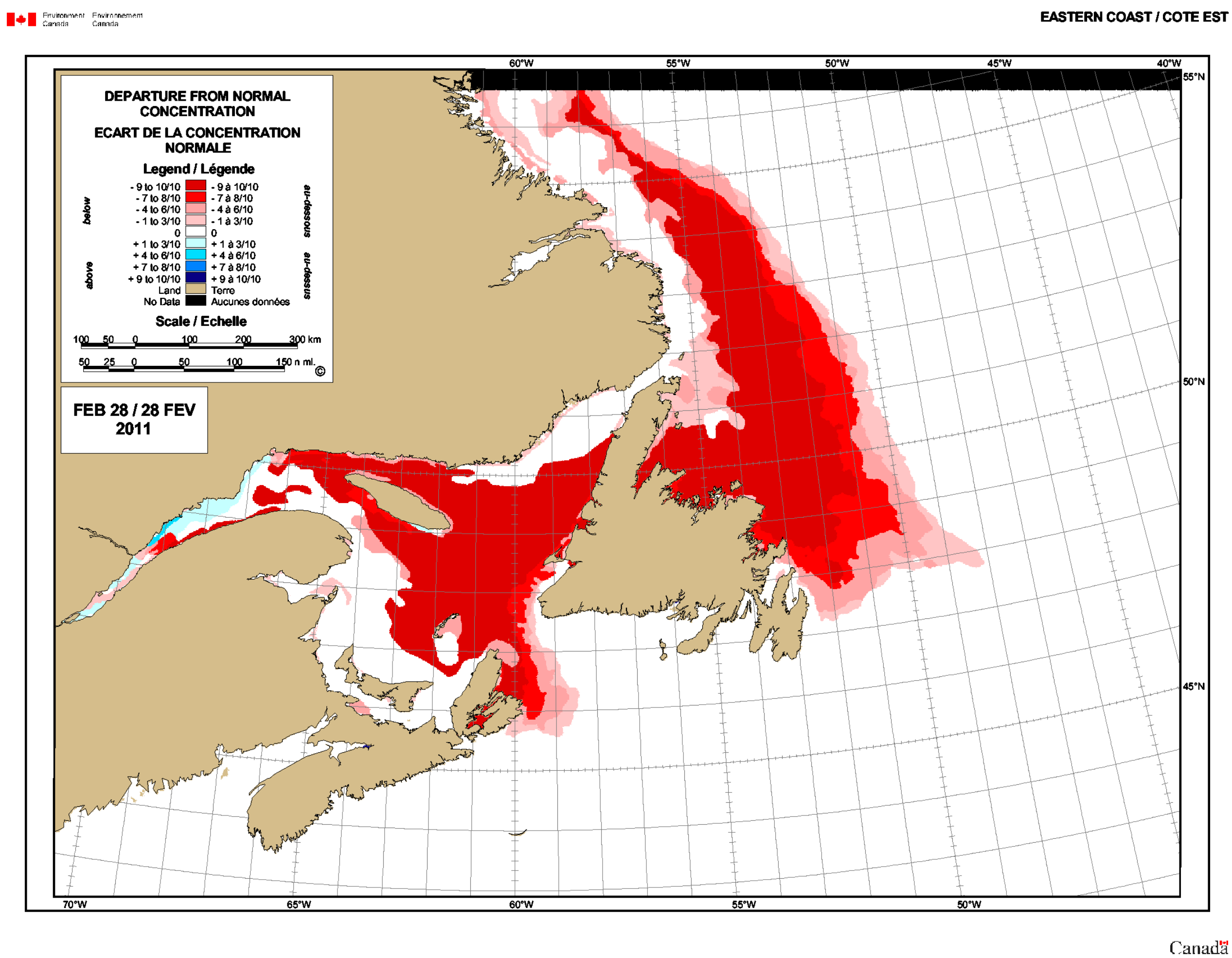


Figure 16. Departure of sea ice from normal on 28 Febuary 2011. The various shades of red indicate areas where there was less sea ice than normal. The white areas near shore indicate regions of normal sea-ice concentrations. Map Courtesy of the Canadian Ice Service.

Over a two-week period from 12-26 February five aerial reconnaissance patrols, two by IIP's pre-season IRD and three by Provincial Aerospace, LTD (PAL), searched from the northern Grand Banks to northern Labrador. PAL is a commercial provider of ice monitoring services to the CIS and the offshore oil and gas industry. The flights in February were sponsored by CIS. The reconnaissance patrols located a small iceberg population, mostly in the sea ice north of Hamilton Inlet, Labrador.

March 2011

Near-normal air temperatures continued in Newfoundland and Labrador during March, with St. John's, Nain, and Goose Bay recording mean monthly values within a degree of normal. Cartwright recorded an air temperature anomaly 1.4°C above normal.

Sea-ice coverage in east Newfoundland waters continued to be far less than normal during the month. By 22 March the sea-ice extent reached its 2011 maximum, at which time the southern ice edge was approximately at the latitude of Cape Freels and the easternmost ice edge was 30 nm offshore. The normal position of the ice edge for the date is about 90 nm farther to the south and 110 nm farther offshore. The subsequent passage of two strong low-pressure systems, the second of which stalled near Newfoundland for several days, brought storm-force onshore winds to the province causing significant compaction of the sea ice against the Newfoundland and southern Labrador coasts. This reduced the extent of the sea ice on the northeast Newfoundland shelf dramatically and set the stage for the rapid retreat that took place in April.

Throughout March, IIP and CIS-sponsored PAL reconnaissance flights continued to monitor a small but growing population of icebergs in northeast Newfoundland waters and along the Labrador coast. By month's end 115 icebergs were being tracked, most in the sea ice north of 52°N. No icebergs passed south of 48°N during the month. For the 111 year period from 1900-2010, the average number of icebergs passing south of 48°N for the month of March is 61.

April 2011

During April, near-normal air temperatures prevailed in Newfoundland and southern Labrador with the monthly mean values within a degree of normal. Northern Labrador was somewhat cooler than normal, with Nain recording a mean temperature difference of -2.0°C.

Throughout the first half of the month, the sea-ice destruction accelerated such that by mid-month the seasonal retreat was three to four weeks ahead of normal (**Figure 17**). During the second half of April, the little remaining sea ice south of 52°N began to retreat northward, and by month's end, the only remaining sea ice was east of the Strait of Belle Isle.

At the beginning of April most of the iceberg population being tracked was within the sea ice, but the rapid sea-ice retreat throughout the month exposed the icebergs on the northeast Newfoundland shelf to increased deterioration. No icebergs passed south of 48°N during April. The 111-year average for the month is 124.

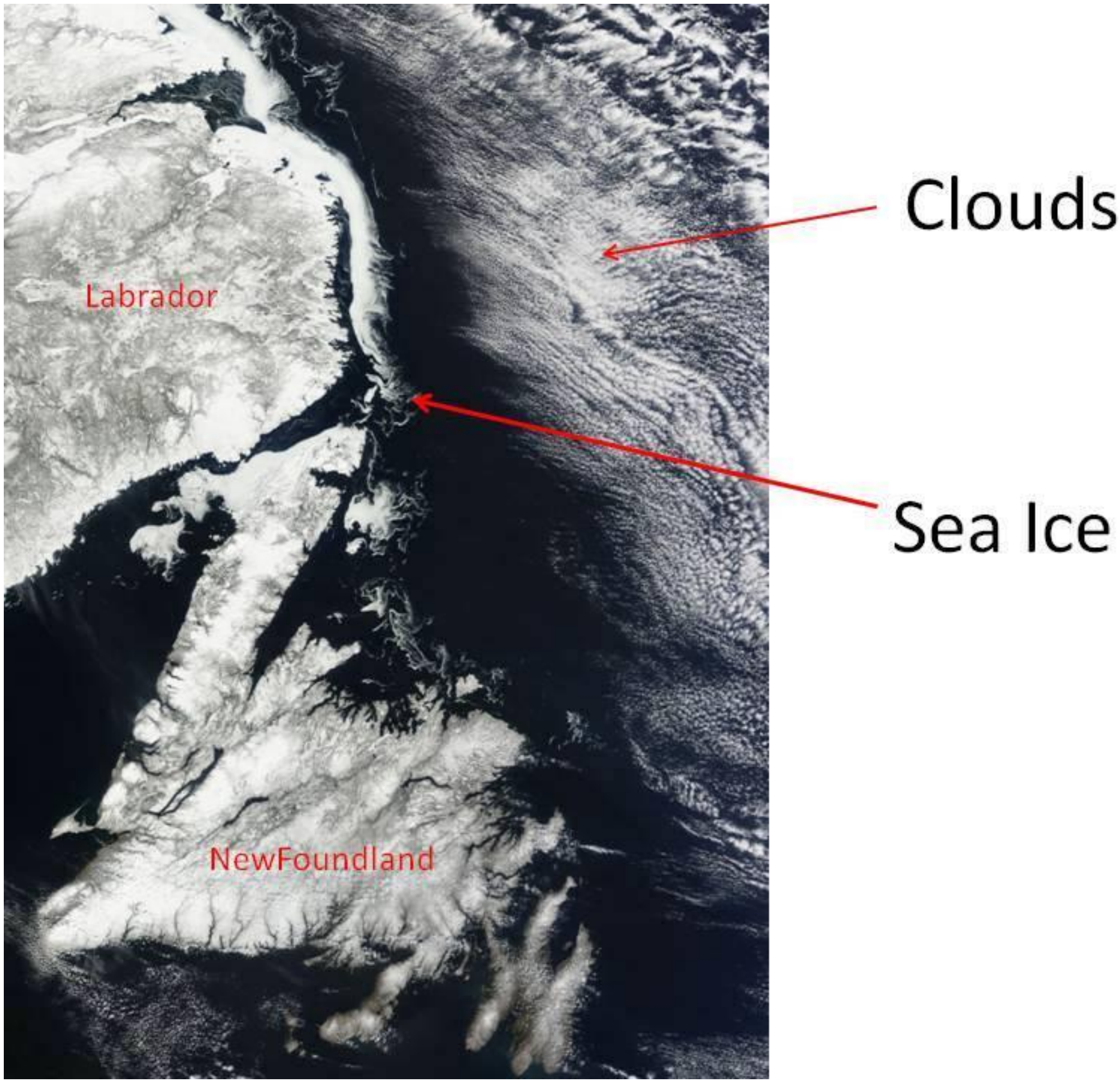


Figure 17. The Moderate Resolution Imaging Spectroradiometer (MODIS) aboard the Terra satellite captured this true-color image on 9 April 2011. Credit: NASA/GSFC/Jeff Schmaltz/MODIS Land Rapid Response Team.

May 2011

Near-normal air temperatures in Newfoundland and Labrador continued in May.

During the first half of the month, sea ice continued its northward retreat, and by mid-month the southern edge of the main pack moved to Cartwright, over 120 nm north of its normal position. Rapid sea-ice retreat continued during the second half of May, and by month's end the southern ice edge was near Nain.

As the sea ice departed the Labrador coast, it left a large population of icebergs in open water. Extensive and frequent aerial reconnaissance by PAL during the last two weeks of May found hundreds of icebergs off the southern Labrador coast between the Strait of

Belle Isle and Hamilton Inlet (**Figure 18**). Included in those icebergs was the leading edge of fragments from the Petermann Ice Island.

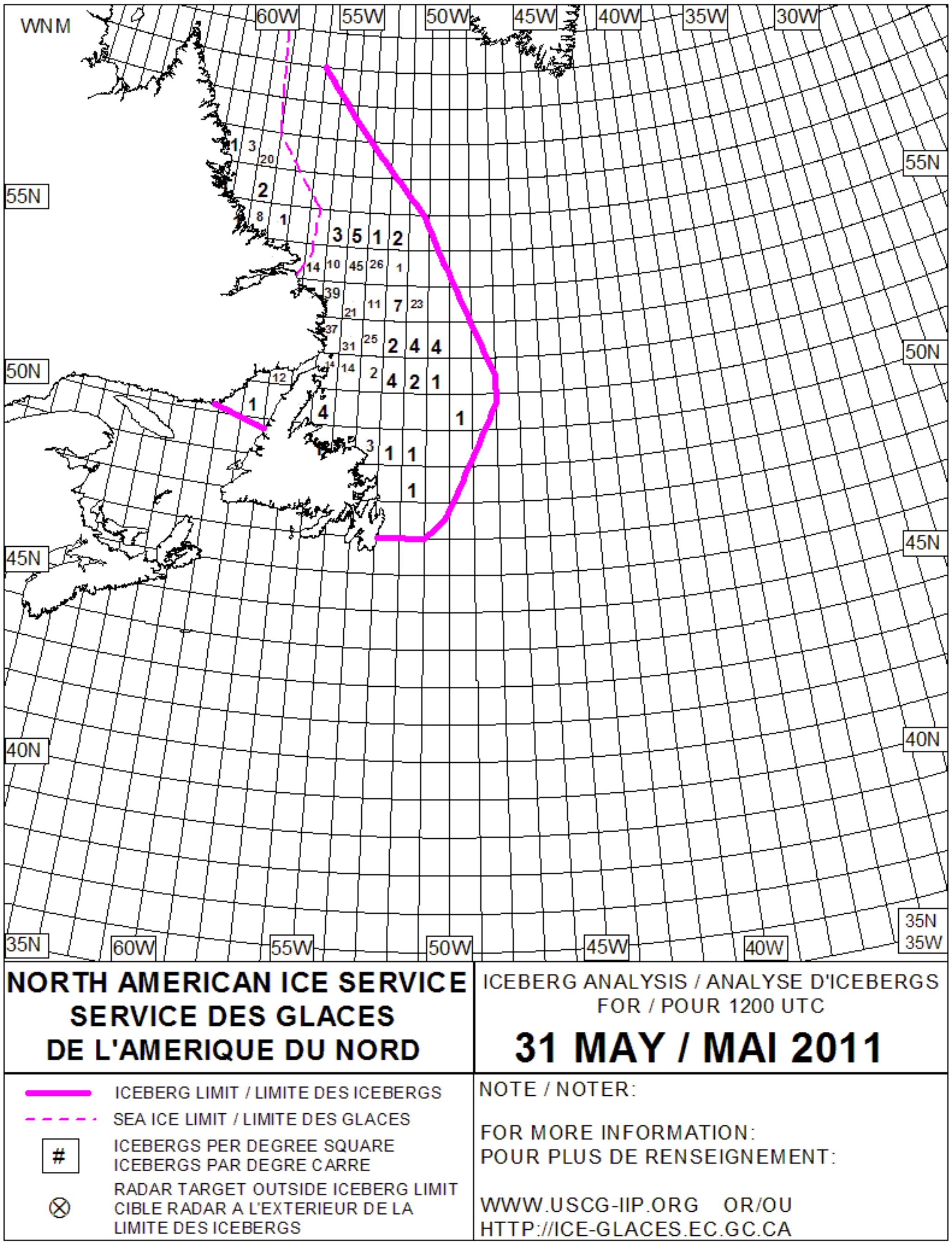


Figure 18. Iceberg distribution on 31 May 2011. The numbers indicate the number of icebergs within a 1° of latitude by 1° of longitude bin.

During May, no icebergs were observed south of 48°N, but IIP's iceberg drift model estimated that three passed south of that latitude. One, a small dry-dock iceberg, was estimated to have reached 47° 13.70' N, 47° 22.57' W, the southernmost predicted iceberg position for the year. The 111-year average number of icebergs for the month is 149.

June 2011

Southern Newfoundland experienced slightly colder-than-normal temperatures in June, with St. John's recording a mean monthly temperature anomaly of -1.9°C. Otherwise, most of the stations in Newfoundland and Labrador reported air temperatures within a degree of normal.

By the middle of the month, about four weeks earlier than normal, the southern edge of the main sea ice pack retreated to Cape Chidley.

During June the largest part of the iceberg population remained north of 50°N, with only scattered icebergs to the south. Throughout the month, two large ice islands from the Petermann Glacier drifted persistently southward along the Labrador coast. No longer protected by a cover of sea ice, they were continuously calving large numbers of icebergs as they moved along their paths. Extensive aerial reconnaissance, by IIP and PAL, analysis of satellite imagery by CIS (CIS, 2011b) and C-CORE (C-CORE, 2011), and many reports from ships allowed IIP to track the growing iceberg population as it approached the eastern entrance to the Strait of Belle Isle. (C-CORE is a Canadian R&D corporation that provides satellite image analysis services to government and industry.)

The southern Petermann Ice Island, IIP-B-b (~ 2.5 nm in length on 9 June), broke into several pieces on 17 June. By the end of the month, its fragments were approaching Belle Isle (~ 52°N). Meanwhile, PII-A remained largely intact during the second half of June as it moved southward. On 27 June it had an area of 16.5 nm^2 and was located about 70 nm northeast of Cartwright.

No icebergs passed south of 48°N during June; the 111-year monthly average is 85.

July through September 2011

The ice conditions from July through September were dominated by the movement of the Petermann Ice Islands and their fragments from the southern Labrador coast to the northern Newfoundland coast. Seasonal warming of the ocean took its toll on these icebergs; however, the shear mass of ice contained in the ice islands kept the region well populated with icebergs throughout the remainder of the ice year.

From July through mid-September the Strait of Belle Isle and its eastern entrance were occupied, at times, by hundreds of icebergs as the fragments of PII-B-b and later PII-A passed southward toward the Newfoundland coast. For example, on 9 July a vessel navigating through the area reported seeing 30 icebergs that created a "wall of icebergs".

The Petermann Ice Islands and the smaller icebergs they calved remained close to the southern Labrador coast and Newfoundland's northern arm. As a result, IIP concluded that they were unlikely to move south of 48°N. Having confirmed there were no icebergs south of 48°N and none in the offshore pipeline, IIP's last 2011 IRD returned to the United States on 20 July.

PII-A was about 25 nm northeast of Belle Isle and approaching the eastern entrance of the strait when this striking photograph was taken by astronaut Ron Garan on the International Space Station on 25 July (**Figure 19**). At the time, PII-A's dimensions were approximately 6.2 nm by 3.1 nm. Although the icebergs it was shedding are small by comparison to the parent ice island, some are over 100 m in length and present formidable obstacles to mariners.

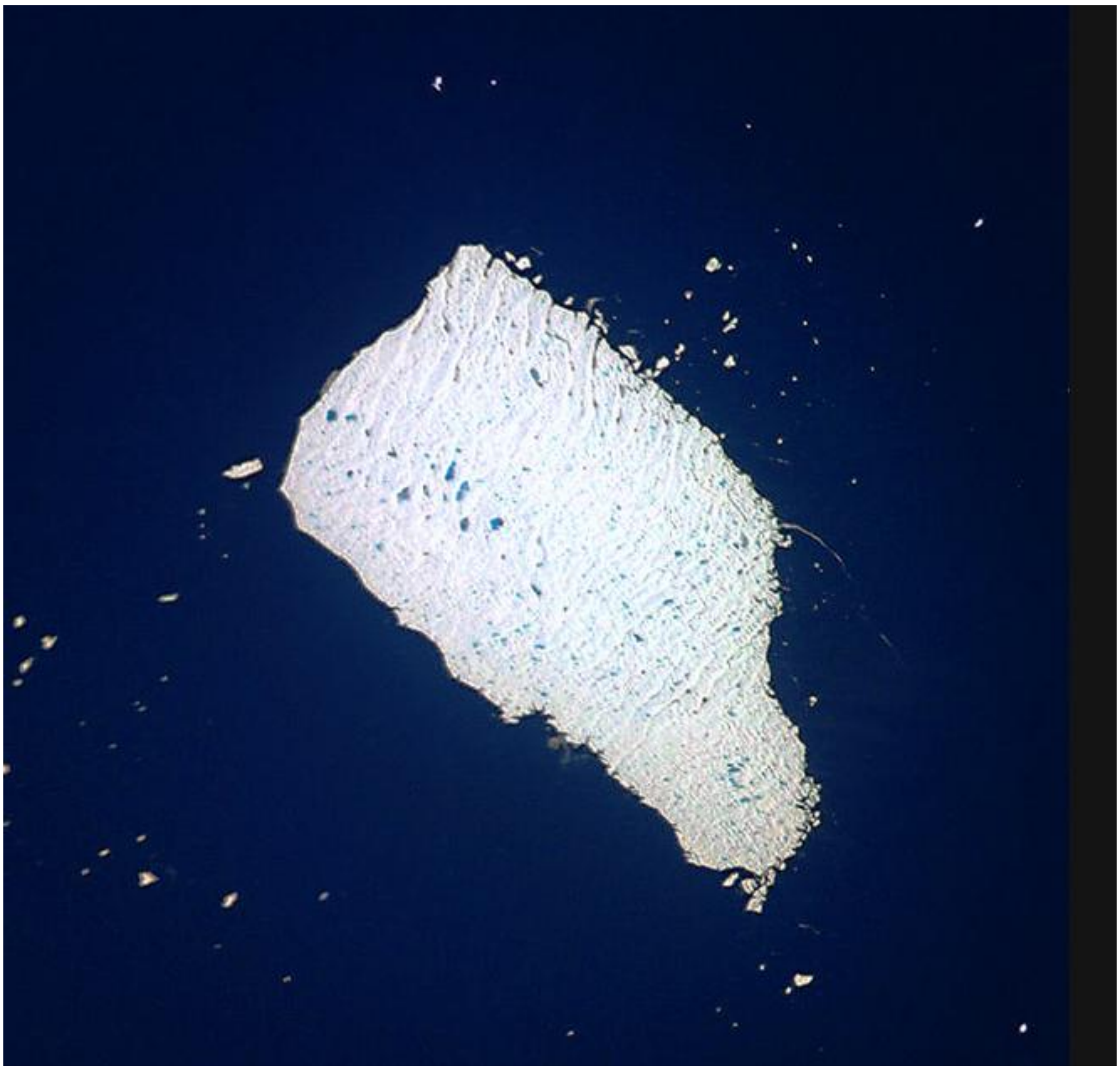


Figure 19. Petermann Ice Island (PII-A) taken on 25 July 2011 by Expedition 27 astronaut Ron Garan aboard the International Space Station. Credit: NASA/Ron Garan, http://www.flickr.com/photos/lightsinthedark/5978011351/

The southernmost iceberg sighted during 2011 was a medium dry-dock iceberg seen at 48°-41.4'N, 53°-09.6'W by a PAL reconnaissance airplane on 26 September, just four days before the end of the ice year. It was likely a product of the deterioration of PII-A.

The 2011 ice year ended with 165 icebergs near Newfoundland (**Figure 20**). While it is very unusual for that many icebergs to be near Newfoundland in September, it has happened several times in IIP's history, mostly in the early part of the 1900s. For example, in 1919 there were reports that 69 icebergs passed south of 48°N in September, and in 1914 there were 52 (IIP, 1926). In a remarkable account that predates IIP's history (Monthly Weather Review, 1884), the New York Maritime Register reported on 17 September that there were 319 icebergs between Cape Freels and Cape Race.

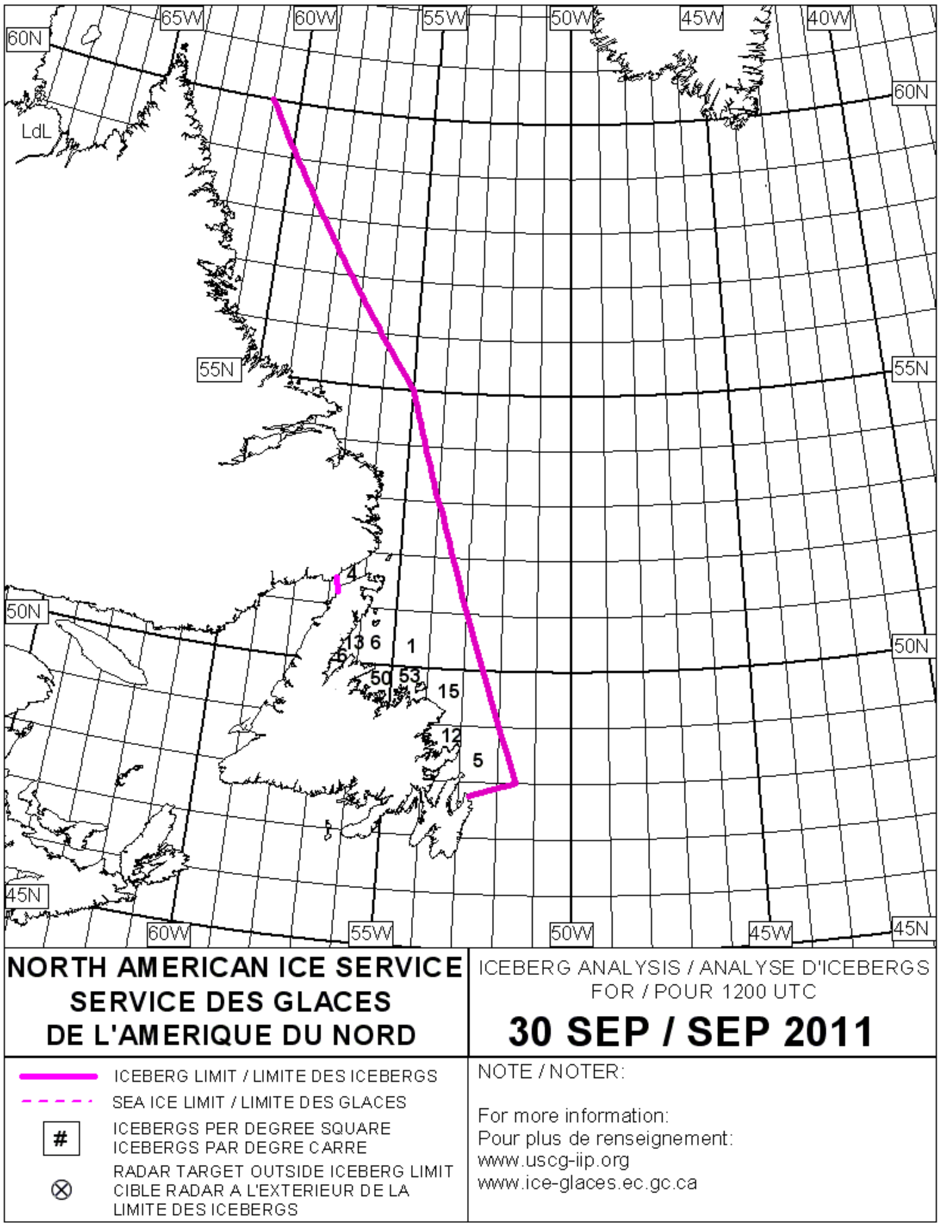


Figure 20. Iceberg distribution on 30 September 2011. The numbers indicate the number of icebergs within a 1° of latitude by 1° of longitude bin.

At the end of the ice year, three large pieces of the original Petermann Ice Island lingered far to the north. PII-B (19.4 nm^2) remained grounded at 69°-38'N, 65°-53'W, while a smaller ice island (3.7 nm^2) that broke free from PII-B entered Lancaster Sound. Finally, PII-C, the smallest of the three (1.7 nm^2 measured on 21 October), was at 77°-05'N, 77°-32'W and continuing to move southward amidst the sea ice in the Kane Basin (CIS, 2011b).

Discussion

By the end of December 2010 it was becoming clear that the 2011 ice year would be far from normal. For the second year in a row, winter environmental conditions in southern Baffin Island and Labrador were extraordinarily unfavorable to the movement of icebergs from Davis Strait to the shipping lanes. During the early winter, persistent onshore winds brought record-breaking warmth to northern Labrador and southern Baffin Island (**Figure 21**). As a result, the development of the seasonal sea-ice cover was much delayed and far below its normal extent. The southern edge of the main sea-ice pack reached Cape Chidley at the end of January, nearly seven weeks later than normal. Abnormally warm conditions persisted in Labrador during the first half of January, delaying the arrival of sea ice to the vicinity of the Strait of Belle Isle until the first week of February, about five weeks later than normal.

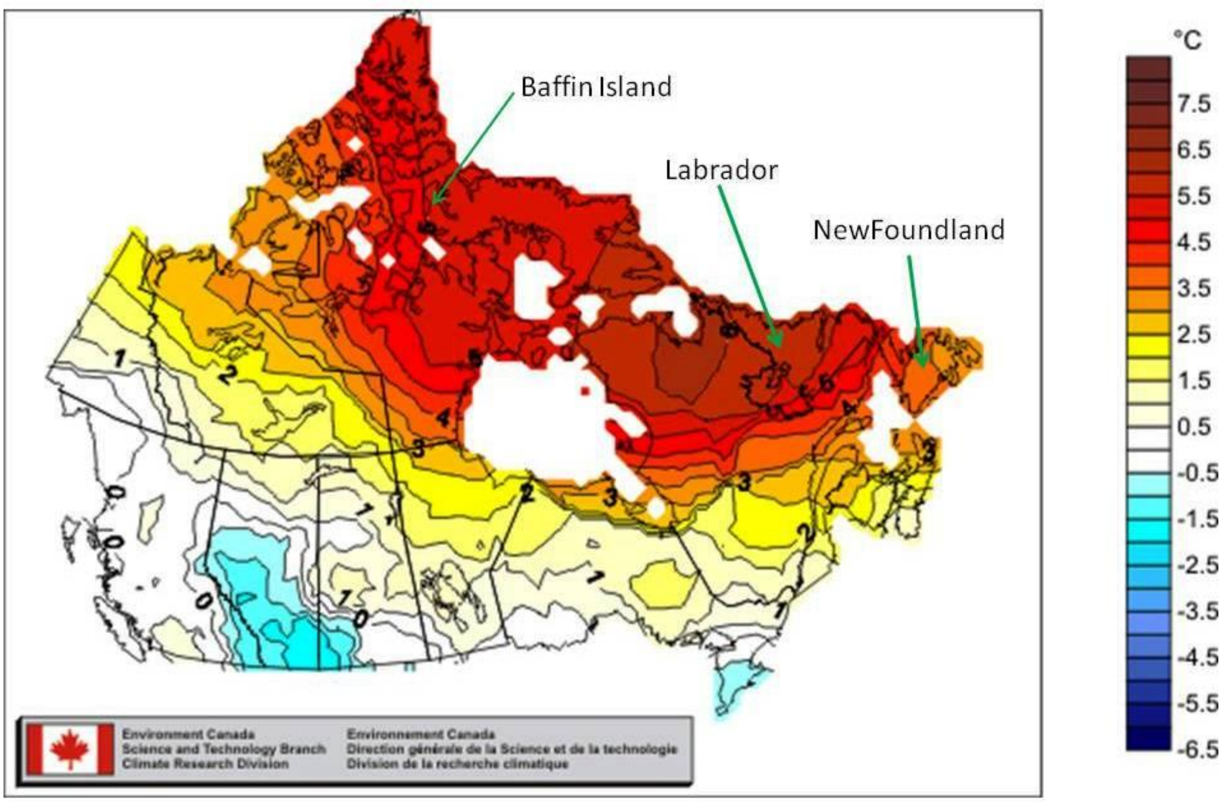


Figure 21. Temperature departures from normal - Winter (Dec, Jan, Feb) 2010/2011 (Environment Canada , 2011b).

Although weather conditions in the region returned to near-normal conditions by the end of January (**Figure 22**), the extraordinary early winter warmth along Canada's east coast set the stage for a remarkably light 2010/2011 sea-ice extent (**Figure 23**). The weekly sea-ice coverage for the combined Grand Banks and southern Labrador waters calculated using the Ice Graph Version 1.03 (CIS, 2011d) was much below average for the entire winter. For southern Labrador waters, the total accumulated ice coverage (TAC), a time-integrated measure of the seasonal sea ice cover, was the lowest in the 43-year data record maintained by CIS. For the Grand Banks, the 2010/2011 season was the second lowest on record. (CIS, 2011c).

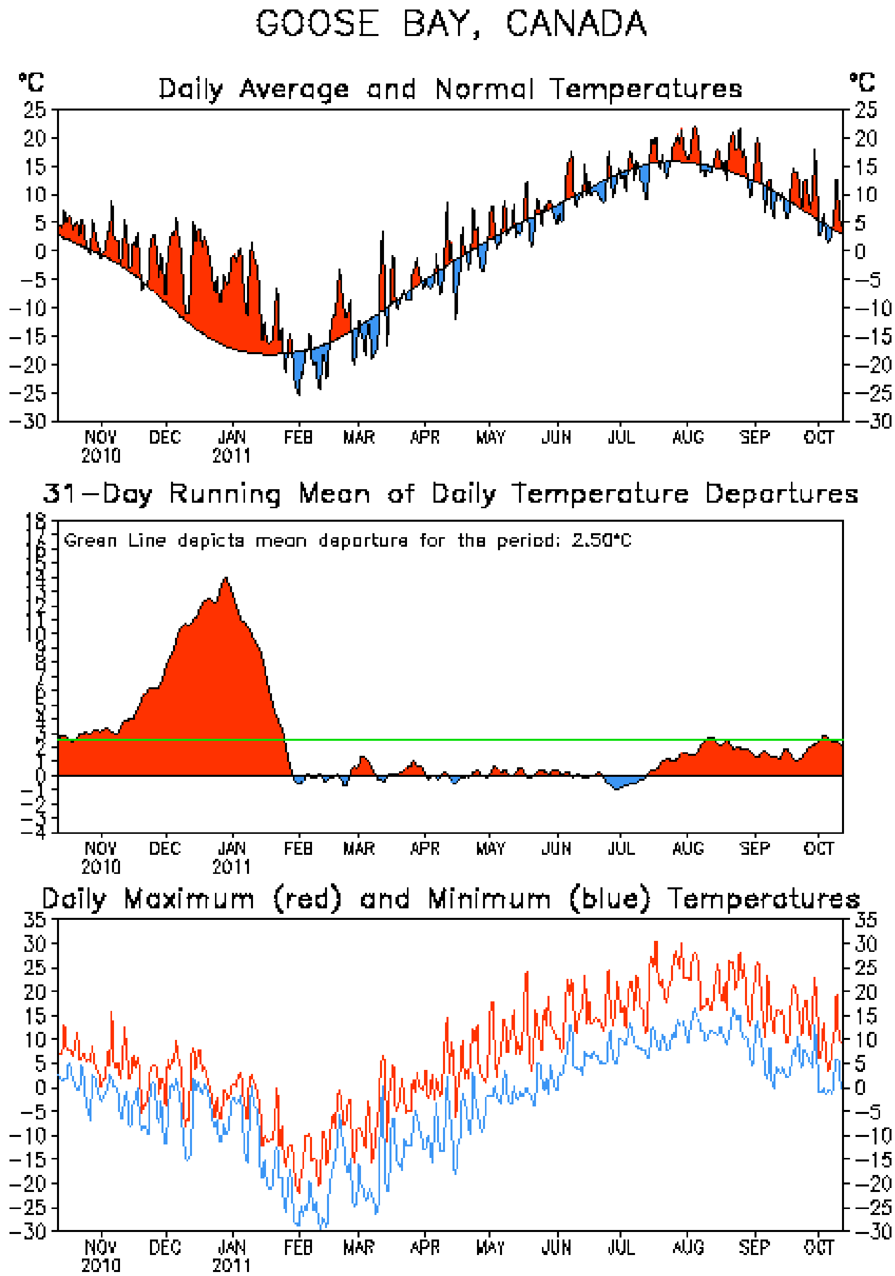


Figure 22. November 2010 – October 2011 air temperature in Goose Bay, Labrador. NOAA/NWS, Climate Prediction Center (NOAA/NWS, 2011b)

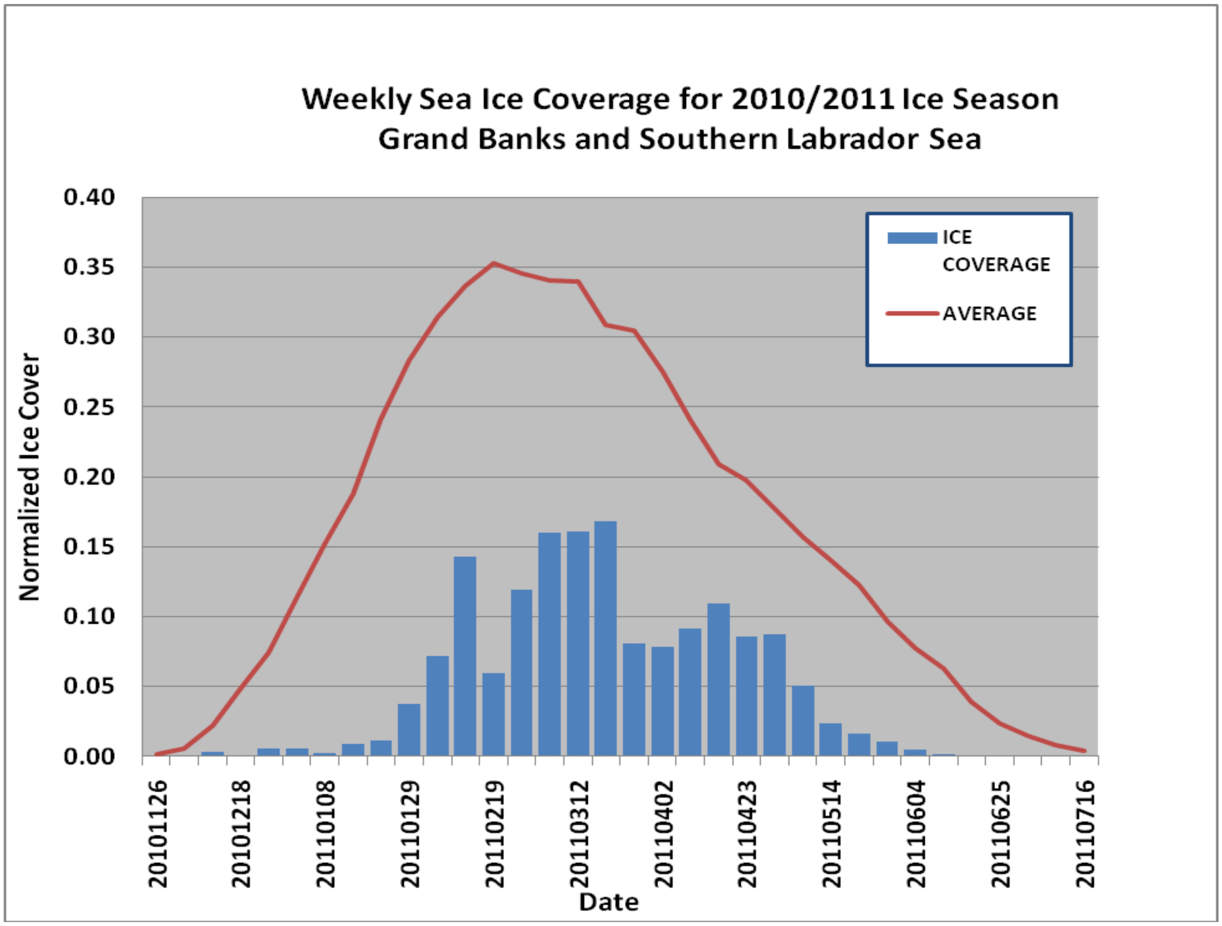


Figure 23. Weekly ice coverage on the Grand Banks and along the Southern Labrador coast for the 2010 - 2011 ice season. The ice coverage is normalized to the total area of the Grand Banks and Southern Labrador coast regions. (CIS, 2011d).

In 2011, no icebergs were observed south of 48oN and three were estimated to have passed that latitude. The 2011 iceberg count is far below the average number of icebergs in IIP's 111-year record (474). The reason for the low number of icebergs in 2011 is not certain, but it is likely that the warm early winter conditions played an important role. The lack of a significant sea-ice cover along the coasts of southern Baffin Island and Labrador in early winter exposed the icebergs in the southward-moving long-shore currents to greater-than-normal deterioration. It is also possible that the persistent onshore winds in December and January moved part of the iceberg population toward the shallow inshore waters where they would be subject to grounding and entrapment in the bays along the coast.

Persistent onshore winds in Labrador, warm air temperatures, and mild sea-ice conditions are characteristic features of a negative phase of the North Atlantic Oscillation (NAO). The NAO, the dominant pattern of winter atmospheric variability in the North Atlantic, fluctuates between positive and negative phases. NAO dynamics have been extensively described by Hurrell et al. (2003). The winter 2011 (December 2010 through March 2011) NAO Index was strongly negative, -1.57 (Hurrell, 2011). This value, called the winter station-based NAO index, is calculated using the difference in normalized sea-

level atmospheric pressure between Lisbon, Portugal, and Stykkisholmur/Reykjavik, Iceland. The data record for the station-based NAO index extends back to 1864.
With the estimate that three icebergs passed south of 48°N, the 2011 ice year enters a tie for sixth place for the lowest number of icebergs in a year (**Table 2**). It is notable that four of the ten lowest iceberg counts in IIP's history have occurred since 2005.

Most, but not all, of the low iceberg counts were in years with strongly negative NAO indices. While it is tempting to argue that strongly negative conditions lead to low iceberg counts, the relationship is more complex than it appears. One of the years, 2005 was a neutral NAO year. In addition, other years have diverged more dramatically from the simple relationship that a low NAO index results in a low iceberg count. For example, in 1996, the NAO index was -3.78 but 611 icebergs passed south of 48°N, a very active year for icebergs. On the other hand, there have been years in which there were few icebergs but a strongly positive NAO index. In a recent example, 1999 had a strongly positive NAO index (1.7), but only 22 icebergs passed south of 48°N.

RANK	YEAR	NAO INDEX	ICEBERGS SOUTH OF 48° N
1 (Tie)	2006	-1.09	0
1 (Tie)	1966	-1.69	0
3 (Tie)	2010	-4.64	1
3 (Tie)	1940	-2.86	1
3 (Tie)	1958	-1.02	1
6 (Tie)	1941	-2.31	3
6 (Tie)	2011	-1.57	3
8	1951	-1.26	8
9 (Tie)	2005	0.12	11
9 (Tie)	1924	-1.13	11

Table 2. Years with the lowest number of icebergs estimated to have drifted south of 48°N and North Atlantic Oscillation Index. Note: The iceberg-count data reflect the current definition of the ice year. In 1940 and 1941 the ice year was the calendar year. In both years it was reported in IIP's annual reports that two icebergs passed south of 48°N during the year. One of these icebergs passed south of 48°N in November 1940 and was originally counted as a 1940 observation. It is now counted as a 1941 observation. Thus, in 1940 one iceberg is listed, and in 1941, three.

Although only a small number of icebergs were estimated to have moved into the southern transatlantic shipping lanes, 2011 will be a memorable ice year because of the Petermann Ice Islands. Two major pieces, PII-B-b and PII-A, reached northern Newfoundland a year from the calving event in Petermann Fjord, over 1800 nm away. Along their southward path, PII-B-b and PII-A shed hundreds of icebergs, most of which remained inshore of the main branch of the Labrador Current. Throughout July and August, Petermann fragments populated the Strait of Belle Isle and its eastern entrance, creating a major obstacle to mariners wishing to use the strait. By mid-September the iceberg population center shifted southward to the many bays along Newfoundland's northern coast where it persisted for several months.

References

Canadian Ice Service. (2010). *Seasonal Outlook, Gulf of St. Lawrence and East Newfoundland Waters, Winter 2010-2011*. Unpublished Manuscript, Canadian Ice Service, 373 Sussex Drive, Block E-3, Ottawa, ON, Canada K1A 0H3, 13 pp.

Canadian Ice Service. (2011a). Sea Ice Climatic Atlas, East Coast 1981-2010. Retrieved 13 October 2011, from http://www.ec.gc.ca/glaces-ice/default.asp?lang=En&n=090AF7D6-1&xml=AE4A459A-FFF4-4E38-A09E-7DF258873739

Canadian Ice Service. (2011b). Petermann Ice Island Updates. Retrieved 1 November, 2011, from http://www.ec.gc.ca/glaces-ice/default.asp?lang=En&n=D32C361E-1&wsdoc=1B226706-42BF-4B94-A481-E9524C81C436

Canadian Ice Service. (2011c). Seasonal Summary for Eastern Canada - Winter 2010-2011. Retrieved on 7 November 2011 from http://www.ec.gc.ca/glaces-ice/default.asp?Lang=En&n=13C120E9-1&wsdoc=E3B757A2-97C1-456C-B3DF-6851F7219856

Canadian Ice Service. (2011d). Canadian Ice Service - Ice Graph Version 1.03. Retrieved 5 November 2011, from http://ice-glaces.ec.gc.ca/IceGraph103/?id=11874&lang=eng

C-CORE. (2011). Personal communications.

Desjardins, Luc. (2010). 2011 East Coast Seasonal Outlook. International Ice Patrol Annual Conference, 2 December 2010.

Environment Canada. (2011a). National Climate Data and Information Archive: Climate Summaries. Retrieved 13 October 2011, from http://climate.weatheroffice.gc.ca/prods_servs/cdn_climate_summary_e.html

Environment Canada. (2011b). Climate Trends and Variations Bulletin - Winter Summary 2010/2011. Retrieved 4 November 2011, from http://www.ec.gc.ca/adsc-cmda/default.asp?lang=en&n=8C03D32A-1

Hurrell, J.W., Y. Kushnir, G. Ottersen, and M. Visbeck (2003). *The North Atlantic Oscillation: Climate Significance and Environmental Impact,* Geophysical Monograph Series, 134, 279pp.

Hurrell, James. (2011). Winter (Dec-Mar) Station Based NAO Index**.** National Center for Atmospheric Research. Retrieved 13 October 2011, from http://www.cgd.ucar.edu/cas/jhurrell/indices.data.html#naostatdjfm

IIP. (1926). Report of the International Ice Observation and Ice Patrol Service in the North Atlantic (Season of 1926), Bulletin N. 15.

Kalnay, E., M. Kanamitsu, R. Kistler, W. Collins, D. Deaven, L. Gandin, M. Iredell, S. Saha, G. White, J. Woollen, Y. Zhu, M. Chelliah, W. Ebisuzaki, W. Higgins, J. Janowiak, K.C. Mo, C. Ropelewski, J. Wang, A. Leetmaa, R. Reynolds, R. Jenne, D. Joseph. (1996). The NCEP/NCAR Reanalysis 40-year Project. Bull. Amer. Meteor. Soc., 77, 437-471.

Met Office. (2011). United Kingdom Meteorological Office. Sea Level Analysis Chart, Retrieved 6 October 2011 from: http://www.wetterzentrale.de/topkarten/tkfaxbraar.htm

Monthly Weather Review. (1884). North Atlantic storms during August, 1884. *Mon. Wea. Rev.*, 12, 184–186.

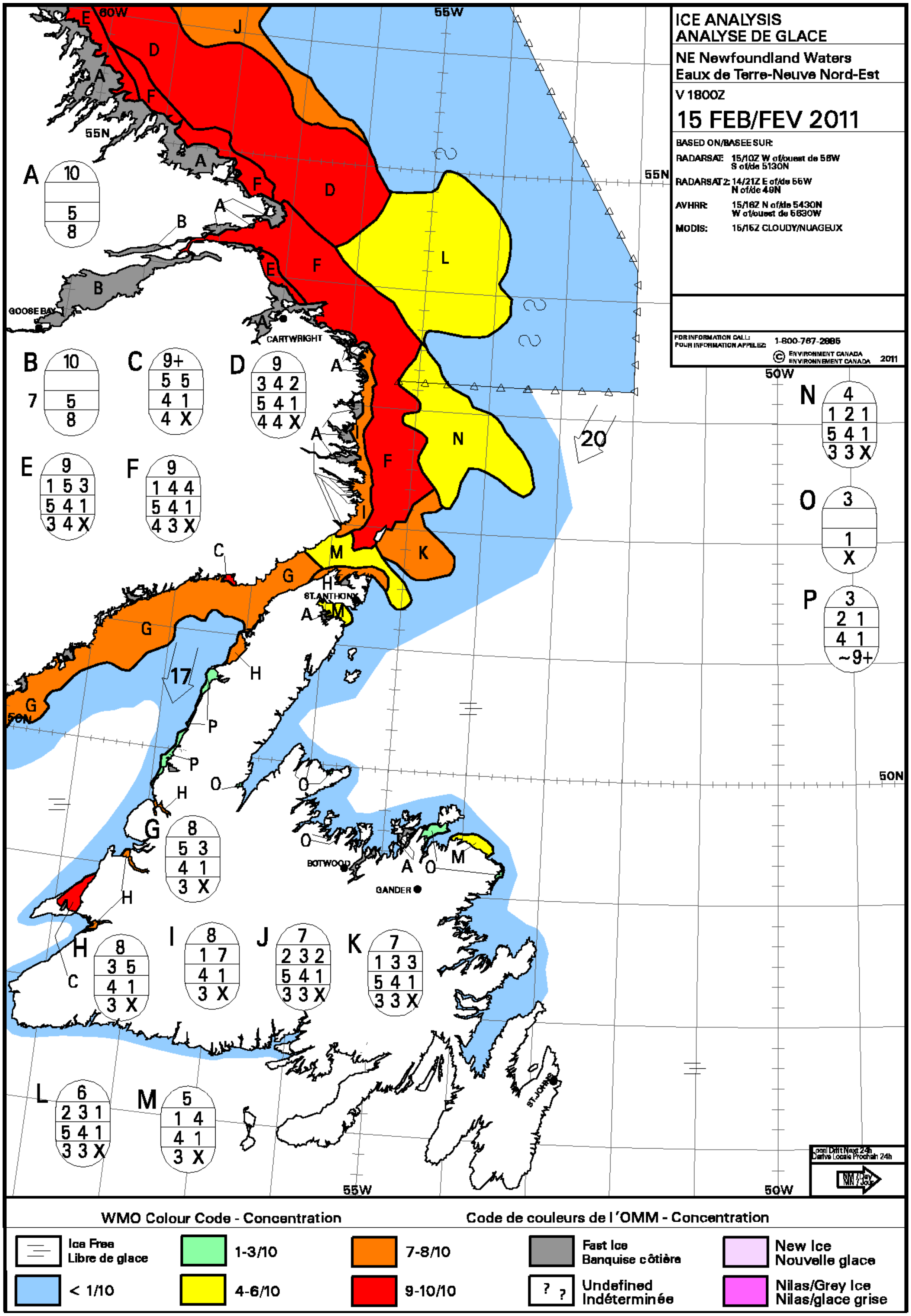
National Oceanic and Atmospheric Administration/National Weather Service. (2011a). NOAA Operational Model Archive & Distribution System. Retrieved 13 October 2011, from http://nomad3.ncep.noaa.gov/ncep_data/index.html

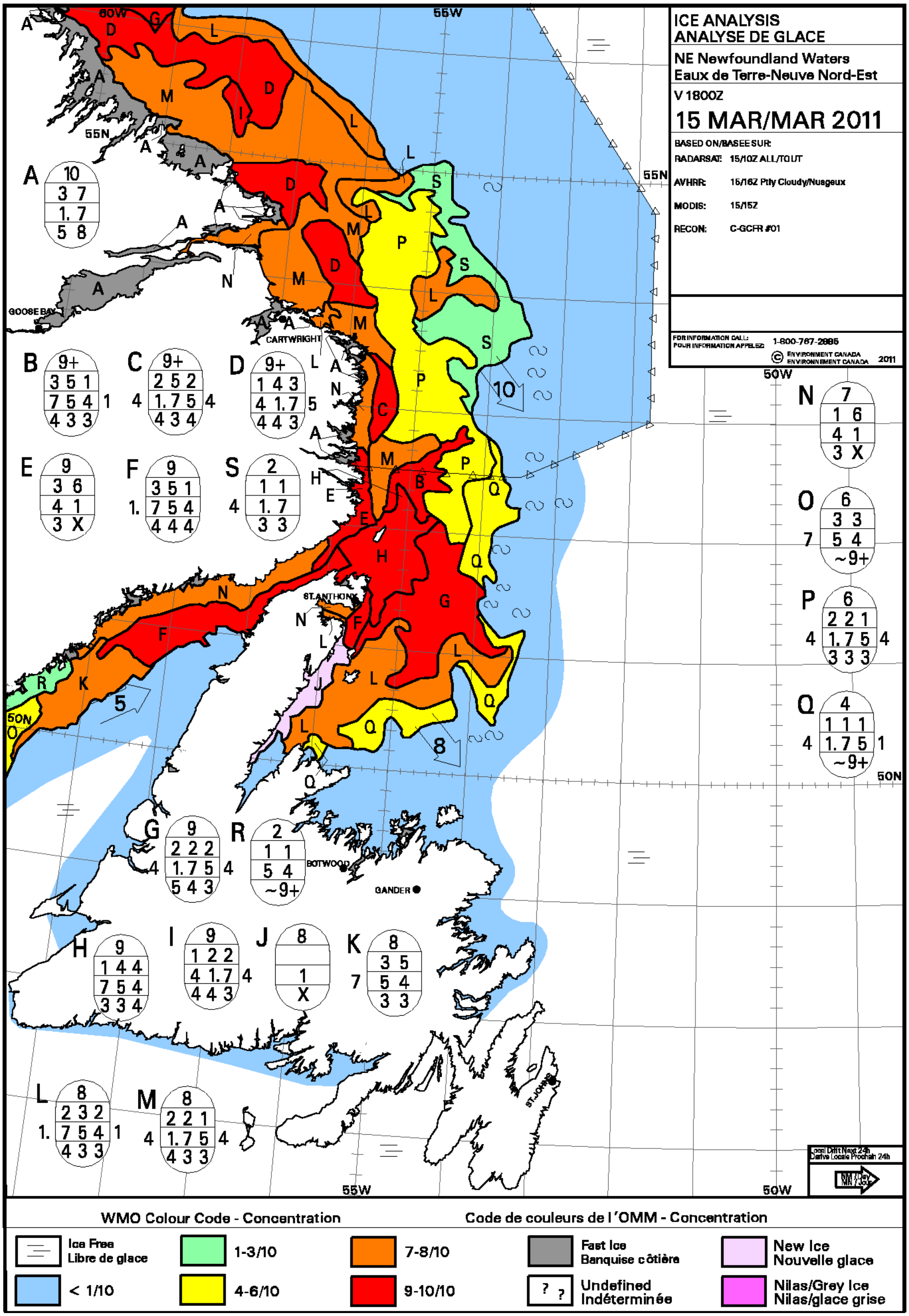
National Oceanic and Atmospheric Administration/National Weather Service. (2011b). National Centers for Environmental Prediction, Climate Prediction Center. Retrieved 13 October 2011 from http://www.cpc.ncep.noaa.gov/products/global_monitoring/temperature/global_temp_accum.shtml

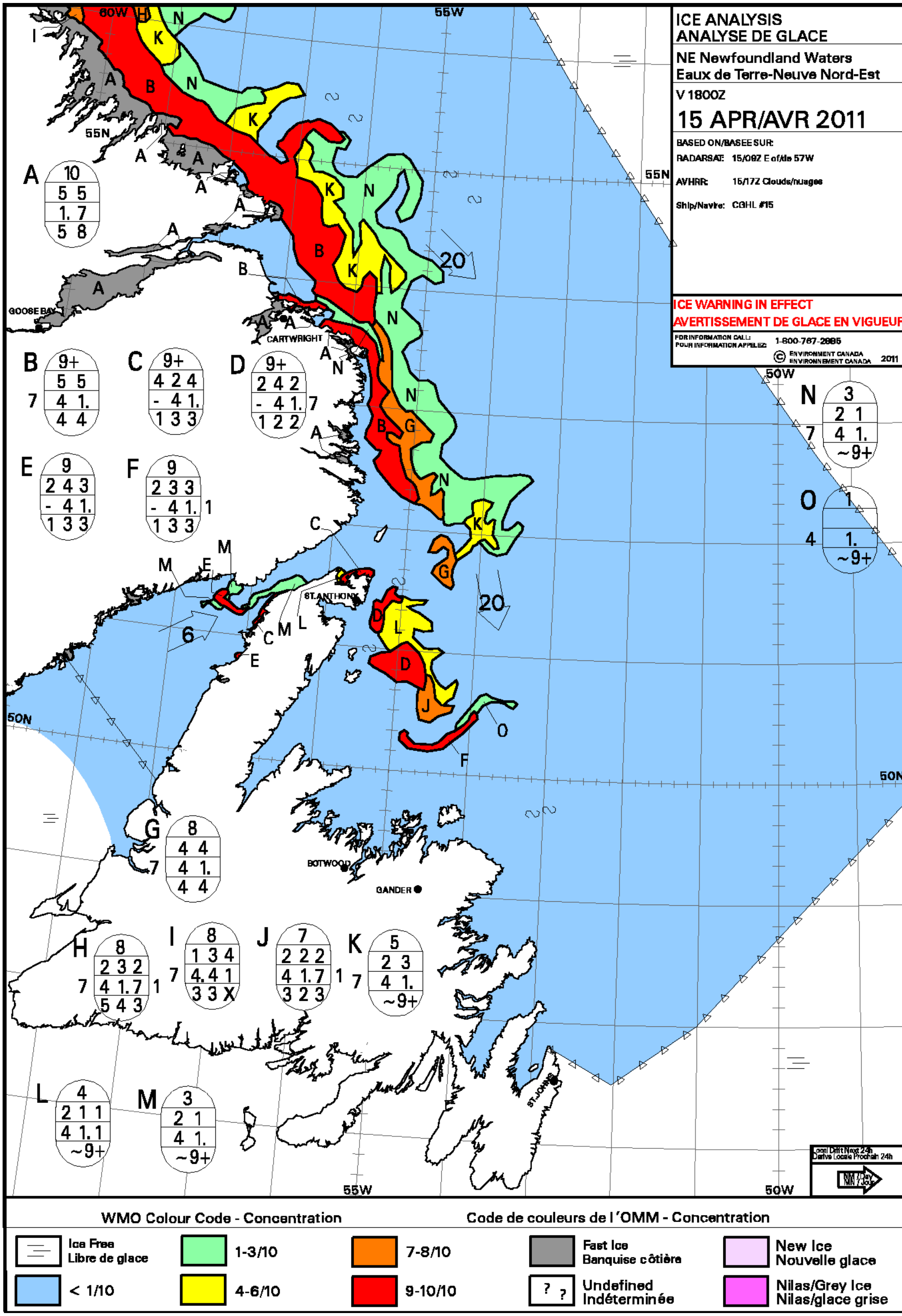
Monthly Sea-Ice Charts

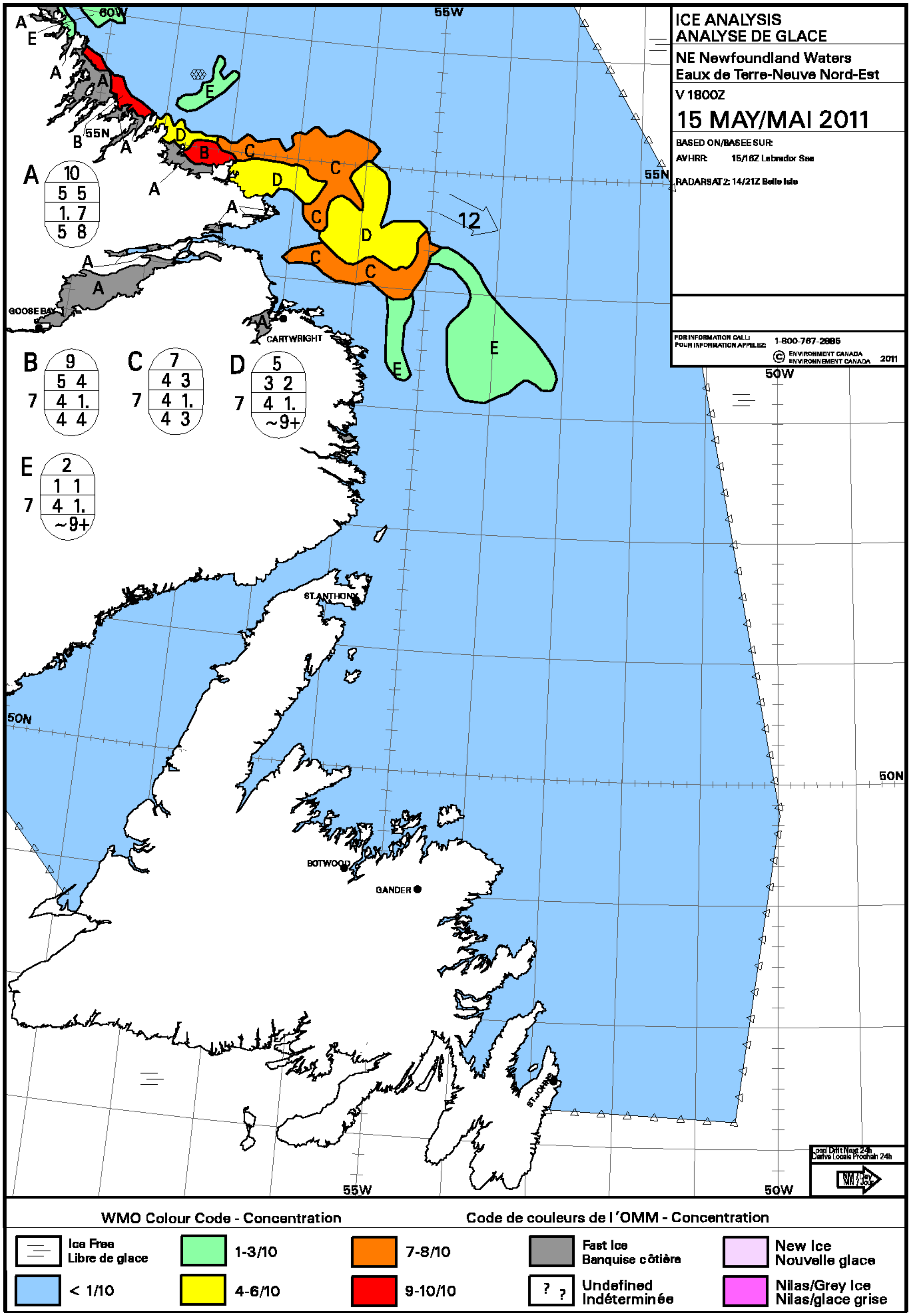
Sea-ice charts are reprinted with permission of the Canadian Ice Service.

Symbology is in accordance with the World Meteorological Organization system for sea-ice.

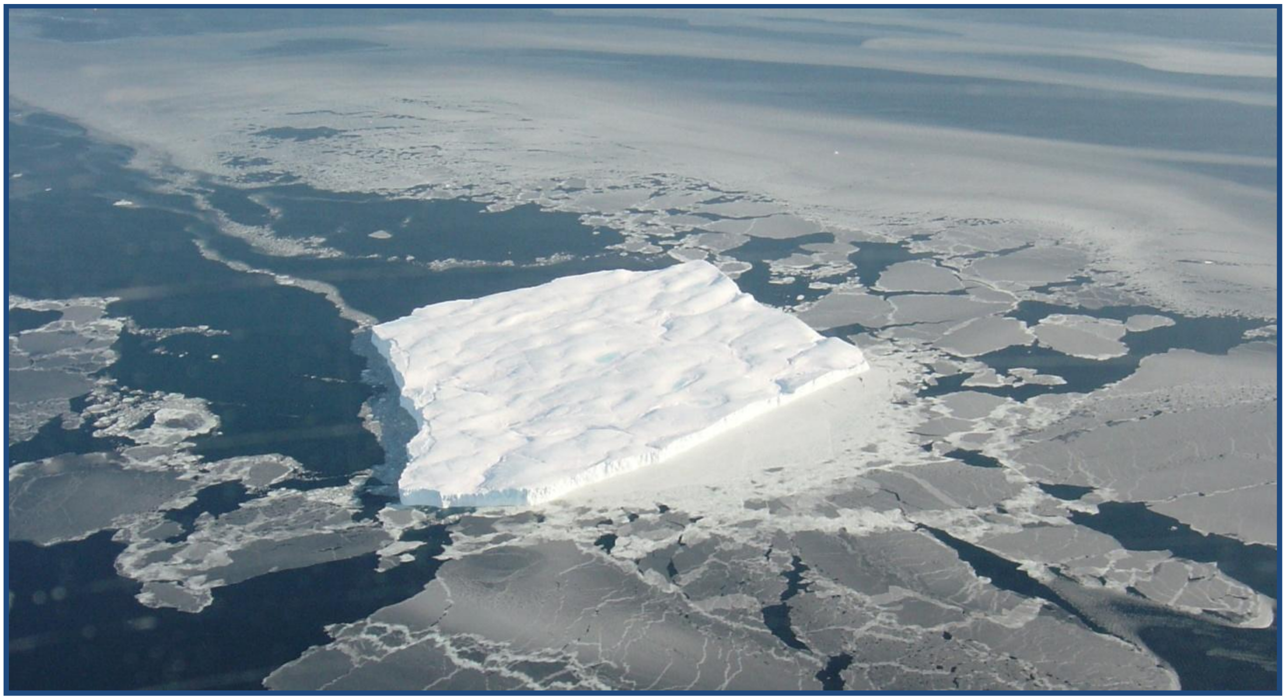

ICE ANALYSIS
ANALYSE DE GLACE
NE Newfoundland Waters
Eaux de Terre-Neuve Nord-Est
V 1800Z
15 FEB/FEV 2011
BASED ON/BASEE SUR:
RADARSAT: 15/10Z W of/ouest de 58W S of/de 5130N
RADARSAT2: 14/21Z E of/de 55W N of/de 49N
AVHRR: 15/16Z N of/de 5430N W of/ouest de 5630W
MODIS: 15/15Z CLOUDY/NUAGEUX
FOR INFORMATION CALL: POUR INFORMATION APPELEZ: 1-800-767-2885
ENVIRONMENT CANADA ENVIRONNEMENT CANADA 2011
60W
55W
50W
55N
50N
GOOSE BAY
CARTWRIGHT
ST.ANTHONY
BOTWOOD
GANDER
ST.JOHN'S
20
17
A 10 5 8
B 10 7 5 8
C 9+ 5 5 4 1 4 X
D 9 3 4 2 5 4 1 4 4 X
E 9 1 5 3 5 4 1 3 4 X
F 9 1 4 4 5 4 1 4 3 X
G 8 5 3 4 1 3 X
H 8 3 5 4 1 3 X
I 8 1 7 4 1 3 X
J 7 2 3 2 5 4 1 3 3 X
K 7 1 3 3 5 4 1 3 3 X
L 6 2 3 1 5 4 1 3 3 X
M 5 1 4 4 1 3 X
N 4 1 2 1 5 4 1 3 3 X
O 3 1 X
P 3 2 1 4 1 ~9+
Local Drift Next 24h
Dérive Locale Prochain 24h
NM / Day
MN / Jour
WMO Colour Code - Concentration
Code de couleurs de l'OMM - Concentration
Ice Free
Libre de glace
< 1/10
1-3/10
4-6/10
7-8/10
9-10/10
Fast Ice
Banquise côtière
Undefined
Indéterminée
New Ice
Nouvelle glace
Nilas/Grey Ice
Nilas/glace grise

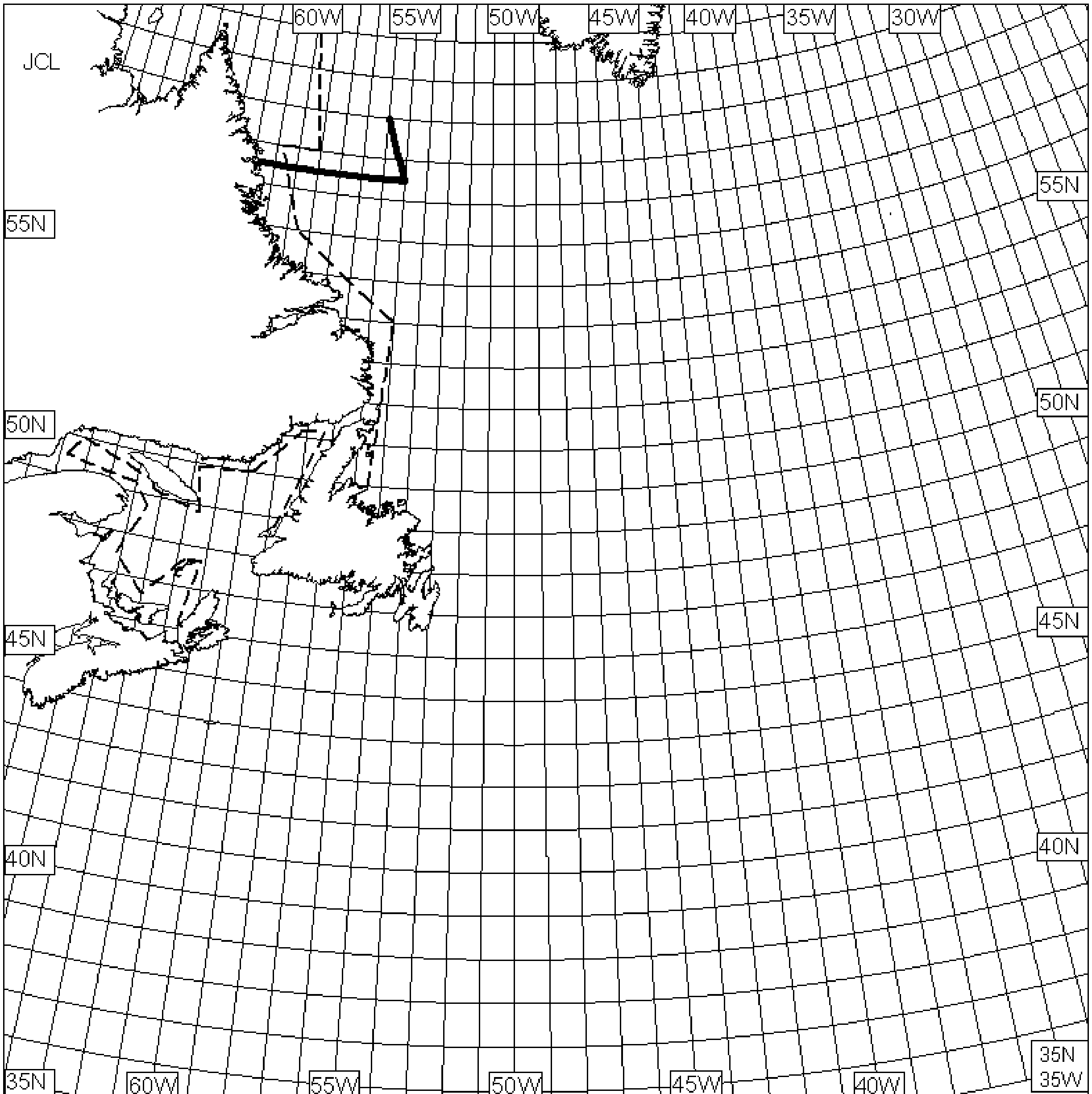

ICE ANALYSIS
ANALYSE DE GLACE
NE Newfoundland Waters
Eaux de Terre-Neuve Nord-Est
V 1800Z
15 MAR/MAR 2011
BASED ON/BASEE SUR:
RADARSAT: 15/10Z ALL/TOUT
AVHRR: 15/16Z Ptly Cloudy/Nuageux
MODIS: 15/15Z
RECON: C-GCFR #01
FOR INFORMATION CALL: POUR INFORMATION APPELEZ: 1-800-767-2885
© ENVIRONMENT CANADA ENVIRONNEMENT CANADA 2011
GOOSE BAY
CARTWRIGHT
ST.ANTHONY
BOTWOOD
GANDER
ST.JOHN'S
60W
55W
50W
55N
50N
WMO Colour Code - Concentration
Code de couleurs de l'OMM - Concentration
Ice Free
Libre de glace
< 1/10
1-3/10
4-6/10
7-8/10
9-10/10
Fast Ice
Banquise côtière
Undefined
Indéterminée
New Ice
Nouvelle glace
Nilas/Grey Ice
Nilas/glace grise


ICE ANALYSIS
ANALYSE DE GLACE
NE Newfoundland Waters
Eaux de Terre-Neuve Nord-Est
V 1800Z
15 APR/AVR 2011
BASED ON/BASEE SUR:
RADARSAT: 15/09Z E of/de 57W
AVHRR: 15/17Z Clouds/nuages
Ship/Navire: CGHL #15
ICE WARNING IN EFFECT
AVERTISSEMENT DE GLACE EN VIGUEUR
1-800-767-2885
ENVIRONMENT CANADA
ENVIRONNEMENT CANADA
2011
GOOSE BAY
CARTWRIGHT
ST.ANTHONY
BOTWOOD
GANDER
ST.JOHN'S
60W
55W
50W
55N
50N
WMO Colour Code - Concentration
Code de couleurs de l'OMM - Concentration
Ice Free
Libre de glace
< 1/10
1-3/10
4-6/10
7-8/10
9-10/10
Fast Ice
Banquise côtière
Undefined
Indéterminée
New Ice
Nouvelle glace
Nilas/Grey Ice
Nilas/glace grise
Local Drift Next 24h
Dérive Locale Prochain 24h

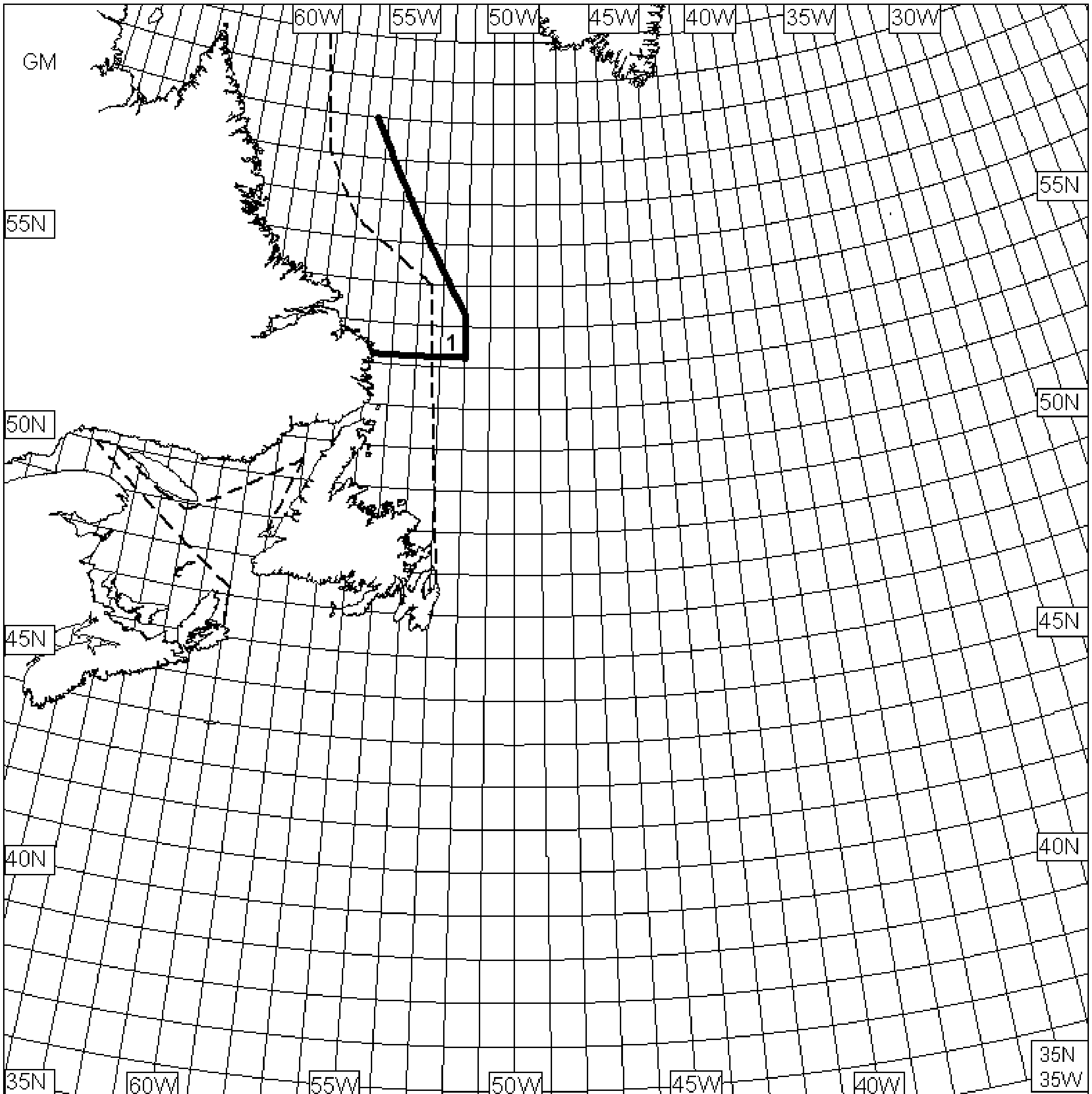

ICE ANALYSIS
ANALYSE DE GLACE
NE Newfoundland Waters
Eaux de Terre-Neuve Nord-Est
V 1800Z
15 MAY/MAI 2011
BASED ON/BASEE SUR:
AVHRR: 15/18Z Labrador Sea
RADARSAT 2: 14/21Z Belle Isle
FOR INFORMATION CALL: POUR INFORMATION APPELEZ: 1-800-767-2885
ENVIRONMENT CANADA ENVIRONNEMENT CANADA 2011
60W
55W
50W
55N
50N
12
GOOSE BAY
CARTWRIGHT
ST.ANTHONY
BOTWOOD
GANDER
ST.JOHN'S
A 10 5 5 1. 7 5 8
B 9 5 4 7 4 1. 4 4
C 7 4 3 7 4 1. 4 3
D 5 3 2 7 4 1. ~9+
E 2 1 1 7 4 1. ~9+
Local Drift Next 24h
Dérive Locale Prochain 24h
NM/Day
MN/Jour
WMO Colour Code - Concentration
Code de couleurs de l'OMM - Concentration
Ice Free
Libre de glace
< 1/10
1-3/10
4-6/10
7-8/10
9-10/10
Fast Ice
Banquise côtière
Undefined
Indéterminée
New Ice
Nouvelle glace
Nilas/Grey Ice
Nilas/glace grise

Semimonthly Iceberg Charts





NORTH AMERICAN ICE SERVICE **SERVICE DES GLACES** **DE L'AMERIQUE DU NORD**	ICEBERG ANALYSIS / ANALYSE D'ICEBERGS FOR / POUR 1200 UTC **01 FEB / FEV 2011**
ICEBERG LIMIT / LIMITE DES ICEBERGS SEA ICE LIMIT / LIMITE DES GLACES # ICEBERGS PER DEGREE SQUARE ICEBERGS PAR DEGRE CARRE ⊗ RADAR TARGET OUTSIDE ICEBERG LIMIT CIBLE RADAR A L'EXTERIEUR DE LA LIMITE DES ICEBERGS	NOTE / NOTER:



NORTH AMERICAN ICE SERVICE
SERVICE DES GLACES
DE L'AMERIQUE DU NORD

ICEBERG ANALYSIS / ANALYSE D'ICEBERGS
FOR / POUR 1200 UTC

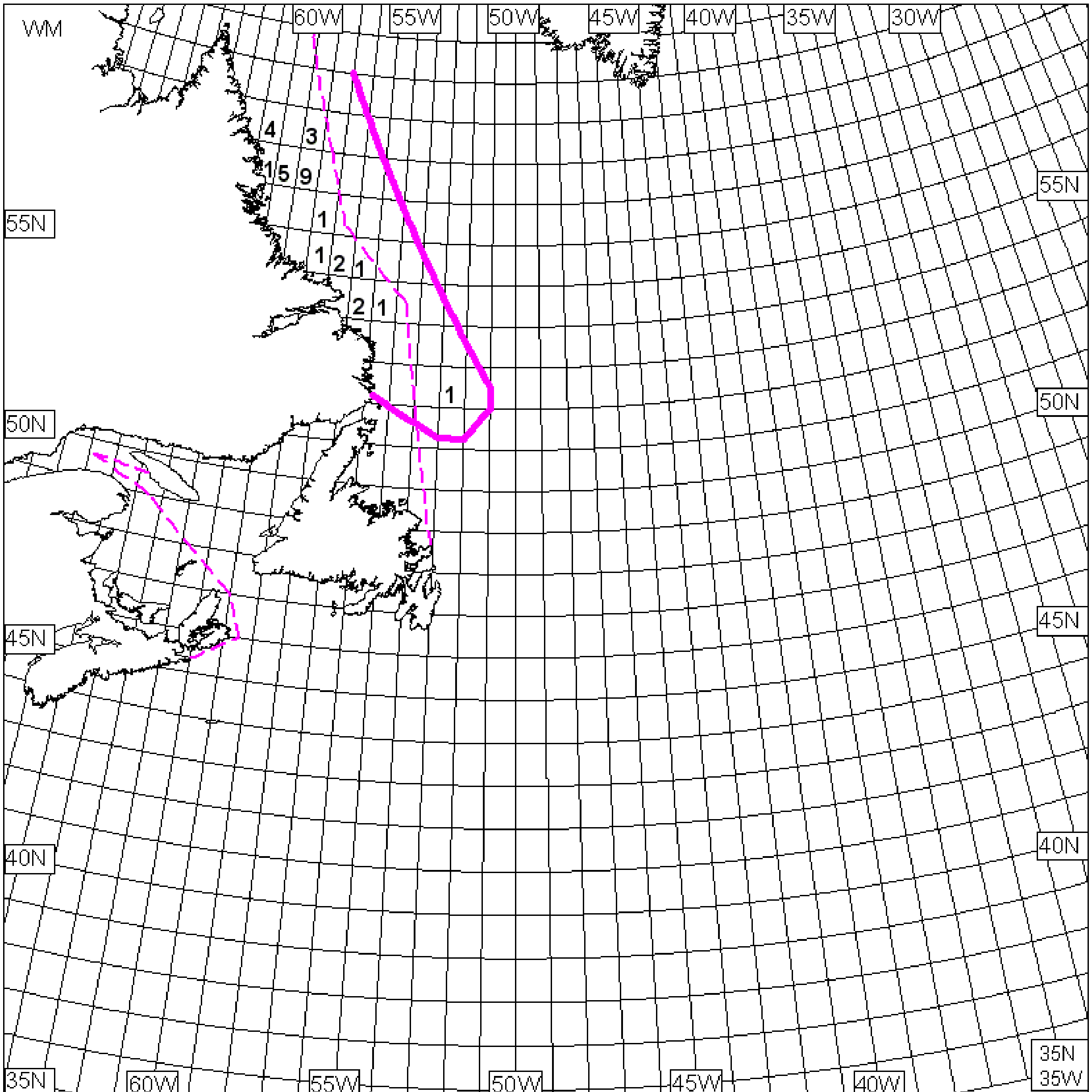
15 FEB / FEV 2011

ICEBERG LIMIT / LIMITE DES ICEBERGS
SEA ICE LIMIT / LIMITE DES GLACES
ICEBERGS PER DEGREE SQUARE / ICEBERGS PAR DEGRE CARRE
⊗ RADAR TARGET OUTSIDE ICEBERG LIMIT / CIBLE RADAR A L'EXTERIEUR DE LA LIMITE DES ICEBERGS

NOTE / NOTER:

FOR MORE INFORMATION:
POUR PLUS DE RENSEIGNEMENT:

WWW.USCG-IIP.ORG OR/OU
HTTP://ICE-GLACES.EC.GC.CA



NORTH AMERICAN ICE SERVICE
SERVICE DES GLACES
DE L'AMERIQUE DU NORD

ICEBERG ANALYSIS / ANALYSE D'ICEBERGS
FOR / POUR 1200 UTC

28 FEB / FEV 2011

ICEBERG LIMIT / LIMITE DES ICEBERGS

SEA ICE LIMIT / LIMITE DES GLACES

ICEBERGS PER DEGREE SQUARE
ICEBERGS PAR DEGRE CARRE

⊗ RADAR TARGET OUTSIDE ICEBERG LIMIT
CIBLE RADAR A L'EXTERIEUR DE LA
LIMITE DES ICEBERGS

NOTE / NOTER:

FOR MORE INFORMATION:
POUR PLUS DE RENSEIGNEMENT:

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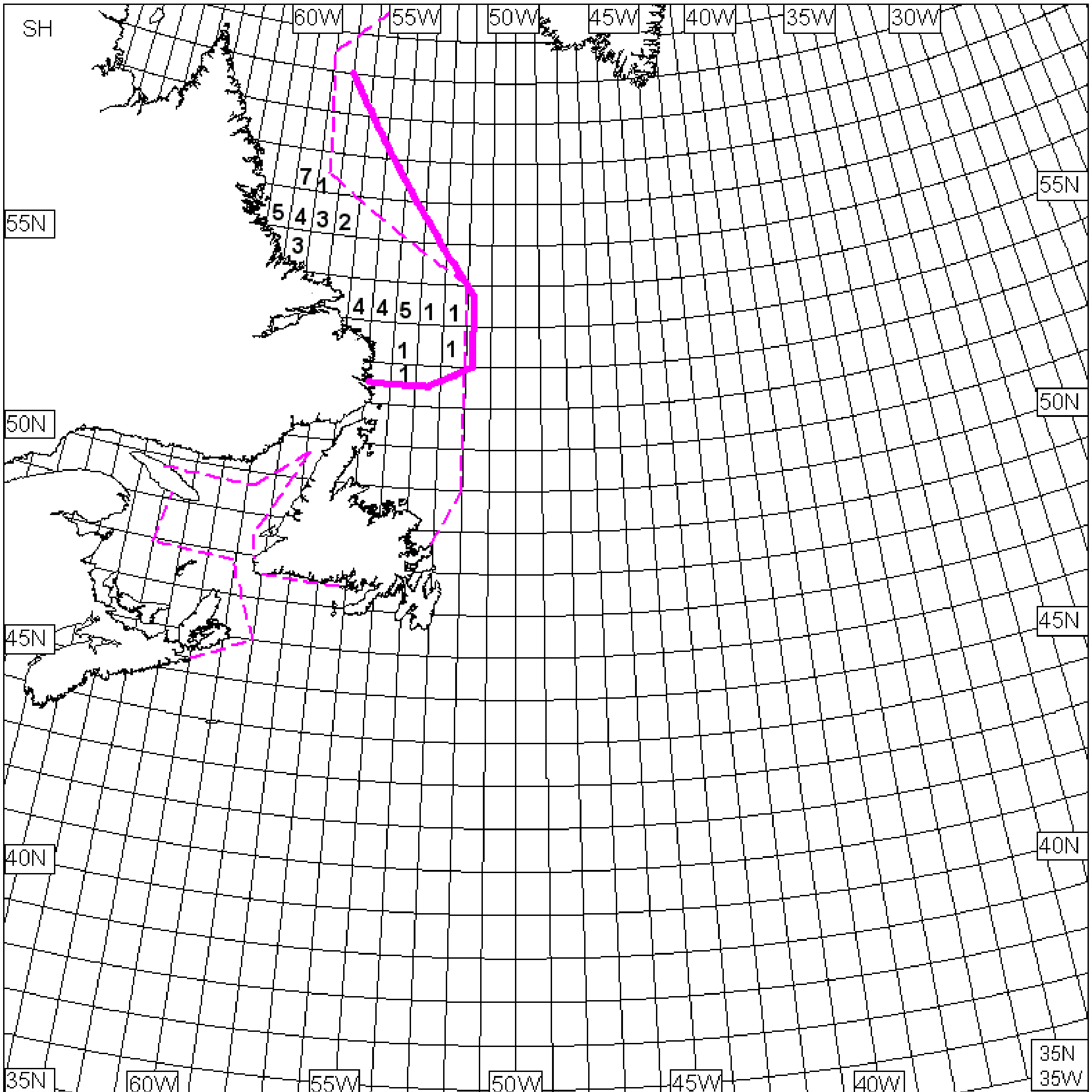

NORTH AMERICAN ICE SERVICE
SERVICE DES GLACES
DE L'AMERIQUE DU NORD

ICEBERG ANALYSIS / ANALYSE D'ICEBERGS
FOR / POUR 1200 UTC

15 MAR / MAR 2011

ICEBERG LIMIT / LIMITE DES ICEBERGS

SEA ICE LIMIT / LIMITE DES GLACES

ICEBERGS PER DEGREE SQUARE
ICEBERGS PAR DEGRE CARRE

⊗ RADAR TARGET OUTSIDE ICEBERG LIMIT
CIBLE RADAR A L'EXTERIEUR DE LA
LIMITE DES ICEBERGS

NOTE / NOTER:

FOR MORE INFORMATION:
POUR PLUS DE RENSEIGNEMENT:

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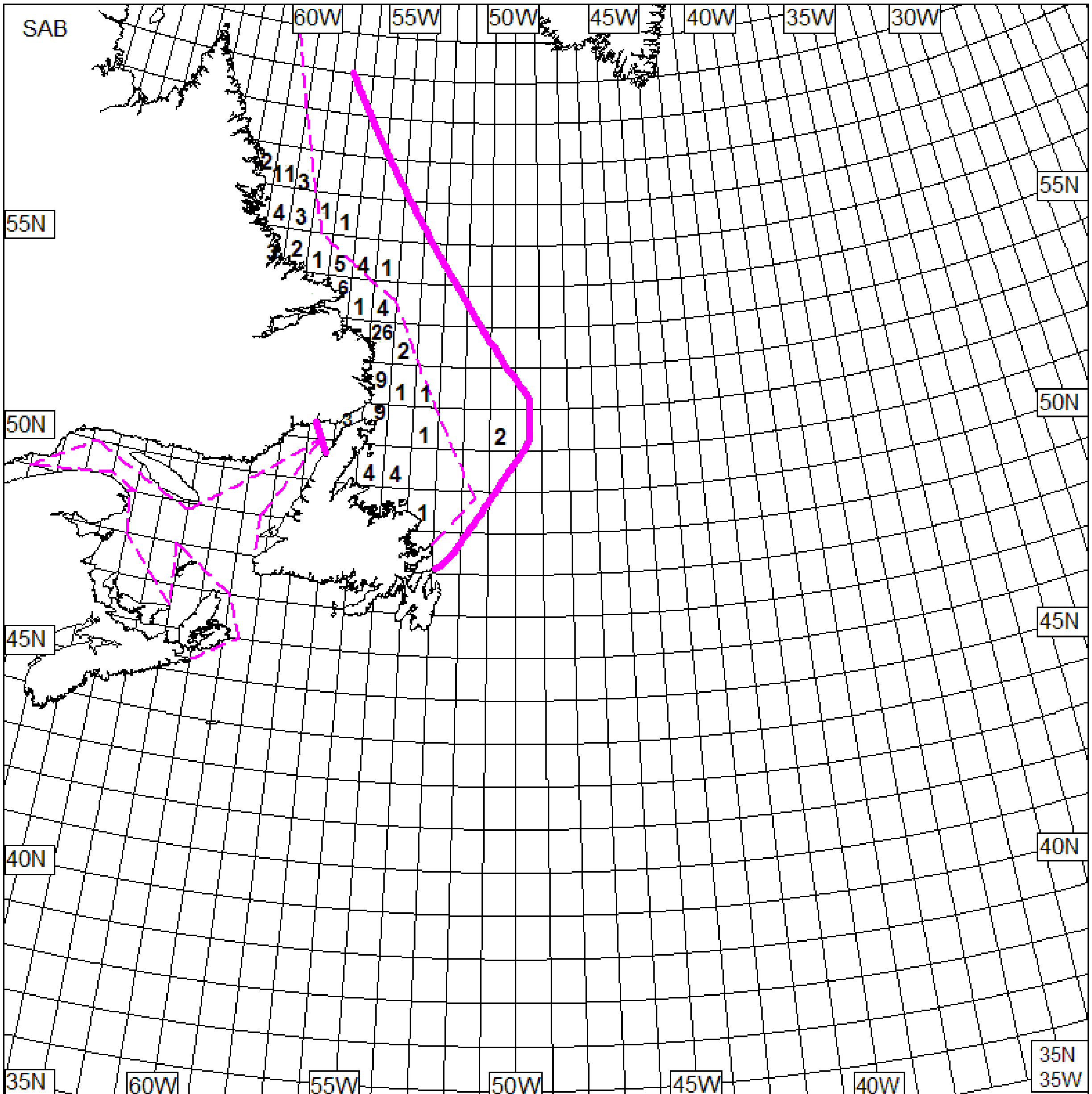

NORTH AMERICAN ICE SERVICE
SERVICE DES GLACES
DE L'AMERIQUE DU NORD

ICEBERG ANALYSIS / ANALYSE D'ICEBERGS
FOR / POUR 1200 UTC

31 MAR / MAR 2011

ICEBERG LIMIT / LIMITE DES ICEBERGS

SEA ICE LIMIT / LIMITE DES GLACES

— ICEBERGS PER DEGREE SQUARE / ICEBERGS PAR DEGRE CARRE

⊗ — RADAR TARGET OUTSIDE ICEBERG LIMIT / CIBLE RADAR A L'EXTERIEUR DE LA LIMITE DES ICEBERGS

NOTE / NOTER:

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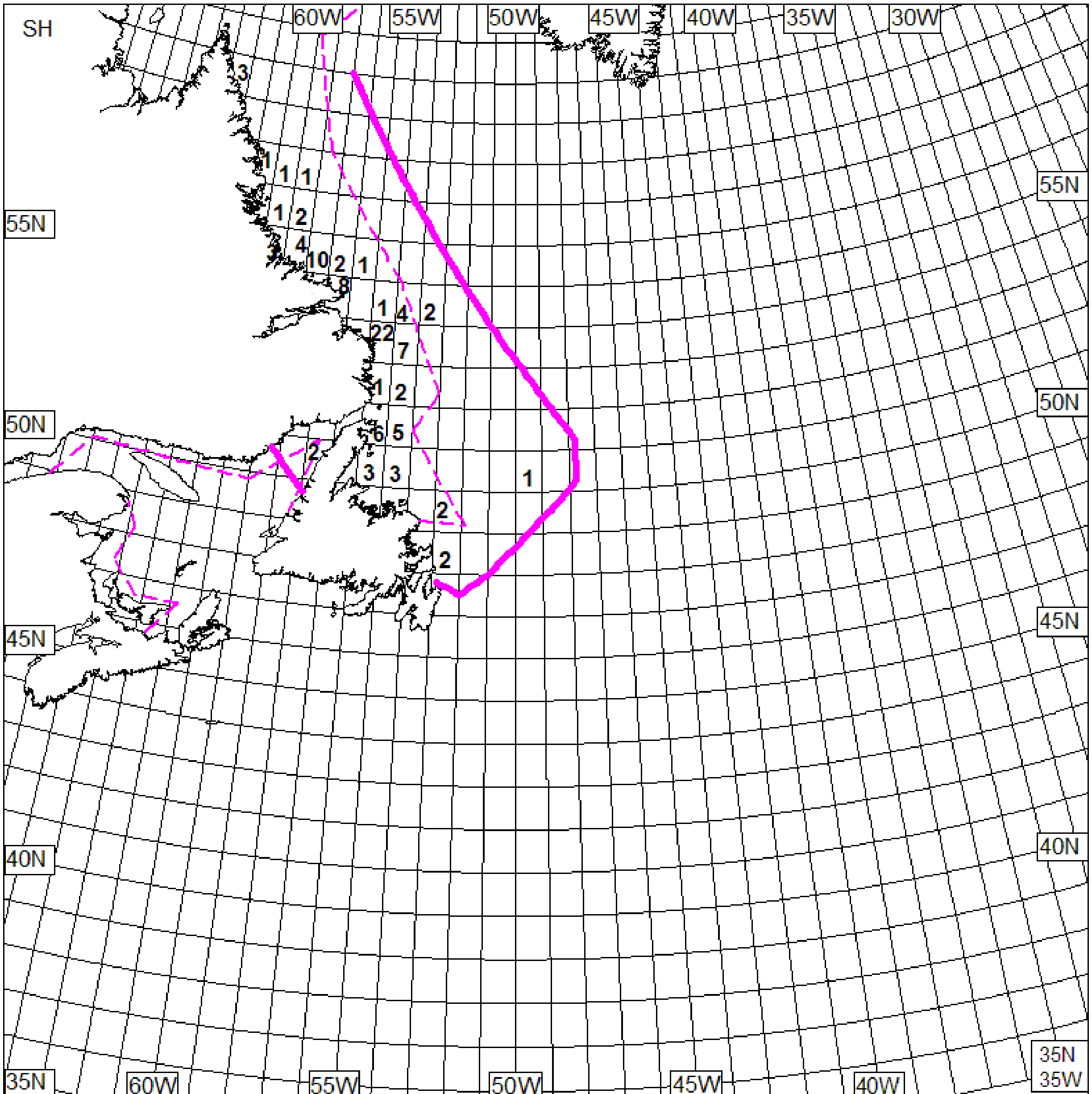


NORTH AMERICAN ICE SERVICE
SERVICE DES GLACES
DE L'AMERIQUE DU NORD

ICEBERG ANALYSIS / ANALYSE D'ICEBERGS
FOR / POUR 1200 UTC

15 APR / AVR 2011

ICEBERG LIMIT / LIMITE DES ICEBERGS

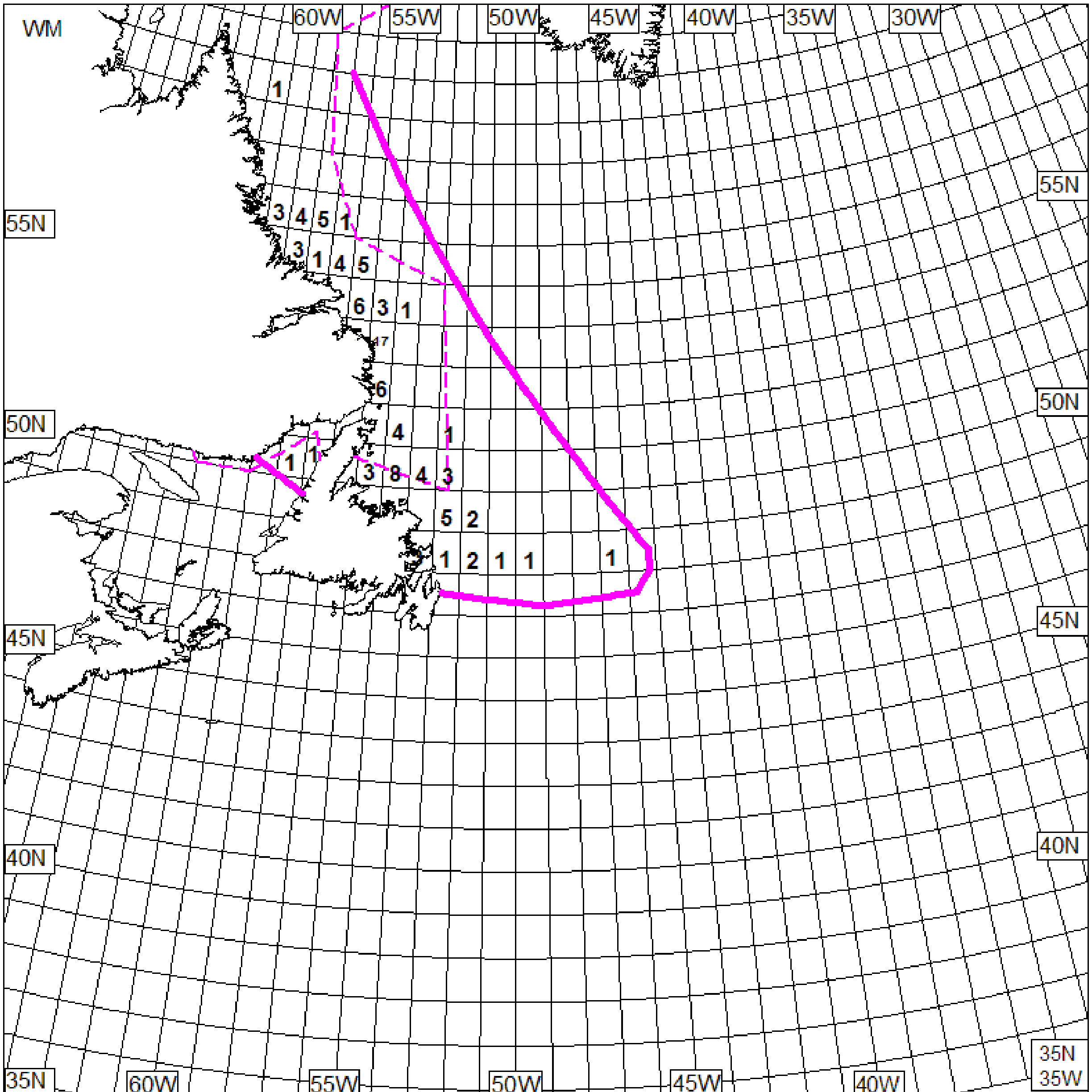
SEA ICE LIMIT / LIMITE DES GLACES

ICEBERGS PER DEGREE SQUARE / ICEBERGS PAR DEGRE CARRE

⊗ RADAR TARGET OUTSIDE ICEBERG LIMIT / CIBLE RADAR A L'EXTERIEUR DE LA LIMITE DES ICEBERGS

NOTE / NOTER:
TODAY WE COMMEMORATE THE 99TH ANNIVERSARY OF THE SINKING OF RMS TITANIC

AUJOURD'HUI EST SOULIGNÉ LE 99IÈME ANNIVERSAIRE DU NAUFRAGE DU TITANIC



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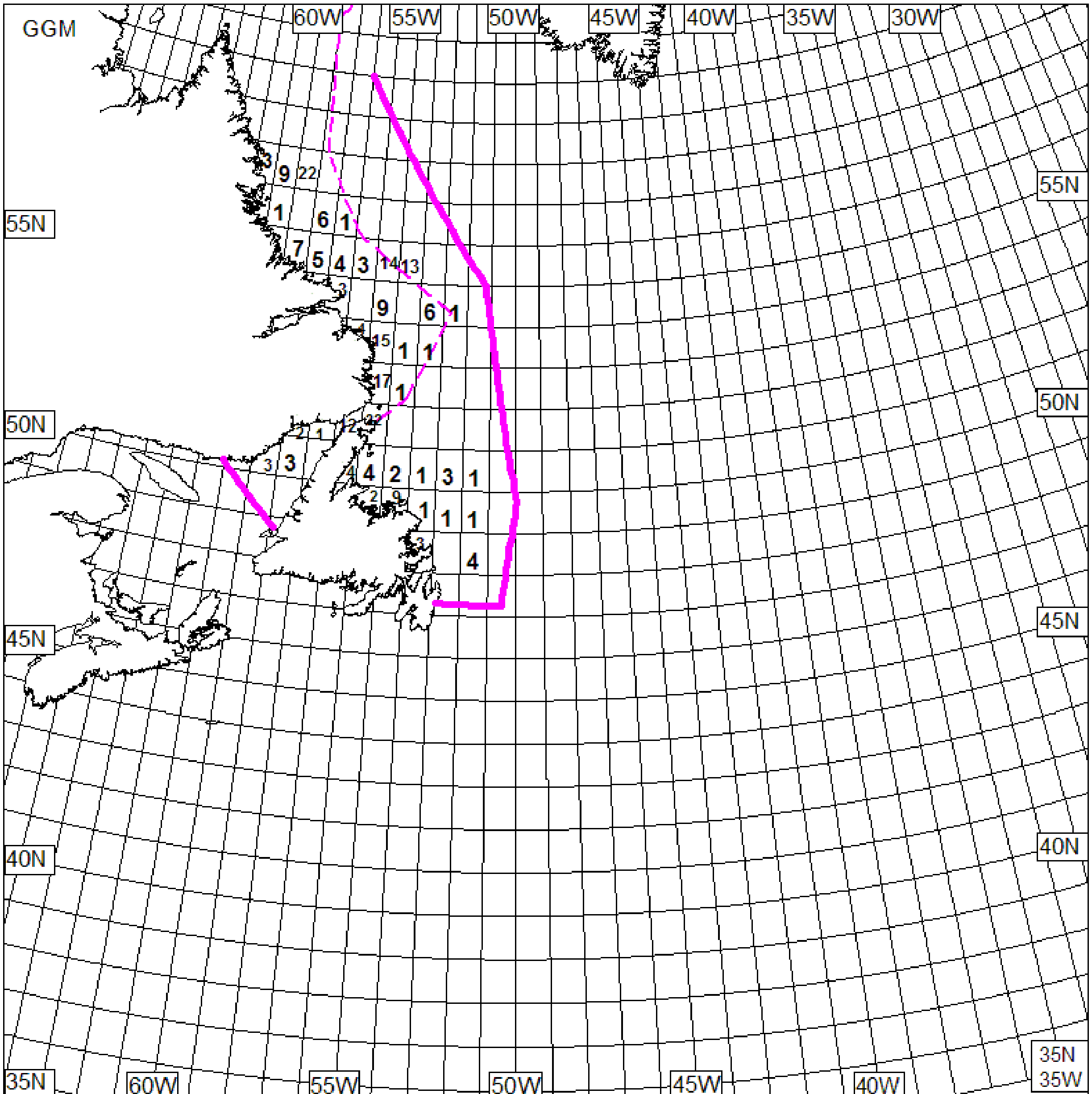
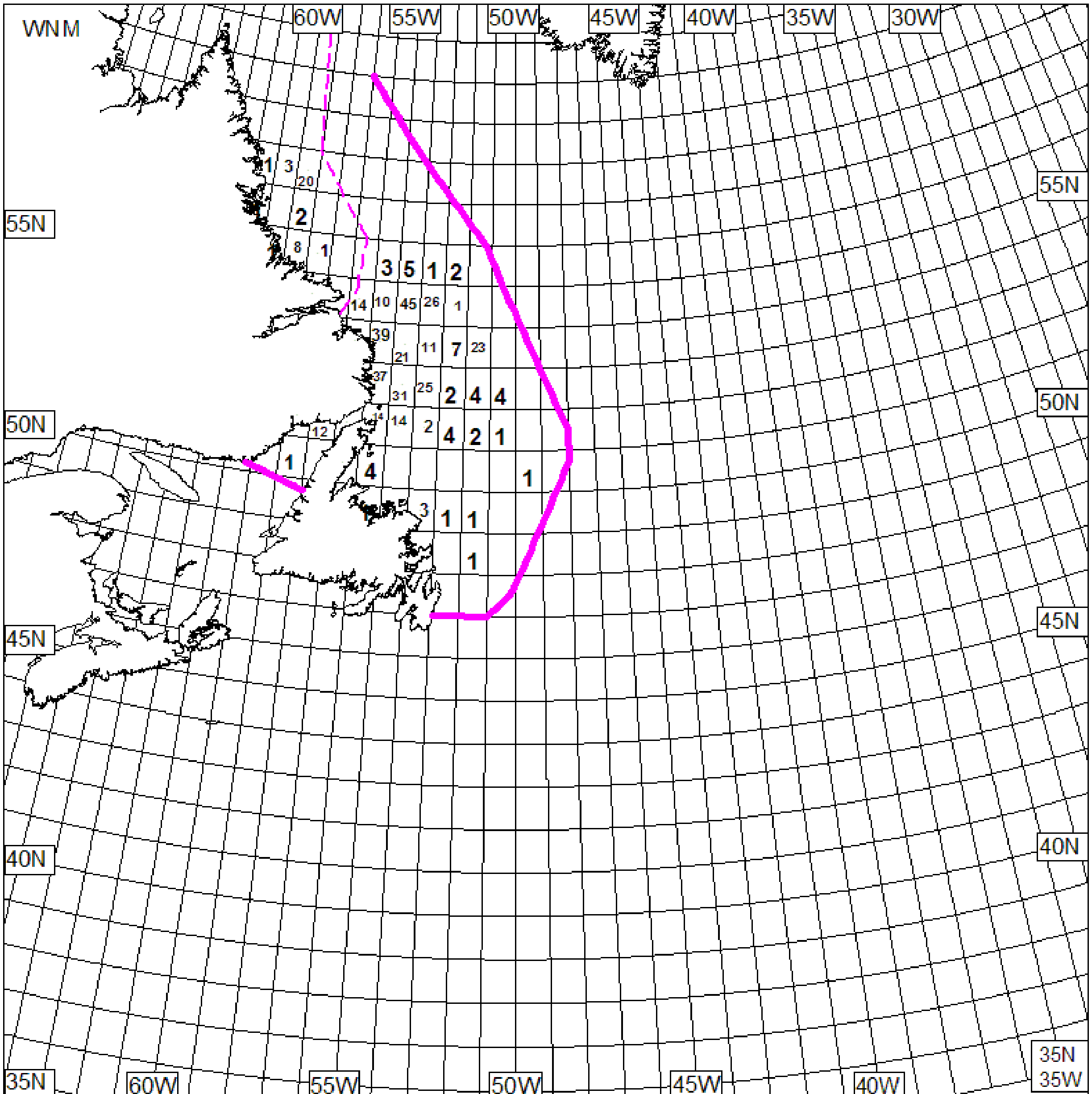
ICEBERG LIMIT / LIMITE DES ICEBERGS SEA ICE LIMIT / LIMITE DES GLACES # ICEBERGS PER DEGREE SQUARE ICEBERGS PAR DEGRE CARRE ⊗ RADAR TARGET OUTSIDE ICEBERG LIMIT CIBLE RADAR A L'EXTERIEUR DE LA LIMITE DES ICEBERGS	NOTE / NOTER: FOR MORE INFORMATION: POUR PLUS DE RENSEIGNEMENT: WWW.USCG-IIP.ORG OR/OU HTTP://ICE-GLACES.EC.GC.CA



NORTH AMERICAN ICE SERVICE SERVICE DES GLACES DE L'AMERIQUE DU NORD	ICEBERG ANALYSIS / ANALYSE D'ICEBERGS FOR / POUR 1200 UTC **15 MAY / MAI 2011**
ICEBERG LIMIT / LIMITE DES ICEBERGS SEA ICE LIMIT / LIMITE DES GLACES # ICEBERGS PER DEGREE SQUARE ICEBERGS PAR DEGRE CARRE RADAR TARGET OUTSIDE ICEBERG LIMIT CIBLE RADAR A L'EXTERIEUR DE LA LIMITE DES ICEBERGS	NOTE / NOTER: FOR MORE INFORMATION: POUR PLUS DE RENSEIGNEMENT: WWW.USCG-IIP.ORG OR/OU HTTP://ICE-GLACES.EC.GC.CA



NORTH AMERICAN ICE SERVICE
SERVICE DES GLACES
DE L'AMERIQUE DU NORD

ICEBERG ANALYSIS / ANALYSE D'ICEBERGS
FOR / POUR 1200 UTC

31 MAY / MAI 2011

ICEBERG LIMIT / LIMITE DES ICEBERGS

SEA ICE LIMIT / LIMITE DES GLACES

\# ICEBERGS PER DEGREE SQUARE
ICEBERGS PAR DEGRE CARRE

⨂ RADAR TARGET OUTSIDE ICEBERG LIMIT
CIBLE RADAR A L'EXTERIEUR DE LA LIMITE DES ICEBERGS

NOTE / NOTER:

FOR MORE INFORMATION:
POUR PLUS DE RENSEIGNEMENT:

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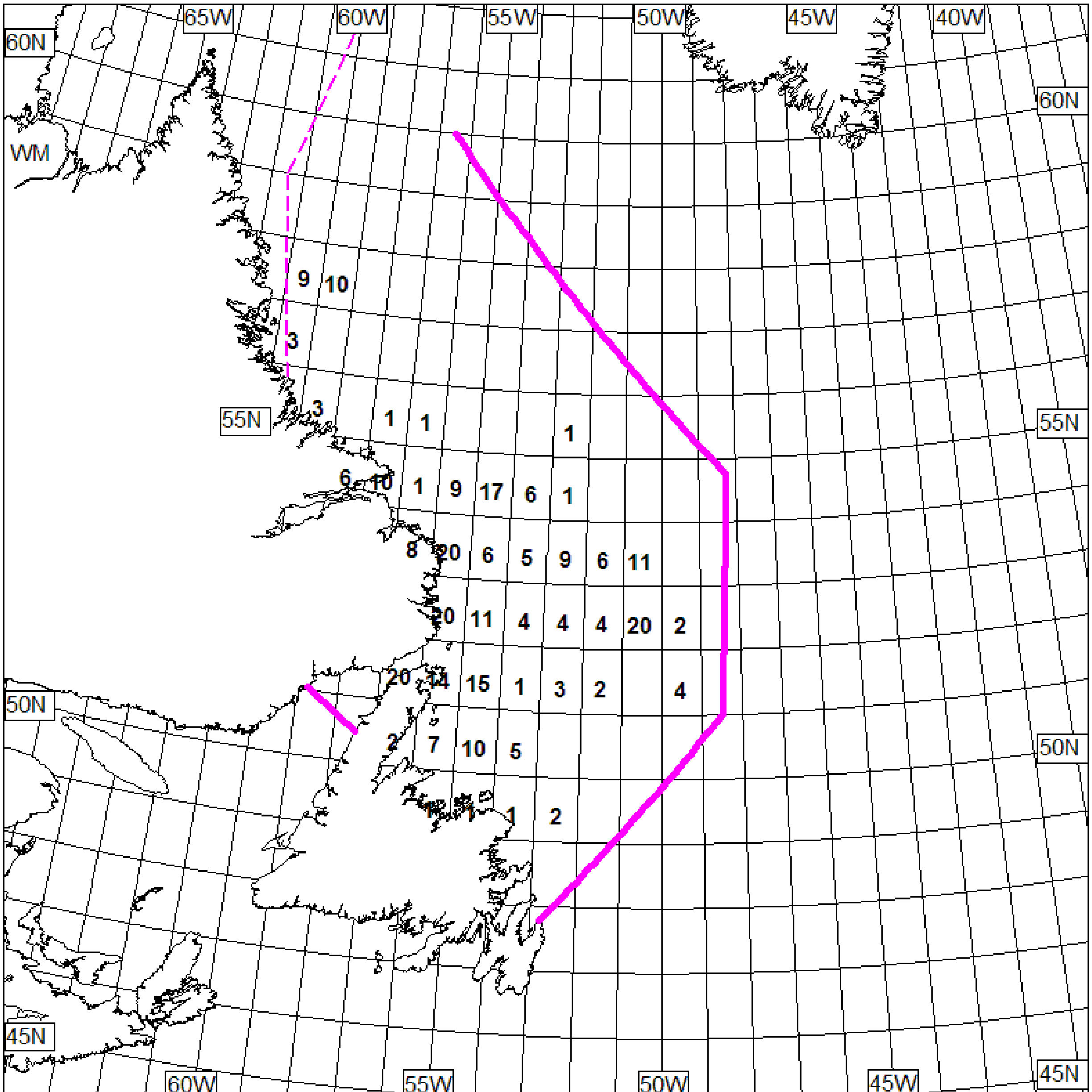
HTTP://ICE-GLACES.EC.GC.CA



NORTH AMERICAN ICE SERVICE
SERVICE DES GLACES
DE L'AMERIQUE DU NORD

ICEBERG ANALYSIS / ANALYSE D'ICEBERGS
FOR / POUR 1200 UTC

15 JUN / JUN 2011

ICEBERG LIMIT / LIMITE DES ICEBERGS

SEA ICE LIMIT / LIMITE DES GLACES

ICEBERGS PER DEGREE SQUARE / ICEBERGS PAR DEGRE CARRE

⊗ RADAR TARGET OUTSIDE ICEBERG LIMIT / CIBLE RADAR A L'EXTERIEUR DE LA LIMITE DES ICEBERGS

NOTE / NOTER:

FOR MORE INFORMATION:
POUR PLUS DE RENSEIGNEMENT:

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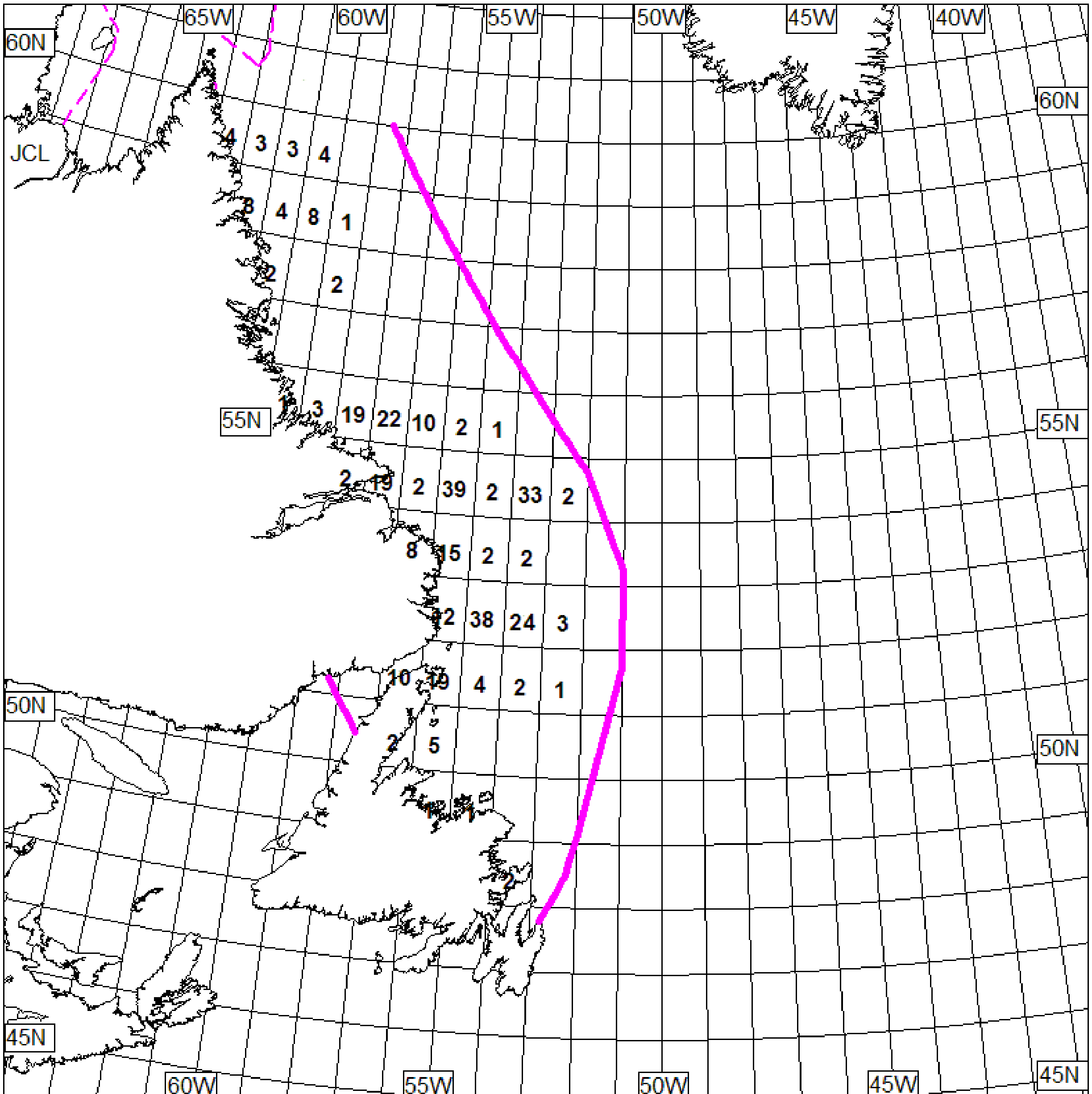
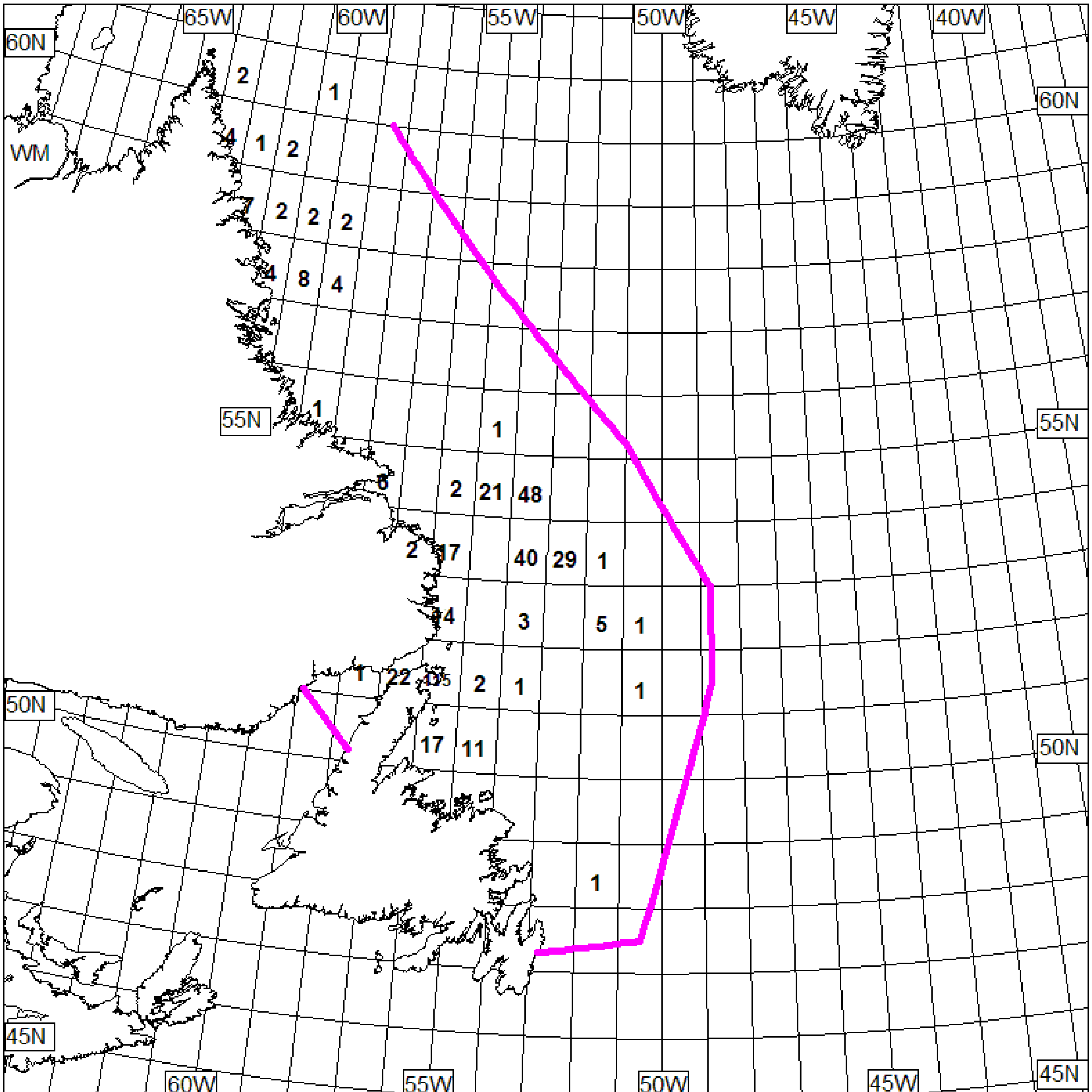


NORTH AMERICAN ICE SERVICE SERVICE DES GLACES DE L'AMERIQUE DU NORD	ICEBERG ANALYSIS / ANALYSE D'ICEBERGS FOR / POUR 1200 UTC **30 JUN / JUN 2011**
ICEBERG LIMIT / LIMITE DES ICEBERGS SEA ICE LIMIT / LIMITE DES GLACES # ICEBERGS PER DEGREE SQUARE ICEBERGS PAR DEGREE CARRE ⊗ RADAR TARGET OUTSIDE ICEBERG LIMIT CIBLE RADAR A L'EXTERIEUR DE LA LIMITE DES ICEBERGS	NOTE / NOTER: FOR MORE INFORMATION: POUR PLUS DE RENSEIGNEMENT: WWW.USCG-IIP.ORG OR/OU HTTP://ICE-GLACES.EC.GC.CA



NORTH AMERICAN ICE SERVICE
SERVICE DES GLACES
DE L'AMERIQUE DU NORD

ICEBERG ANALYSIS / ANALYSE D'ICEBERGS
FOR / POUR 1200 UTC

15 JUL / JUI 2011

ICEBERG LIMIT / LIMITE DES ICEBERGS

SEA ICE LIMIT / LIMITE DES GLACES

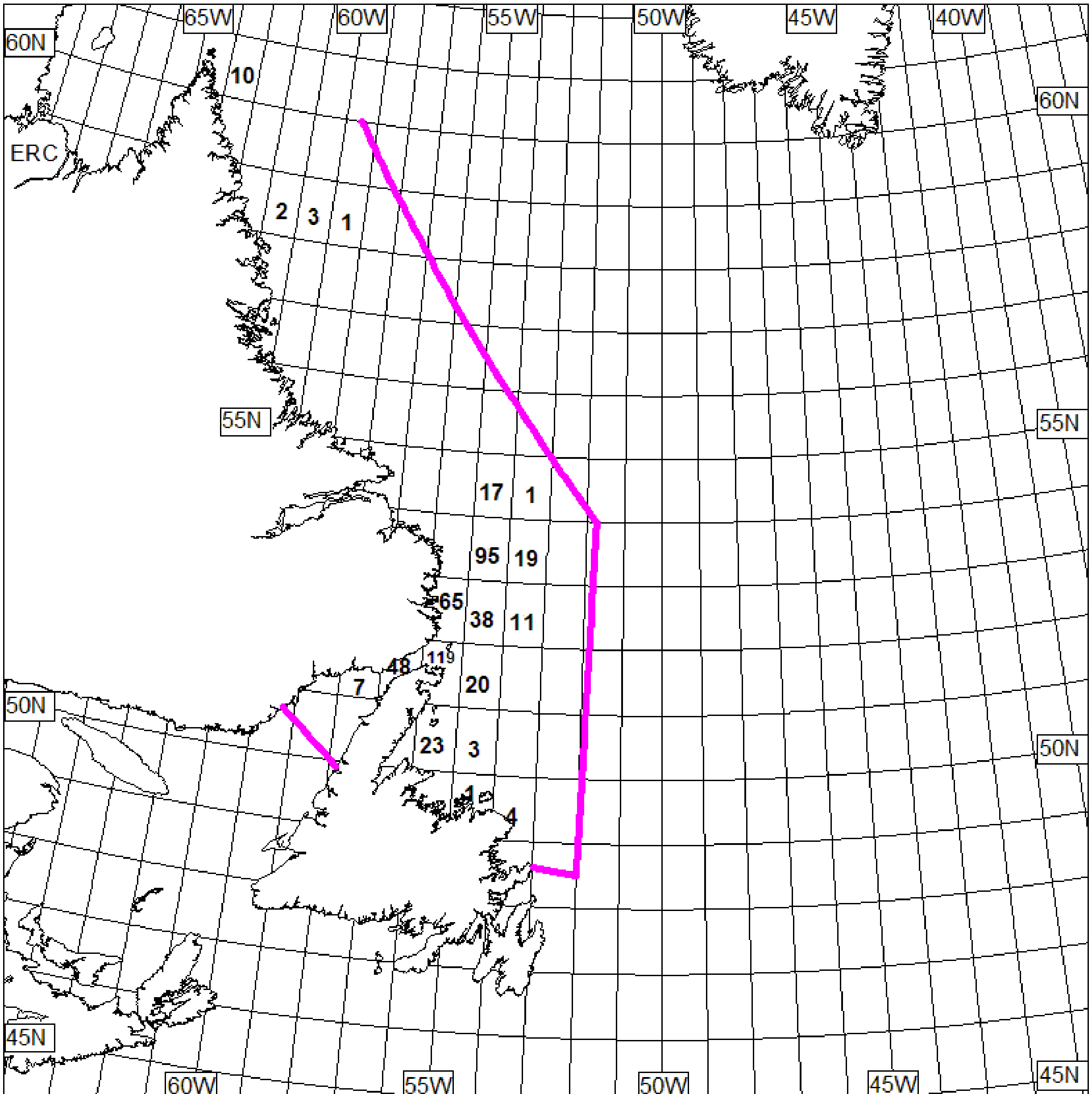
ICEBERGS PER DEGREE SQUARE
ICEBERGS PAR DEGRE CARRE

⊗ RADAR TARGET OUTSIDE ICEBERG LIMIT
CIBLE RADAR A L'EXTERIEUR DE LA LIMITE DES ICEBERGS

NOTE / NOTER:

FOR MORE INFORMATION:
POUR PLUS DE RENSEIGNEMENT:

WWW.USCG-IIP.ORG OR/OU
HTTP://ICE-GLACES.EC.GC.CA



NORTH AMERICAN ICE SERVICE SERVICE DES GLACES DE L'AMERIQUE DU NORD	ICEBERG ANALYSIS / ANALYSE D'ICEBERGS FOR / POUR 1200 UTC **31 JUL / JUI 2011**
ICEBERG LIMIT / LIMITE DES ICEBERGS SEA ICE LIMIT / LIMITE DES GLACES # ICEBERGS PER DEGREE SQUARE ICEBERGS PAR DEGRE CARRE ⊗ RADAR TARGET OUTSIDE ICEBERG LIMIT CIBLE RADAR A L'EXTERIEUR DE LA LIMITE DES ICEBERGS	NOTE / NOTER: FOR MORE INFORMATION: POUR PLUS DE RENSEIGNEMENT: WWW.USCG-IIP.ORG OR/OU HTTP://ICE-GLACES.EC.GC.CA

Acknowledgements

Commander, International Ice Patrol acknowledges the following organizations for providing information and assistance:

Canadian Coast Guard
Canadian Forces
Canadian Ice Service
Canadian Maritime Atlantic Command Meteorological and Oceanographic Center
C-CORE
Department of Fisheries and Oceans Canada
German Federal Maritime and Hydrographic Agency
National Geospatial-Intelligence Agency
National Ice Center
National Weather Service
Nav Canada Flight Services
Provincial Aerospace Limited
U. S. Coast Guard Air Station Elizabeth City
U. S. Coast Guard Atlantic Area Staff
U. S. Coast Guard Automated Merchant Vessel Emergency Response System
U. S. Coast Guard Aviation Training Center Mobile
U. S. Coast Guard Communications Area Master Station Atlantic
U. S. Coast Guard First District Command Center
U. S. Coast Guard First District Staff
U. S. Coast Guard Headquarters Staff
U. S. Coast Guard Intelligence Coordination Center
U. S. Coast Guard Operations Systems Center
U. S. Coast Guard Research and Development Center
U. S. Naval Atlantic Meteorology and Oceanography Center
U. S. Naval Fleet Numerical Meteorology and Oceanography Center

It is important to recognize the outstanding efforts of the personnel assigned to the International Ice Patrol during the 2011 Ice Season:

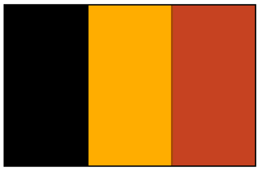
CDR L. K. Mack
LCDR G. G. McGrath
Dr. D. L. Murphy
Mrs. B. J. Lis
LCDR J. L. Cass
LT S. R. Houle
LT E. R. Christensen
MSTCS J. C. Luzader
YN1 I. O. Gonzalez
MST1 W. W. Mendenhall
MST1 K. A. Farah
MST2 G. J. Woolverton
MST2 S. A. Baumgartner
MST2 C. R. Hendry
MST2 W. N. Moran
MST2 S. J. Weitkamp
MST3 M. M. Sanks

International Ice Patrol Staff produced this report using Microsoft® Office Word & Excel 2007.

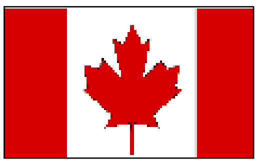
Appendix A

Contracting Nations

Belgium



Canada



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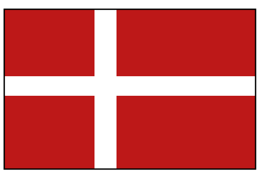
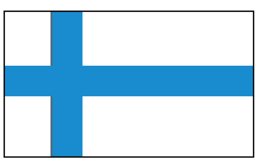


Finland



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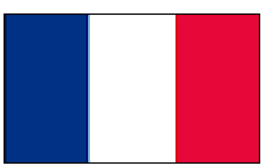
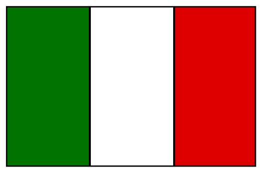


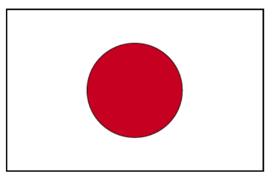
Germany

Greece

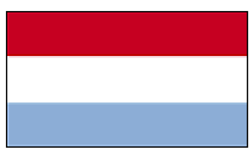
Italy



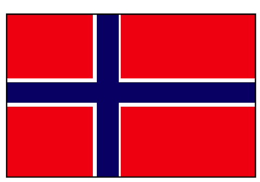
Japan



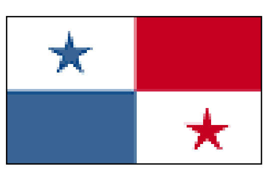
Netherlands



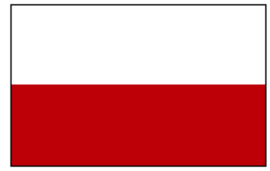
Norway



Panama

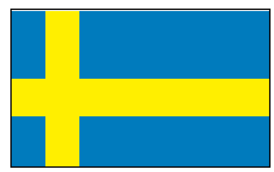


Poland

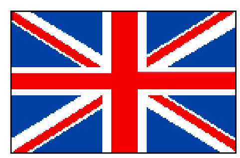


Spain

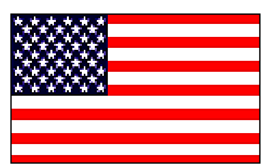
Sweden



United Kingdom



United States of America



Appendix B

Ship Reports for Ice Year 2011 (Oct 1st, 2010 – Sep 30th, 2011)

Ships Reporting By Flag	Reports
BAHAMAS	
AJAX	5
CLIPPER LEADER	1
FEDERAL FUJI	1
JAEGER ARROW	1
LAKATAMIA	3
MIEDWIE	15
PODLASIE	14
STORM RANGER	1
BARBADOS	
FEDERAL MASS	3
FEDERAL RHINE	5
FEDERAL SAGUENAY	4
BERMUDA	
MILAN EXPRESS	1
CANADA	
ALGONOVA	2
ALGOSCOTIA	1
ATLANTIC ENTERPRISE	1
GB OCEAN BILLOW	1
JIM KILABUK	1
MARIA DESGAGNES	1
MATTEA	1
MOKAMI	1
SALARIUM	3
UMIAK 1	8
CHINA, PEOPLES REPUBLIC	
BALTIC ID	2
DARYBRAHMA	7
CYPRUS	
FEDERAL DANUBE	4
FEDERAL POWER	1
IRYDA	6
ISA	37
ISADORA	14
ISOLDA	2
ELBE	5
ISOLDA	16
DENMARK	
MAERSK BELFAST	1
OCEAN TIGER	1
OW ATLANTIC	2

Ships Reporting By Flag	Reports
FINLAND	
MT PURHA	8
PALVA	19
FRANCE	
SAMCO AMERICA	5
GERMANY	
METEOR	1
SEAPIKE	8
GIBRALTAR	
TRANSHAWK	4
GREECE	
ANANGEL ARGONAUT	2
CAP CHARLES	31
CAP LAURENT	4
CAP PIERRE	96
CAP THEODORA	1
MINERVA GEORGIA	10
HONG KONG	
OOCL Belgium	2
OOCL MONTREAL	1
IRISH REPUBLIC	
ARKLOW MEADOW	4
ISLE OF MAN	
BET PRINCE	1
BRITISH TRANQUILLITY	6
HAVELSTERN	1
ITALY	
SOUTH RIVER	3
LIBERIA	
CAPE AGAMEMNON	3
*EVA N	208
HS ELEKTRA	3
ZIEMIA ZAMOJSKA	12
RUGIA	14
UMANG	4
ZIEMIA LODZKA	27
MALTA	
ANTHIA	1
BOGDAN	3
MICHAEL S	2

MARSHALL ISLANDS	
FEDERAL WESER	1
JURKALNE	2
MAESTRO TIGER	1
NETHERLANDS	
ALASKABORG	1
CFL PROSPECT	5
FLEVOBORG	3
FLINTERDUIN	5
MAERSK PALERMO	1
MAERSK PEMBROKE	7
METSABORG	1
ORANJEBORG	1
QAMUTIK	3
UMIAVUT	1
NETHERLANDS ANTTILLES	
MEDEMBORG	1
NORWAY	
SKS DEE	8
TIRRANNA	23
ARCTIC SUNRISE	1
PANAMA	
BLUE BAIE	4
C. DISCOVERY	1
CAROUGE	1
CEPHEUS LEADER	4
EVER URBAN	4
GRAND DIVA	7
PHOENIX LIGHT	7
RUSSIA	
NOVAYA ZEMLYA	3

SINGAPORE	
TORM LANA	2
SWEDEN	
ATLANTIC COMPANION	2
TRANSFIGHTER	2
TAIWAN	
CHINA STEEL DEVELOPER	2
UNITED KINGDOM	
CMA CGM GEORGIA	11
MONTREAL EXPRESS	1
NEW ORLEANS EXPRESS	1
TORONTO EXPRESS	1
UNITED STATES OF AMERICA	
KNORR	103
UNKNOWN	
SHIP	9
VANUATU	
SOLIDARNOSC	11

*** DENOTES CARPATHIA AWARD WINNER**

IIP awards the vessel that submits the most reports each year. The award is named after the *Carpathia*, credited with rescuing 705 survivors of the *Titanic* disaster.

Appendix C

NAIS Iceberg Chart Harmonization

Introduction

In June 2010, the International Ice Patrol (IIP) joined the North American Ice Service (NAIS) Collaborative Arrangement, formalizing a longstanding and productive partnership with the Canadian Ice Service (CIS) and the U.S. National Ice Center (NIC). The Collaborative Arrangement is an Annex of the Memorandum of Understanding between the U.S. National Oceanic Atmospheric Administration and Environment Canada for collaboration on weather, climate, and other earth systems for the enhancement of health, safety and economic prosperity.

The goal of NAIS is to transform individual organizational strengths into a unified source of ice information and meet all marine ice information needs and obligations of the U.S. and Canadian governments. To that end, NAIS is working on harmonizing products among the services to create seamless information for mariners from any of the three services. The Summary of Operations chapter covers some of the details and mechanics of iceberg chart harmonization including procedural challenges while this appendix covers high-level challenges, benefits and risks, and lessons learned during this initial iceberg product harmonization.

Background

In the mid-2000s, NAIS started harmonizing products with ice information products for the Great Lakes, an adjoining area of responsibility. NAIS then moved to harmonization of iceberg information products for the North Atlantic, an overlapping area of responsibility. CIS and IIP historically shared environmental data, iceberg information, and reconnaissance results, as well as an iceberg model. However, they had different customer bases and traditionally produced separate iceberg analyses. CIS produced a daily iceberg analysis year-round and IIP produced a daily iceberg analysis when icebergs threatened transatlantic shipping lanes (as determined by Commander, IIP). When IIP was producing daily products, CIS used IIP's limit on their products. Technical advancements and the NAIS collaborative effort resulted in changes to CIS and IIP processes that made producing one iceberg analysis between the services a logical next step.

In 2006, CIS and IIP had the technical means to synchronize their iceberg model databases rather than CIS passing IIP iceberg information as icebergs drifted south of 52°N. The synchronization ensured that both iceberg models reflected the iceberg information received by the other service. This was a key achievement because the combination of a synchronized database and identical models meant both services could focus on standardizing the operating procedures and creating consistent products. In 2007, in part due to the synchronization effort in 2006, and in part to ensure day-to-day consistency, IIP started drawing the iceberg limit up to 58°N. However, IIP products did not publish the limit up to 58°N and indicated that the iceberg limit north of 50°N was available from CIS. This practice continued until 2009 when the IIP chart was modified to show iceberg density by number in one-degree of latitude by one-degree of longitude squares up to 58°N vice an ‘area of many bergs’, a term used only by IIP.

In fall 2009, CIS and IIP held a workshop to develop a common chart template. Following this workshop, they agreed to start publishing one daily iceberg analysis between the two services under the NAIS Collaborative Arrangement. IIP agreed to publish iceberg products for the NAIS operations area (**Figure 1**) from 1 February through 31 July to coincide with the normal timeframe that IIP was traditionally publishing daily products for both Canadian and international waters. CIS agreed to publish iceberg products from 1 Aug to 31 Jan when the iceberg population is normally limited to Canadian waters only. This agreement was intended to result in a shift to temporal vice geographic responsibility for each service.

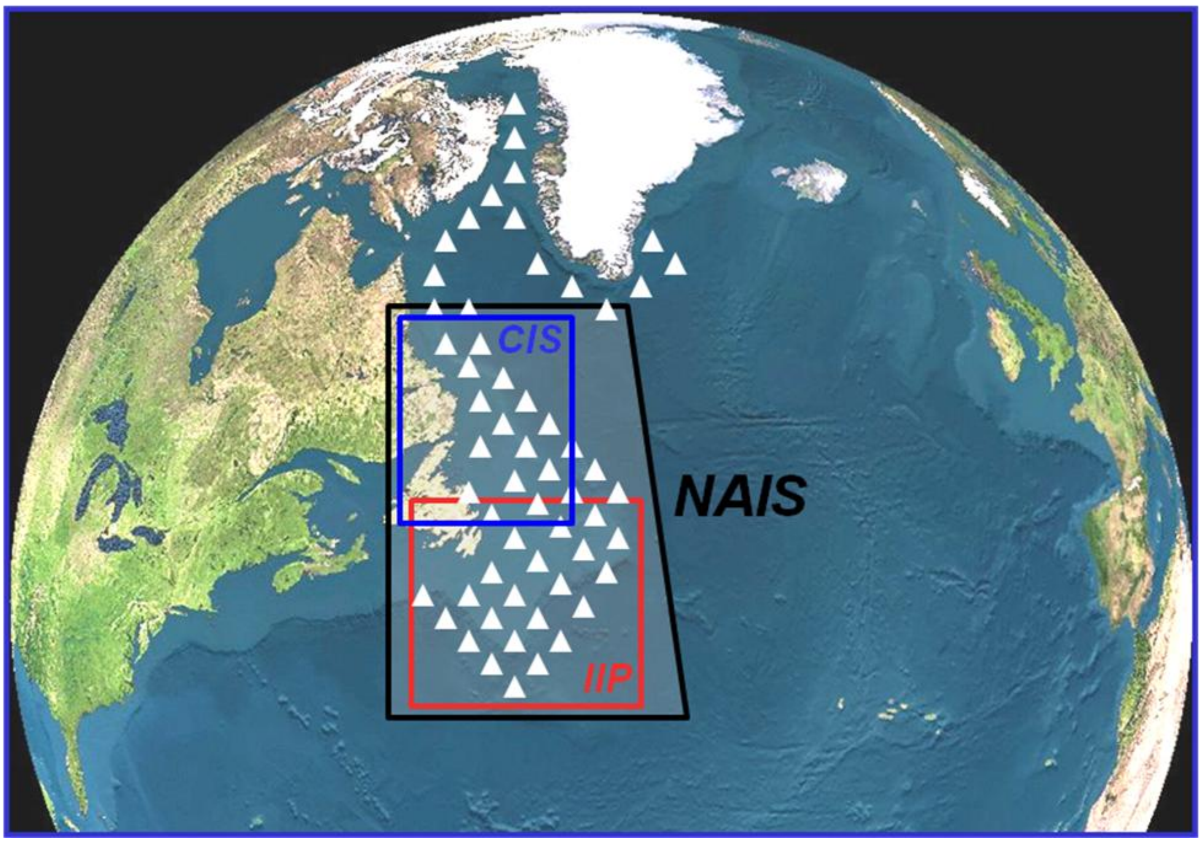


Figure 1. CIS (blue) and IIP (red) traditional areas of responsibility and the new NAIS (black) operations area.

By the eighth annual NAIS meeting in June 2010, a joint NAIS iceberg chart template (**Figure 2**) had been developed and the decision was made to proceed with implementation in February 2011. The effort stalled temporarily due to significant personnel turnover at IIP and several personnel deployments to the servicewide response to the Deepwater Horizon oil spill in the Gulf of Mexico. In early October 2010, IIP identified the major challenges of implementation. High-level questions regarding the legal standing of NAIS, the liability of each service, and language considerations arose. Additional challenges included notifying mariners of the planned changes, standardizing procedures and terminology between the services, finalizing the chart template and production processes, and ensuring auxiliary information products produced a consistent and accurate message. In the following months, these challenges were addressed and on 1 February 2011, IIP published the first NAIS iceberg chart that was distributed to mariners by both CIS and IIP.

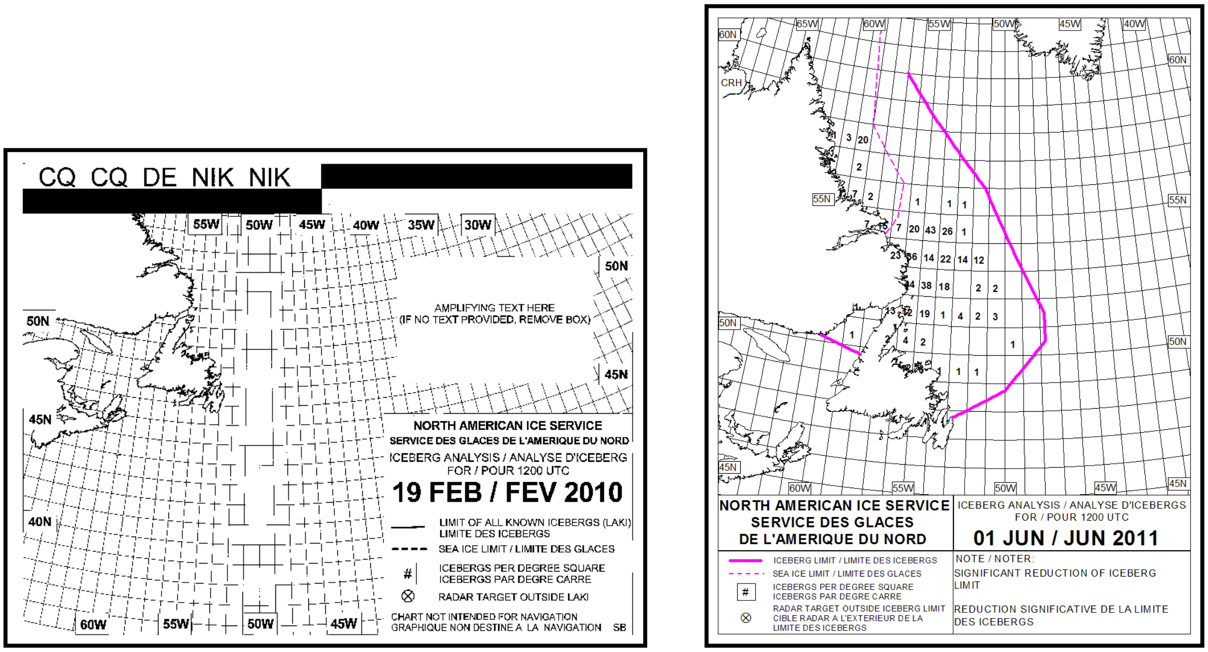


Figure 2. Initial NAIS iceberg chart template and actual chart from the 2011 season**.**

High-Level Challenges

One of the first challenges to consider was the legal standing of NAIS in terms of liability. Commander, IIP worked with the U.S. Coast Guard Headquarters Office of International Law via the Program Manager to address this issue. After review, the Office of International Law indicated that the NAIS Collaborative Arrangement had no legal standing but that issuing products under the Arrangement was acceptable because the product was traceable back to either CIS or IIP.

Additionally, Commander, IIP worked with the Office of International Law to address the potential increased operational risk of additional spatial and temporal liability. Some additional spatial liability was incurred in 2009 when IIP started publishing a chart that displayed the iceberg population up to 58°N. Under harmonization, IIP would be setting and publishing the iceberg limit up to 60°N and west of the Strait of Belle Isle, areas IIP had not provided information on previously. Additional temporal liability was incurred by committing to a specified timeframe for publishing iceberg products. IIP was likely to be publishing products at times it traditionally would not have, primarily early and late in the season that previously relied on Commander, IIP decisions. Secondarily, during a very light iceberg season as in 2010, IIP was likely to be publishing products at times it traditionally would not have been publishing daily products and when there was no iceberg threat on the Grand Banks. Likewise, CIS was in the position of potentially incurring some additional temporal and geographic liability if icebergs remained south of 48°N after they took responsibility on 1 August.

In response, the Office of International Law indicated that the broad authority of SOLAS, particularly the verbiage indicating that "during the rest of the year the study and observation of ice conditions shall be maintained as advisable" allowed the additional spatial and temporal responsibilities incurred. In addition, the Office of International Law recommended including a disclaimer on iceberg information products to indicate what areas were explicitly covered by the daily products and what areas were not covered. Such a disclaimer was developed and agreed on with CIS to be published in a chart information sheet available to product users.

A third challenge under harmonization was reconciling the language requirements of the Canadian government to publish in both English and French. The chart template was developed in both languages but some concessions for space were made. However, there was concern that the text products, particularly those abbreviated for NAVTEX distribution, would become unwieldy using both languages. The Office of International Law indicated that both English and French are official and working languages of the International Maritime Organization and that English is the standard notification language for the Global Maritime Distress and Safety System. Additionally, publishing in both languages did not invalidate any products. Currently the graphic Iceberg Chart is bilingual. The text Iceberg Bulletin and NAVTEX distributed by Ice Patrol is in English only but the CIS text Iceberg Bulletin, primarily for domestic waters is produced in both languages. At this time, CIS and IIP continue to harmonize the text products and intend to meet the dual language requirements where necessary.

Benefits and Risks

There were several challenges of product harmonization at many levels that took significant time and effort by both CIS and IIP to resolve. The main benefits of moving to harmonized products between IIP and CIS were reducing redundancy, improving efficiency, and ultimately providing a better product to the maritime community with a customer-focused approach. A single NAIS iceberg analysis will serve mariners better, particularly for approaches to the Strait of Belle Isle, and will improve IIP's situational awareness of the iceberg population north of the Grand Banks.

The main risks for IIP of moving to NAIS products were the liability issues discussed above. Additionally, there was some concern about the loss of identity or less visibility as an independent ice service. This was evaluated as acceptable to move the NAIS organization forward. In addition, prior to harmonization, CIS and IIP agreed to maintain their current reconnaissance strategies. There is some risk that a future reduction of iceberg reconnaissance by CIS could result in IIP having to conduct iceberg reconnaissance when it traditionally may not have in order to ensure the accuracy of products in the timeframe of IIP responsibility. Due to a light season in 2011, the overall picture of the success of harmonization remains to be seen. An average iceberg season will be a true test of the overall concept, particularly in terms of reconnaissance coverage and resources.

Lessons Learned

Embarking on chart harmonization had broad effects on other areas of IIP operations. IIP's relationship with the U.S. National Geospatial-Intelligence Agency, as the NAVAREA IV

Coordinator responsible for out-of-season iceberg notification, had to be evaluated for continued applicability. That effort was delayed during IIP's period of responsibility and is being evaluated now. CIS and IIP also had to reconsider how they received iceberg reports and for which areas. Prior to harmonization, mariners were requested to provide iceberg sighting information to CIS or IIP depending on the iceberg population. Chart harmonization suggested that one receiver of iceberg reports for the North Atlantic would be beneficial. That issue is also currently being evaluated.

The most significant lesson learned from iceberg chart harmonization was the sequence of steps (**Figure 3**) that should be taken for future product harmonization within NAIS. The harmonization started with production of a chart template and worked from that effort to determine major issues and challenges. In fact, starting with a discussion of the philosophy and goals of harmonizing would likely have been much more illustrative of the lack of common IT infrastructure, procedures, and workflow that are being addressed now. Although such a discussion may have delayed implementation of a harmonized iceberg chart it may have resulted in a far more efficient harmonization process.

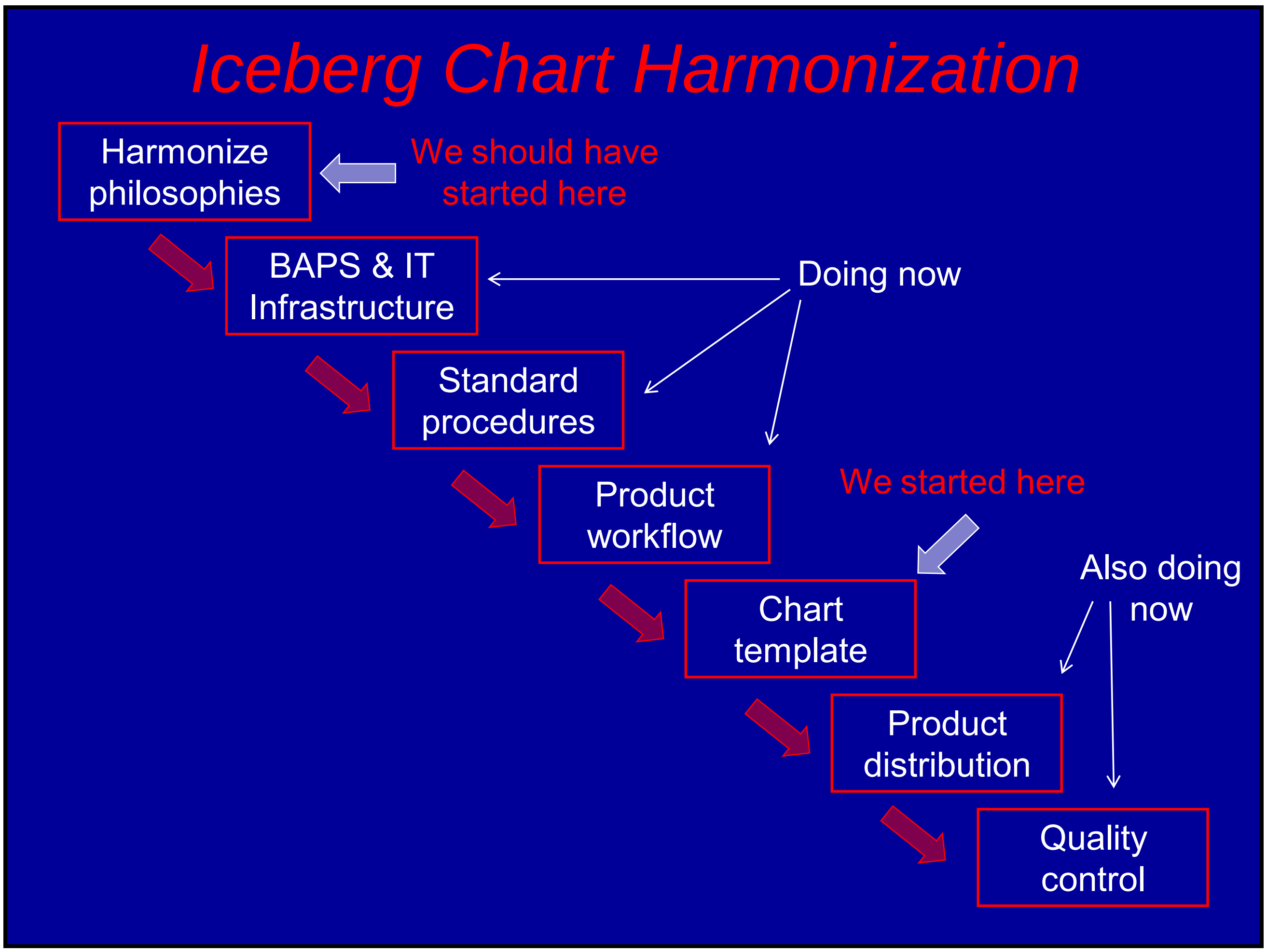


Figure 3: Suggested sequence of steps for future product harmonization within NAIS.

Future Steps

As IIP ended their period of NAIS responsibility in 2011, efforts began toward standardizing procedures and workflow for full iceberg product harmonization in 2012. Evaluating product distribution and quality control as well as developing a joint NAIS reconnaissance strategy for light and average iceberg seasons are in progress.

Finally, once iceberg product harmonization is complete, an evaluation of whether the process was worth the significant effort is needed. A measured examination of improvements in efficiency, reduction in resources, and improved service to mariners will be required to fully answer that question. Due to a light season in 2011, the overall picture of the success of harmonization remains to be seen - an average iceberg season will be a true test of the overall concept, especially in terms of reconnaissance coverage and resources.

Significant work remains but the harmonization of the iceberg chart in 2011 was a significant step toward the larger goal of harmonizing the iceberg programs at CIS and IIP.

Appendix D

International Ice Patrol's Iceberg Counts 1900-2011

Donald L. Murphy

Introduction

Each year, the International Ice Patrol (IIP) estimates the number of icebergs that pass south of 48°N, the latitude south of which icebergs are considered a menace to North Atlantic mariners. The dataset (**Table 1** represented in **Figure 1**) extends from 1900, 12 years before the sinking of *RMS Titanic*, to the present.

For several reasons, these iceberg counts do not constitute a rigorous, scientific data set and should be interpreted with great care. For example, IIP's reconnaissance operations focus on the icebergs closest to the transatlantic shipping routes, and rarely does IIP conduct a comprehensive survey of the area south of 48°N. In addition, the methods of observation have changed radically over the years as new technologies became available to detect and track icebergs. The earliest data were obtained from visual observations from early 1900s sailing vessels, while the recent information is obtained from visual and radar observations from modern ships, aircraft, and satellites.

Origins of the Data

The origin of **Table 1** can be traced to the 1926 IIP Annual Report in which monthly iceberg counts were presented for 1900 through 1926. The early part of the iceberg history was reconstructed with data gleaned from mariner's reports to the United States Hydrographic Office, mostly those printed in the Hydrographic Bulletin, and IIP records (IIP, 1926). In all the years that followed, IIP has presented monthly iceberg counts from its own records and published them in its annual reports.

Changes in the Definition of the Ice Year

Table 1 reflects the current definition of the ice year, which extends from October through the following September. The yearly total is simply the summation of the monthly values. The 111-year mean (1900-2010) is provided to compare with 2011 observations. For each line, the year is based on the year of the January that appears in the line.

At the time of the 1926 reconstruction, the ice year was the same as the calendar year. IIP maintained this convention until 1967 when its definition was changed to September to August. There were two reasons for this change. First, it recognized the seasonal nature of IIP's operations. Icebergs usually stopped arriving on the Grand Bank in late summer and didn't resume until winter, possibly as early as November or December. Thus, the late summer is a natural break in the movement of icebergs onto the Grand Banks. Second, and on a more pragmatic level, IIP did not have wait until the end of the calendar year to prepare its annual report.

The second change followed the 1982 iceberg season, when the ice year was redefined as October through September. This small change was undertaken for two reasons. First, it reduced the likelihood that an ice season would carry over into the following ice year. Second, it fell into line with the U. S. Government's fiscal year. The first reason probably carried more weight; since the 1982 season ended very late (1 September 1982), and IIP was concerned about the carry-over issue.

Each time the definition of the ice year was changed, the yearly totals were recomputed, so the new values would be internally consistent. These computations caused some small inconsistencies with the original yearly totals presented in the various IIP annual reports. For example, in 1940 and 1941 the ice year was the calendar year. In both years it was reported in IIP's annual reports (IIP, 1940 and IIP, 1941) that two icebergs passed south of 48°N during the year. One of these icebergs passed south of 48°N in November 1940 and was originally counted as a 1940 observation. It is now counted as a 1941 observation. Thus, in 1940 there is one iceberg listed, and in 1941, three.

Observations versus Estimates

The earliest counts were simply a total number of icebergs observed south of 48°N. The icebergs were seen by vessels traversing the northwest Atlantic and reported to the U. S. Hydrographic Service or, after 1913, to the Ice Patrol vessel. The details of the counting process are not known, but it is likely that efforts were made to avoid counting duplicate observations. This task is more challenging than it seems. An iceberg's appearance can change dramatically from day to day and the complex ocean currents make it difficult to predict the movement of an iceberg accurately, even for short periods. As a result, IIP was careful to refer to the monthly iceberg counts as estimates (IIP, 1927).

Beginning in 1932, IIP conducted routine oceanographic surveys to determine the ocean currents near the Grand Banks. The resulting current maps were used by the patrol vessels to guide their iceberg searches and help determine whether a reported iceberg had been seen before. This may have improved the ability to recognize whether an iceberg report was for a new detection or a re-sighting of a previously reported iceberg, but the process was far from precise.

Anderson (1993) describes the details of the iceberg counting process from 1960 through 1991. For most of the period, 1960-1988, the estimates were determined by hand counting the paper records of the iceberg reports and the model output. The model output sometimes included icebergs that were seen north of 48°N but were estimated by the model to have drifted south of that latitude, without being seen again. It is likely that this became more common when the computerized version of the iceberg model made it possible to predict the movements of a large number of icebergs.

In 1989, the iceberg-counting process was automated, and has changed little since. The monthly estimates of the number of icebergs passing south of 48°N are determined using the output of IIP's iceberg drift model. The counts include icebergs seen south of 48°N as well as icebergs observed north of 48°N but estimated by the model to have drifted south of 48°N.

Discussion

There is remarkable year-to-year variability evident in the 112-year record of IIP's iceberg counts. The mean number of icebergs estimated to have passed south of 48°N is 474, but the range and year-to-year variability is remarkable. The greatest number of icebergs (2202) occurred in 1984, while twice in IIP's history (1966 and 2006) no icebergs were estimated to have passed south of 48°N for either ice year. Five times in IIP's history there has been at least one iceberg estimated to have passed south of 48°N during each of the months of the ice year; 1915, 1919 through 1921, and 1985. April and May are, by far, the months with the most icebergs entering the shipping lanes.

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	Icebergs South of 48 N
1900	0	0	0	10	0	0	5	32	33	6	1	1	88
1901	1	0	0	1	0	0	4	13	29	22	6	5	81
1902	1	2	5	3	0	1	1	13	5	16	1	0	48
1903	1	0	0	0	2	400	166	151	52	23	7	0	802
1904	0	0	1	0	0	12	63	82	89	14	3	2	266
1905	0	0	0	3	2	168	373	109	100	50	9	8	822
1906	8	0	15	14	11	77	49	133	87	18	16	0	428
1907	0	0	0	0	1	11	162	248	138	64	11	0	635
1908	0	0	3	1	0	7	39	82	51	2	2	20	207
1909	15	3	0	0	55	147	134	321	181	121	45	19	1041
1910	1	0	0	0	0	0	34	10	3	3	0	0	51
1911	0	0	0	0	8	41	112	72	77	21	40	3	374
1912	0	8	14	1	0	34	395	345	159	63	19	0	1038
1913	0	3	0	2	4	37	109	292	71	14	4	7	543
1914	0	6	4	1	41	32	27	419	71	22	46	52	721
1915	13	1	6	14	72	67	96	97	71	28	17	5	487
1916	0	1	0	0	0	0	0	25	29	0	0	0	55
1917	0	0	0	0	0	13	3	3	9	10	0	0	38
1918	0	0	0	0	0	12	23	26	37	27	34	22	181
1919	1	14	3	3	4	5	25	75	56	26	36	69	317
1920	2	12	4	6	43	20	5	211	86	18	5	18	430
1921	19	10	4	17	5	43	210	198	175	53	24	4	762
1922	10	1	6	0	3	35	71	245	83	21	11	6	492
1923	27	21	0	0	3	28	65	83	42	10	3	2	284
1924	0	0	0	3	0	6	2	0	0	0	0	0	11
1925	0	0	0	0	3	5	8	58	22	13	0	0	109
1926	0	0	0	0	3	15	58	168	85	4	6	2	341
1927	3	1	0	4	10	26	93	153	95	5	3	0	393
1928	0	0	0	0	0	14	156	190	87	55	5	0	507
1929	4	4	0	0	0	45	332	460	376	107	1	0	1329
1930	0	18	12	14	116	87	89	101	62	3	1	1	504

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	Icebergs South of 48 N
1931	1	0	0	0	0	2	1	10	0	0	0	0	14
1932	0	0	0	0	1	43	321	90	58	1	0	0	514
1933	0	0	0	0	2	4	12	162	36	0	0	0	216
1934	0	0	0	1	0	0	245	228	87	14	1	0	576
1935	0	0	0	0	0	46	177	501	134	11	3	0	872
1936	0	0	3	0	0	0	8	14	0	0	0	0	25
1937	0	0	0	20	53	121	124	137	14	1	0	0	470
1938	0	0	0	2	3	38	212	286	110	13	0	0	664
1939	0	0	0	0	0	22	173	471	150	28	6	0	850
1940	0	0	0	0	0	0	0	1	0	0	0	0	1
1941	0	1	0	0	0	0	1	1	0	0	0	0	3
1942	0	0	0	0	0	30	0	0	0	0	0	0	30
1943	0	0	0	0	0	25	90	298	270	150	7	0	840
1944	0	0	0	0	0	31	319	213	106	30	1	0	700
1945	0	0	0	0	6	352	253	256	92	109	15	0	1083
1946	0	0	0	0	2	67	98	168	88	7	0	0	430
1947	0	0	0	3	1	2	5	11	26	15	0	0	63
1948	0	0	0	0	0	60	210	185	68	0	0	0	523
1949	0	0	0	0	0	1	23	20	3	0	0	0	47
1950	0	0	0	0	12	61	183	135	58	7	0	1	457
1951	1	2	0	0	3	2	0	0	0	0	0	0	8
1952	0	0	1	0	0	0	12	2	0	0	0	0	15
1953	0	0	0	0	0	21	11	18	6	0	0	0	56
1954	0	0	0	1	16	47	165	65	16	2	0	0	312
1955	0	0	0	0	0	10	32	14	5	0	0	0	61
1956	0	0	0	0	0	9	13	34	21	3	0	0	80
1957	0	0	0	3	43	41	172	265	288	113	6	0	931
1958	0	0	0	0	0	0	0	0	0	1	0	0	1
1959	0	0	0	0	0	14	266	180	186	43	0	0	689
1960	0	2	3	3	0	0	41	161	44	4	0	0	258
1961	0	0	0	0	6	60	30	16	1	0	1	0	114
1962	1	0	1	0	0	14	70	21	10	3	0	1	121
1963	0	0	0	0	0	4	20	0	1	0	0	0	25
1964	0	0	0	0	3	88	225	19	28	5	1	0	369
1965	0	0	0	0	1	19	33	22	1	0	0	0	76
1966	0	0	0	0	0	0	0	0	0	0	0	0	0
1967	0	0	0	0	0	25	134	209	65	8	0	0	441
1968	0	0	0	0	0	0	104	44	60	14	4	4	230
1969	0	0	0	0	0	0	0	35	17	1	0	0	53
1970	0	0	0	0	0	0	5	2	70	8	0	0	85

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	Icebergs South of 48 N
1971	0	0	0	0	0	31	4	20	7	11	0	0	73
1972	0	0	0	0	40	185	501	559	225	48	26	4	1588
1973	0	0	6	54	110	134	212	159	151	19	1	0	846
1974	0	0	0	0	1	99	345	446	266	168	61	1	1387
1975	0	0	0	0	24	41	10	20	5	0	0	0	100
1976	0	0	0	0	0	33	13	67	35	3	0	0	151
1977	0	0	0	0	3	7	12	0	0	0	0	0	22
1978	0	0	0	0	0	5	28	35	7	0	0	0	75
1979	0	0	0	0	5	20	81	34	9	3	0	0	152
1980	0	0	0	1	3	7	0	9	4	0	0	0	24
1981	0	0	0	0	0	48	10	5	0	0	0	0	63
1982	0	0	0	0	0	17	61	13	94	3	0	0	188
1983	0	0	2	9	165	124	339	465	168	76	4	0	1352
1984	0	0	0	0	0	101	953	484	227	335	93	9	2202
1985	3	11	7	2	57	129	208	205	247	123	39	32	1063
1986	0	0	0	0	3	40	60	59	24	18	0	0	204
1987	0	0	5	2	14	48	76	29	127	15	2	0	318
1988	0	0	0	0	0	8	95	33	20	19	10	2	187
1989	3	0	0	0	19	127	68	39	35	10	0	0	301
1990	0	0	0	0	9	112	376	187	76	26	7	0	793
1991	0	0	0	0	20	115	144	269	1030	325	71	0	1974
1992	0	0	0	0	69	53	99	230	103	171	132	19	876
1993	0	0	16	112	336	276	428	338	188	50	8	1	1753
1994	0	0	0	0	79	529	208	377	387	161	24	0	1765
1995	0	0	0	0	43	385	334	405	218	41	6	0	1432
1996	0	0	0	0	0	4	297	187	108	14	1	0	611
1997	0	0	0	0	10	475	162	238	80	43	3	0	1011
1998	0	0	0	0	5	26	70	1017	247	15	0	0	1380
1999	0	0	0	0	0	1	2	11	5	3	0	0	22
2000	0	0	0	0	0	286	239	212	65	41	0	0	843
2001	0	0	0	0	4	31	31	19	4	0	0	0	89
2002	0	0	0	0	16	173	316	308	64	0	0	0	877
2003	0	0	0	0	0	84	263	494	76	10	0	0	927
2004	0	0	0	0	0	0	24	114	117	7	0	0	262
2005	0	0	0	0	0	9	1	1	0	0	0	0	11
2006	0	0	0	0	0	0	0	0	0	0	0	0	0
2007	0	0	0	0	0	4	40	71	183	26	0	0	324
2008	0	0	0	0	0	45	712	173	43	3	0	0	976
2009	0	0	0	0	0	286	266	450	180	21	1	0	1204
2010	0	0	0	0	0	0	0	0	1	0	0	0	1

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	Icebergs South of 48 N
2011	0	0	0	0	0	0	0	3	0	0	0	0	3
Total 1900-2011	115	121	121	310	1573	6745	13785	16494	9406	3238	890	320	53118
Mean 1900-2011	1	1	1	3	14	60	123	147	84	29	8	3	474
Mean 1900-2010	1	1	1	3	14	61	124	149	85	29	8	3	479
YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	TOTAL

Table 1. Number of icebergs estimated by IIP to have passed south of 48° N since 1900.

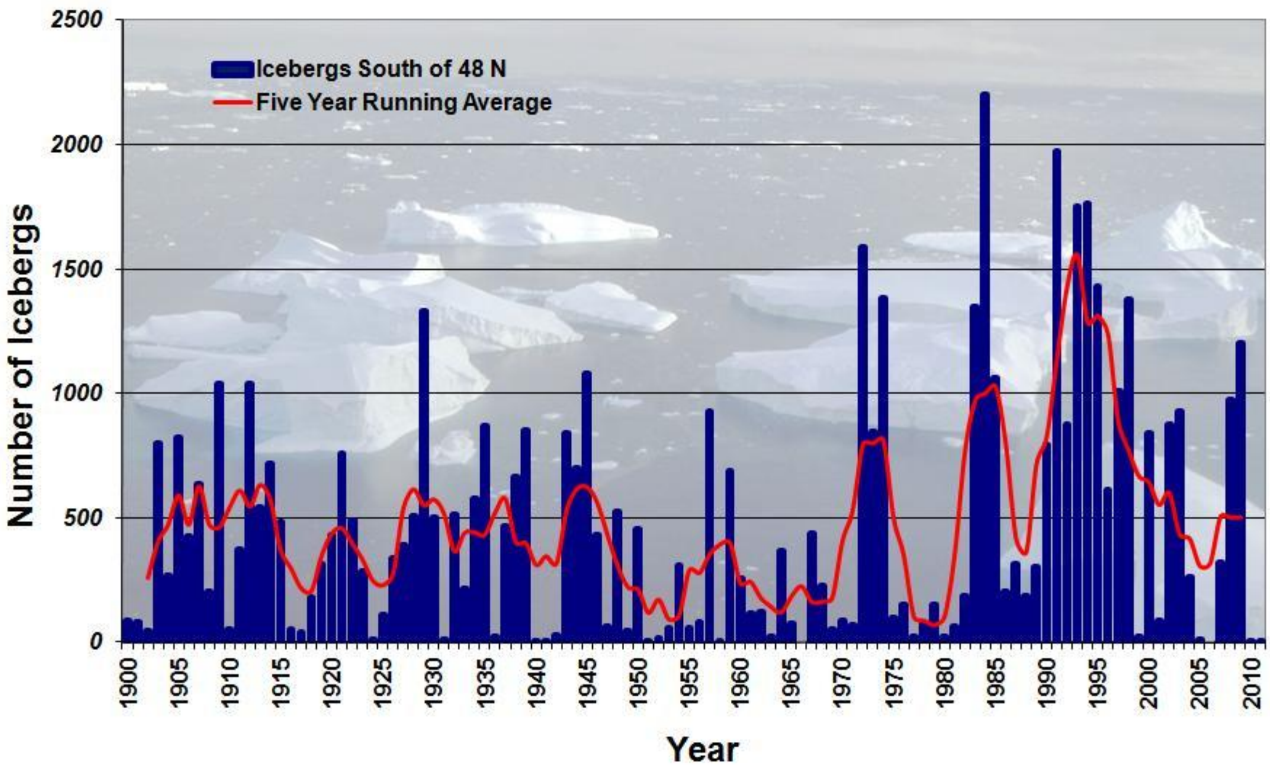


Figure 1. Number of icebergs estimated by IIP to have passed south of 48° N since 1900.

References

Anderson, I., 1993, International Ice Patrol's Iceberg Sighting Data Base 1960-1991, Appendix D in Report of the International Ice Patrol in the North Atlantic, Bulletin No. 79.

International Ice Patrol, 1926. International Ice Observation and Ice Patrol Service in the North Atlantic Ocean, Season of 1926, Bulletin No. 15, 127 p.

International Ice Patrol, 1927. International Ice Observation and Ice Patrol Service in the North Atlantic Ocean, Season of 1926, Bulletin No. 16, 119 p.

International Ice Patrol, 1940. International Ice Observation and Ice Patrol Service in the North Atlantic Ocean, Season of 1940, Bulletin No. 30, 89 p.

International Ice Patrol, 1941. International Ice Observation and Ice Patrol Service in the North Atlantic Ocean, Season of 1941, Bulletin No. 31, 62 p.

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