Homeland Security

United States Coast Guard

Report of the International Ice Patrol in the North Atlantic

2012 Season
Bulletin No. 98
CG-188-67

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Season of 2012

CG-188-67

Forwarded herewith is Bulletin No. 98 of the International Ice Patrol, describing the Patrol's services and ice conditions during the 2012 season. With almost 500 icebergs crossing 48° N, this was a moderate season and the first time in three years that icebergs threatened transatlantic shipping lanes. Fragments of an ice island that calved from the Petermann Glacier in Northern Greenland in August of 2010 finally reached the Grand Banks and contributed to the moderate season. The Ice and Environmental Conditions section presents a discussion of the meteorological and oceanographic conditions during the season.

During 2012, Ice Patrol vigilantly monitored the iceberg danger and generated daily products under the North American Ice Service from February to August while the Canadian Ice Service generated daily products for the remainder of the year. Both services continued harmonization efforts to reduce redundancy and improve efficiency between the services and ultimately improve service to mariners. The details of harmonization are described in the Summary of Operations section and Appendix B. Additionally, an evaluation of the joint reconnaissance strategy developed by the North American Ice Service is described in Appendix C.

Also in 2012, an alternatives analysis study for replacement of the iceberg analysis and prediction system was completed and funding was obtained to start the replacement as described in Appendix D. In February, Ice Patrol conducted the third deployment in three years with the U.S. Coast Guard's HC-144A aircraft for cold-weather evaluation of the platform as described in the Iceberg Reconnaissance section. In April, Ice Patrol commemorated the centennial of the sinking of Titanic, participating in several events including a joint commemorative wreath and rose petal drop over the resting site as described in Appendix E. In July, Dr. Don Murphy, Ice Patrol's Oceanographer since 1984, retired after 35 years of dedicated service to the U.S. Coast Guard.

On behalf of the dedicated men and women of the International Ice Patrol, I hope you enjoy reading this report on the 2012 season.

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

International Ice Patrol
2012 Annual Report

Contents

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Cover: Titanic Centennial Commemoration Art, Mr. Chris Rose, COMDT (CG-1313).

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
FY	Fiscal Year
HC-130J	Missionized C-130 long-range reconnaissance aircraft
HC-144A	Medium-range Maritime Patrol Aircraft
HF	High Frequency
IIP	International Ice Patrol
IDS	Iceberg Detection Software
IRD	Ice Reconnaissance Detachment
KT	Knot or Nautical Mile Per Hour
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
NWS	National Weather Service
OPCEN	Operations Center
PAL	Provincial Aerospace Limited
RADAR	Radio Detection and Ranging (also radar)
SAR	Synthetic Aperture Radar
SOLAS	Safety of Life at Sea
SST	Sea Surface Temperature
WOCE	World Ocean Circulation Experiment

Introduction

This is the 98th 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 2012. 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 ice chart and text bulletin in 2012 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 through May 2012 when he was relieved by RDML Daniel B. Abel.

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

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

Summary of Operations

The International Ice Patrol monitors iceberg danger in the North Atlantic as mandated by the International Convention for the Safety of Life at Sea. IIP works within a collaborative arrangement with the Canadian Ice Service (CIS) and the U.S. National Ice Center (NIC) formally titled the North American Ice Service (NAIS). The mission of NAIS is to leverage the strengths of the three services to monitor and provide the highest quality, timely and accurate ice analysis, in order to meet the needs of maritime interests.

Following successful harmonization of the iceberg chart between CIS and IIP in 2011, continued harmonization efforts were implemented in 2012 with an improved product distribution process. Previously, IIP products were distributed through various e-mails and file transfer protocols (FTP), manually intensive processes prone to error. Now, daily NAIS products are distributed through the product distribution system (PDS) operated by CIS. All products generated by IIP are sent to CIS via one FTP for distribution through the PDS (**Figures 1 and 2**). The PDS converts and distributes the products to IIP customers via e-mail and FTP. The lone exception is the chart to the National Weather Service (NWS). The PDS is not able to convert the NAIS Iceberg Chart into the file format that NWS requires for broadcast. IIP developed a script that converts the chart and distributes it via FTP directly to NWS. IIP utilization of the CIS PDS was a significant step forward towards harmonization and continuity of operations between the services. More details on the harmonization efforts are included in **Appendix B**.

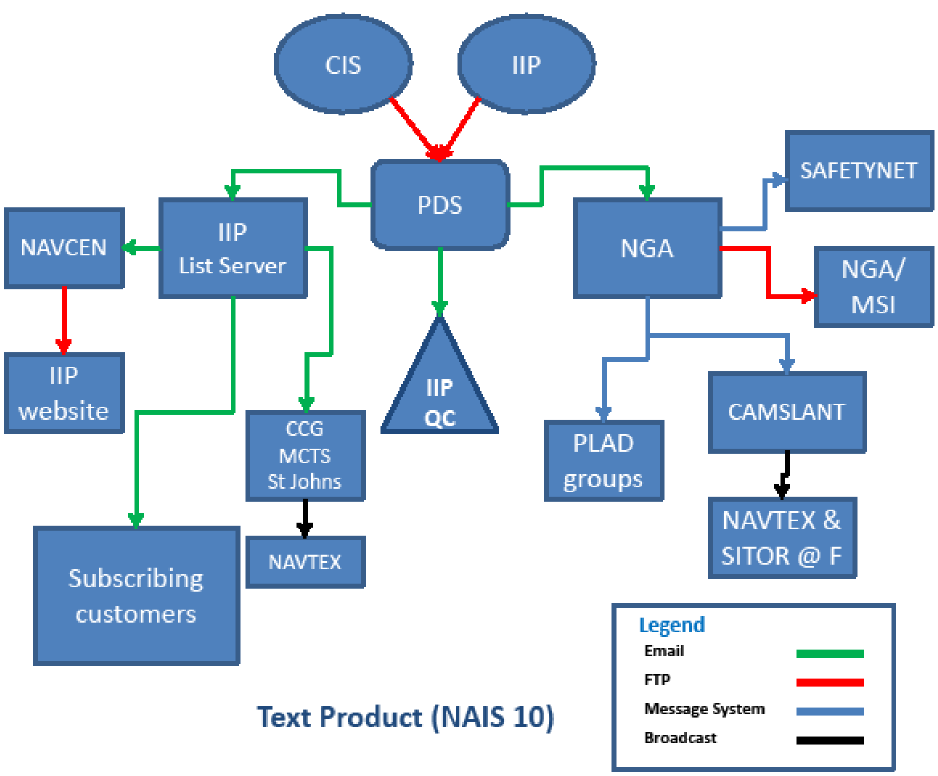

Figure 1. Text product distribution flowchart.

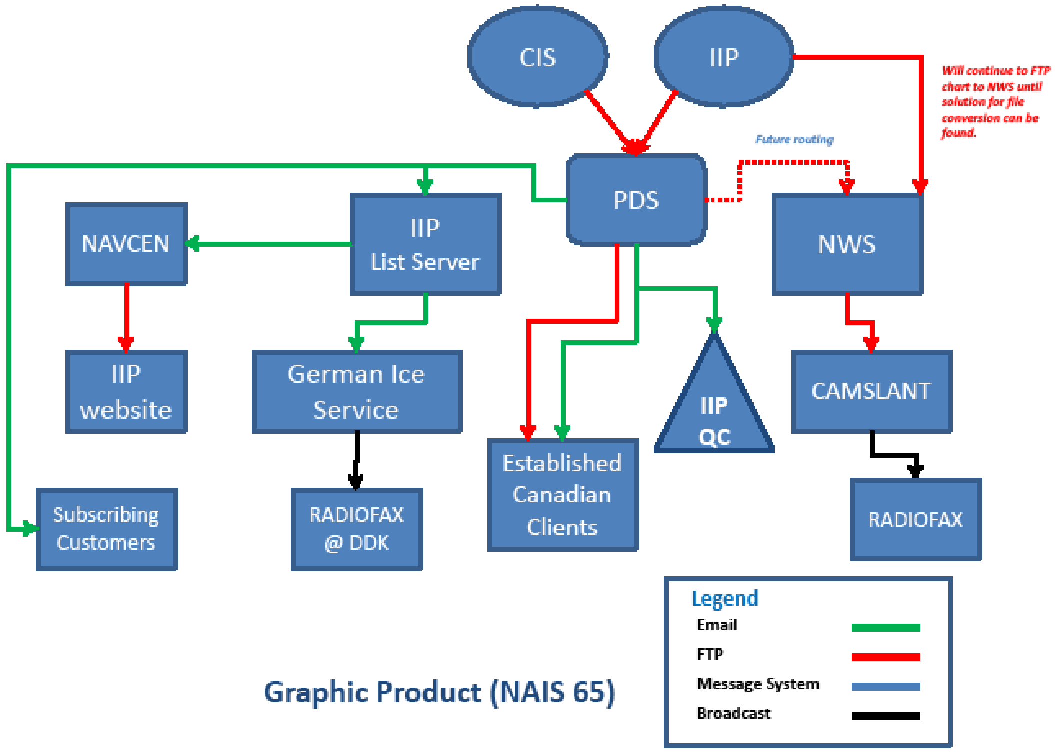

Figure 2. Graphic product distribution flowchart.

Products and Broadcasts

In 2012, IIP transmitted 365 scheduled NAIS Iceberg Bulletins with 99.7% of scheduled NAIS Bulletins reaching SafetyNET (a satellite-based, worldwide maritime safety information broadcast service) on time (prior to or at 0000Z). Bulletins over Simplex Teletype over Radio (SITOR) service via Communications Station Boston were delivered 100% on time. Navigational Telex (NAVTEX) warnings that contain the same information as the Bulletin were delivered 99.5% on time.

Rarely, IIP will receive a report of an iceberg or radar target outside the published limit that challenges the accuracy of the NAIS products and is a threat to safe navigation. The process for reporting icebergs was streamlined in 2012 and Canadian Coast Guard Marine Communications and Traffic Service (MCTS) St. John’s receives most iceberg reports. If MCTS determines that an iceberg or radar target is outside of the published limit they generate and transmit a Notice to Shipping (NOTSHIP). The NOTSHIP is automatically forwarded to the National Geospatial-Intelligence Agency (NGA) and the information is disseminated through a NAVAREA IV warning. This is the primary means of relaying this critical iceberg information to the transatlantic mariner and allows IIP to then produce and transmit a revised product during the active watch. It also ensures that the information is disseminated immediately when IIP’s watch is not active. In this case, products are revised if necessary when the active watch resumes. During the 2012 Ice Season, IIP received three NOTSHIP’s, one transmitted in error that required no product revision, one significantly expanding the limit in early February, and one radar target outside the published limit. Only the significant expansion required a revision of the Iceberg Limit. As a result, the Iceberg Limit accuracy for the 2012 Ice Season was 99.5%.

Iceberg Reports

A critical factor contributing to IIP's successful safety record is the support received from the maritime community. This support is measured annually by the number of voluntary iceberg reports IIP receives from the maritime community in a fiscal year (FY). In order to more efficiently serve the maritime community, IIP modified the reporting process in 2012. In consideration of reliable oceanographic information resources, IIP no longer solicits for stand-alone sea surface or water temperature reports as in years past and is solely requesting iceberg reports. Ship reports remain a critical source of information and IIP encourages vessels transiting within or near the Grand Banks of Newfoundland to report iceberg sightings in a timely manner. Receiving on-scene and near real-time information further enhances the accuracy of IIP products. IIP recognizes the vessel submitting the most iceberg reports for the year with the Carpathia Award (**Appendix A**).

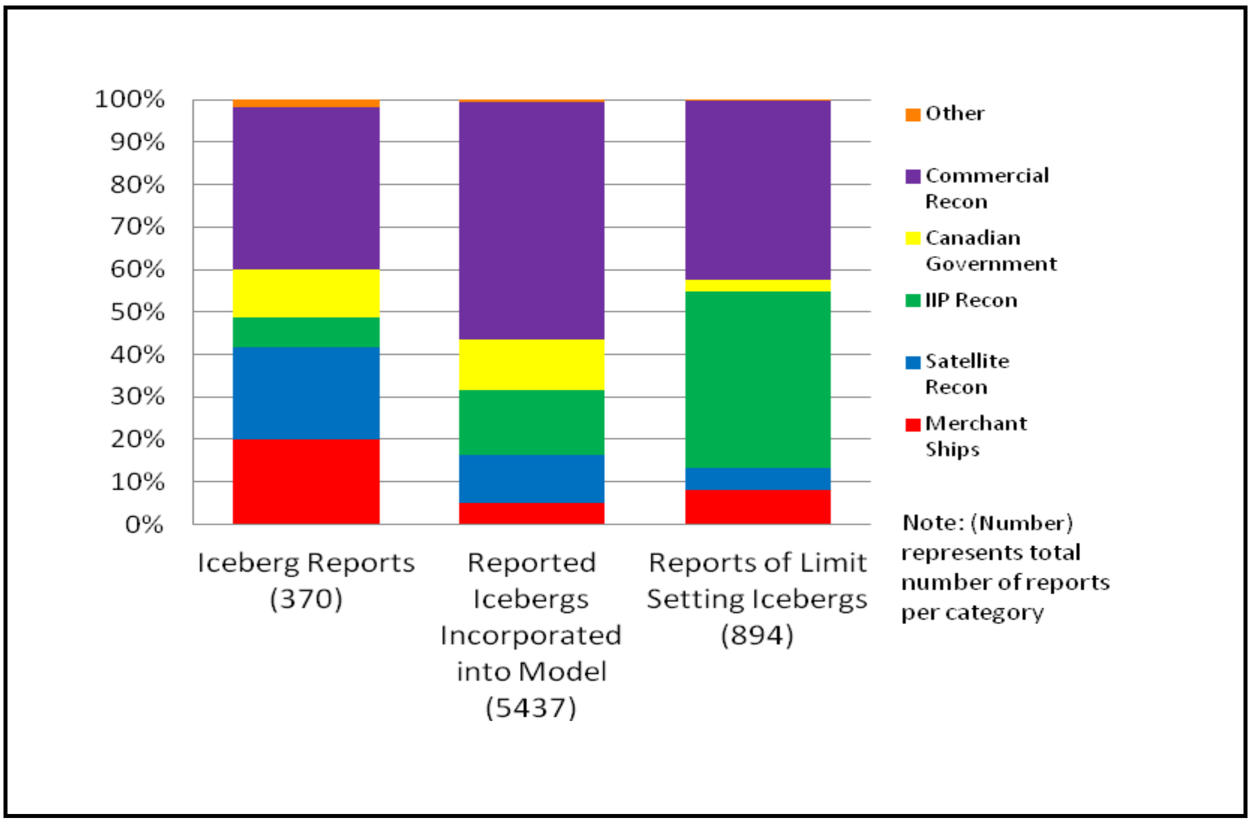

Figure 3. Percentage of iceberg reports, reported icebergs incorporated into model, and reports of limit setting icebergs by reporting source in 2012.

As mentioned above, the process for submitting iceberg reports was streamlined in 2012 to improve effectiveness. Iceberg reports are now consistently being sent to Canadian Coast Guard MSCTS St. John's via Inmarsat satellite or other means. The IIP Operations Center received, analyzed, and processed 370 iceberg reports (**Figure 3**, column1), primarily via MCTS. The 370 iceberg reports were approximately double the 188 reports in 2011 primarily due to the moderate season in comparison to the light season in 2011. Commercially contracted reconnaissance by Provincial Aerospace Limited (PAL) provided 147 (38%) iceberg reports. Satellite reconnaissance was responsible for the second highest number of iceberg reports at 83 (22%). Merchant ships tallied the third highest number with 77 (20%). IIP aerial reconnaissance flights provided 27 (7%) and the Canadian Government, including Canadian Coast Guard vessels, Canadian Forces aircraft, and lighthouse operators, combined to deliver 43 (11%) iceberg reports. Various other sources, including scientific research vessels, fishing vessels, and one passenger vessel combined to relay the remaining 7 (2%) iceberg reports.

The iceberg reports contained 6773 icebergs, growlers, bergy bits or radar targets, 5437 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 iceberg reports 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 iceberg products are being broadcast to the maritime community. The percentage of updates to BAPS by reporting source is portrayed in **Figure 3,** Column 2**.** Commercial flights (56%) provided the majority of the information incorporated into BAPS this year.

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 42% of all limit-setting iceberg sightings or detections as shown in **Figure 3,** Column 3**.** PAL flights (42%) made an equivalent contribution to sightings of limit-setting icebergs.

Satellite Reconnaissance

In an effort to build confidence in incorporating satellite reconnaissance into operations, IIP continued satellite data ground truth comparisons in 2012. Last year, IIP ordered 81 Radarsat-2 (RSA2) images for acquisition and processing. NIC further supplemented this image tally by funding 100 TerraSAR-X (TSX) images. IIP also contracted C-CORE to process ~50 images to assist in an assessment of current SAR capabilities. The output from C-CORE is a coded message that is ingested directly into BAPS. This contract was awarded during fiscal year (FY) 2012 so that unused funds could be applied to the 2012 season as well. IIP received satellite messages from three different satellites, Radarsat-1 (RSA1), RSA2, and TSX, using various modes of search. These images were not used operationally due to time latency (IIP, 2011).

For 2011 some basic comparisons between the satellite systems and modes tested could be documented however, due to an extremely light iceberg season, ordering conflicts, weather and aircraft issues, no aircraft ground truth information could be collected during the 2011 effort.

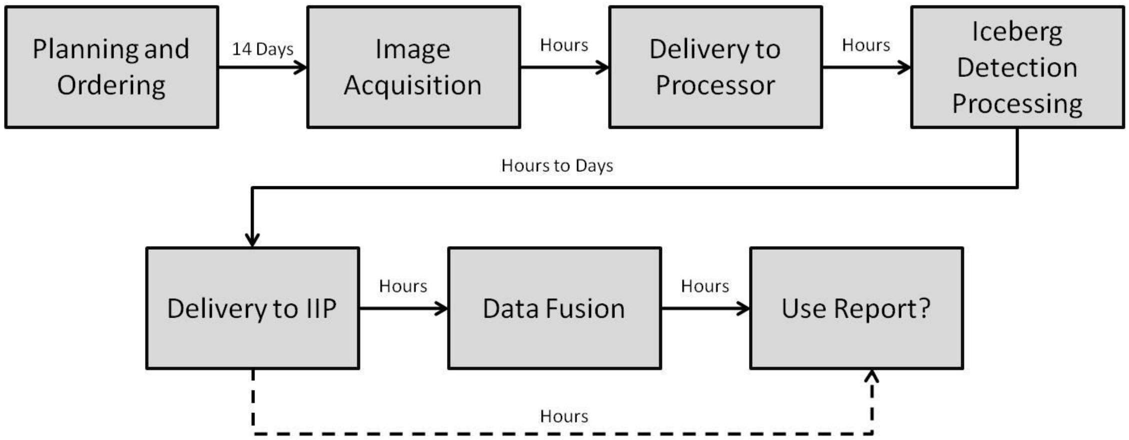

Figure 4: Satellite ordering and use flow chart.

During 2012, IIP worked with C-CORE again to expend the remainder of the funding, applying the same planning process as that used during the 2011 season. **Figure 4** schematically shows the process followed to acquire satellite information for incorporation into IIP daily operations. IIP successfully collected ground truth data on four different dates for comparison to C-CORE derived iceberg information from RSA2 imagery. The first image was collected on 29 April using the Fine mode (50 km swath, ~7 m resolution). Though an IIP under-flight was scheduled on this date, the flight was cancelled due to a medical issue with a critical aircrew member. Fortunately, a PAL flight occurred a few hours after the satellite pass with excellent results. **Figure 5** shows three PAL targets and three C-CORE/RSA2 targets with an approximately 3.5-hour time difference. The differences in position for these targets are consistent with expected iceberg drift during this short time period.

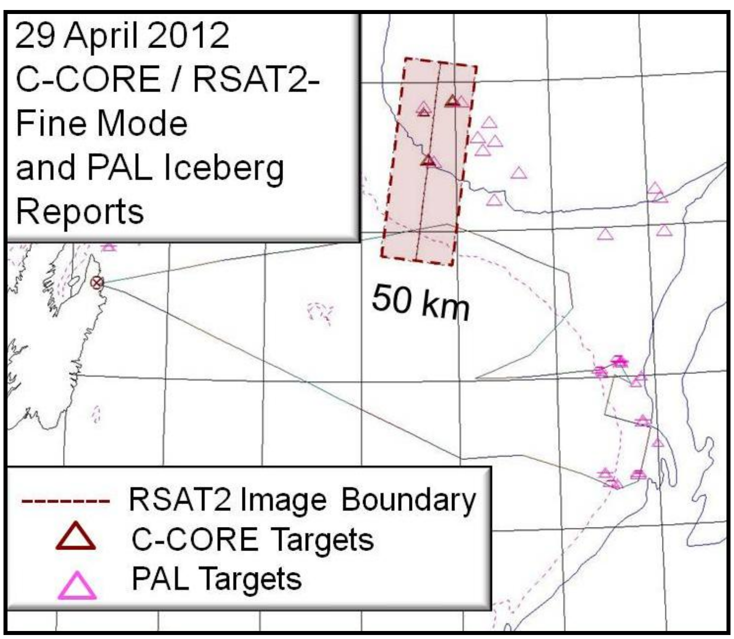

Figure 5: Satellite comparison results for 29 April 2012.
RSA2 Fine mode vs. PAL aerial reconnaissance.

The next image could not be collected until 26 May due to multiple conflicts with other satellite users, using the Wide-Fine mode (150 km swath, ~7 m resolution) with mixed results (several missed or improperly identified targets). The reason for the difference in performance between the 29 April and 26 May images is the subject of further IIP analysis.

On 09 June, IIP collected ground truth data for another Fine mode satellite image. This image was collected in an area where IIP expected to see a mixture of icebergs and ships near the Grand Banks oil production facilities. However, no icebergs had drifted into the scene by the time of the satellite pass. Further, conducting an under-flight near the facilities created a challenging safety of flight environment while attempting to descend to identify and document iceberg targets in the vicinity of multiple aircraft and vessels servicing the oil rigs. Even though their were no icebergs, the comparison between satellite derived information and aircraft observations was excellent for targets present, i.e., the satellite did not report any false iceberg targets and only missed three out of 19 vessels sighted.

On 08 July, IIP collected ground truth data further north between 52^{o}N and 55^{o}N along the southern Labrador coast. This image was also collected in the Fine mode (50 km swath, ~7 m resolution) with mixed results: there were several instances of missed satellite targets along with false positives. There were several factors that may have influenced the quality of this comparison to include the proximity to land and the presence of several clusters of growlers in the scene.

Finally, at IIP's request C-CORE processed a series of images along the Labrador coast that were requested in support of CIS iceberg reconnaissance on 8 days during the month of September. While there was no ground truth available for these images, some comparisons have been performed between the C-CORE Iceberg Detection Software (IDS) algorithm and a CIS analyst.

IIP received multiple reports from C-CORE through their Iceberg Finder program. Together with the research reports described above, C-COREs satellite derived messages contained 934 reports of icebergs, 13.8% of the total icebergs reported in 2012. 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 614 icebergs, showing a presumed accuracy rate of 65.7%. Of the 614 icebergs used, 47 of them were used to set the iceberg limit, 5.2% of total limit-setting bergs.

IIP plans to dedicate several flights during the 2013 season to collect additional ground truth data to document the satellite detection and identification effectiveness and to guide an eventual transition to a mix of reconnaissance that relies more on satellites than aerial reconnaissance. IIP is in the process of analyzing data from both 2011 and 2012 and will document results in a more detailed technical report that will be provided as an Appendix to the 2013 Annual Report.

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 that drifted south, as modeled by BAPS. The second measurement is season length, measured in the number of days that there were icebergs south of 48°N. Prior to 2011, the definition of season length was the period between decisions by Commander, International Ice Patrol to open and close the season.

In 2012, 499 icebergs (not including bergy bits or growlers) were modeled to have drifted south of 48°N. These icebergs were reported and/or modeled south of 48°N from 17 March through 02 July, a season length of 109 days. The time period from 1983 through the present represents IIP's modern era, when aircraft equipped with radars were used for iceberg reconnaissance. **Figure 6** compares the number of icebergs south of 48°N (blue columns) and season length in days (red line) for this time period. The average number of icebergs south of 48°N during this period is 775.

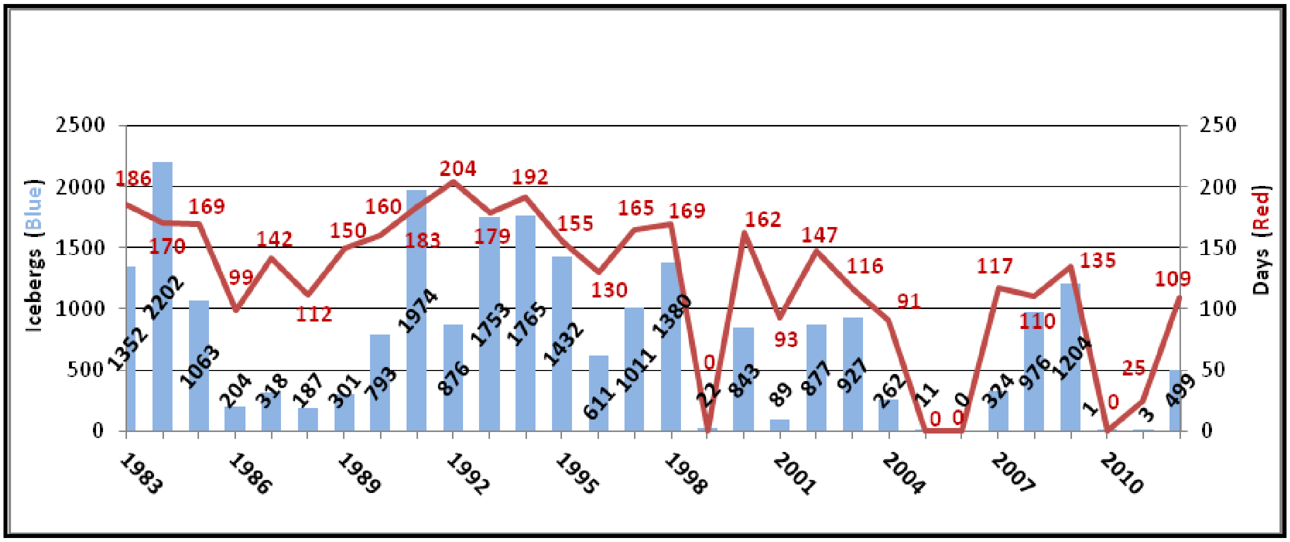

Figure 6: Number of icebergs south of 48°N (blue columns) and season length in days (red line),1983-present.

Customer Behavior

Throughout the 2012 season, IIP monitored shipping traffic in the vicinity of the iceberg limit to gain insight into customer behavior. Several times per week, IIP staff performed a cursory review of the publicly available ship tracking webpage, http://www.sailwx.info/. In some instances, vessels appeared to maneuver to remain outside of the iceberg limit while others sailed through the warning area. In an effort to more systematically observe customer behavior, the IIP Program Manager at USCG Headquarters requested support from MIFC LANT. Using commercially available Automatic Identification System (AIS) broadcasts, MIFC LANT conducted an unclassified vessel traffic analysis in IIP's area of responsibility off the Grand Banks for the period from 01 February through 03 June 2012. **Figure 7** provides an excerpt from the MIFC LANT analysis on 15 May 2012 (right panel) together with the IIP product for the same date (left). The small red square shows the approximate location of the Hibernia oil production facility.

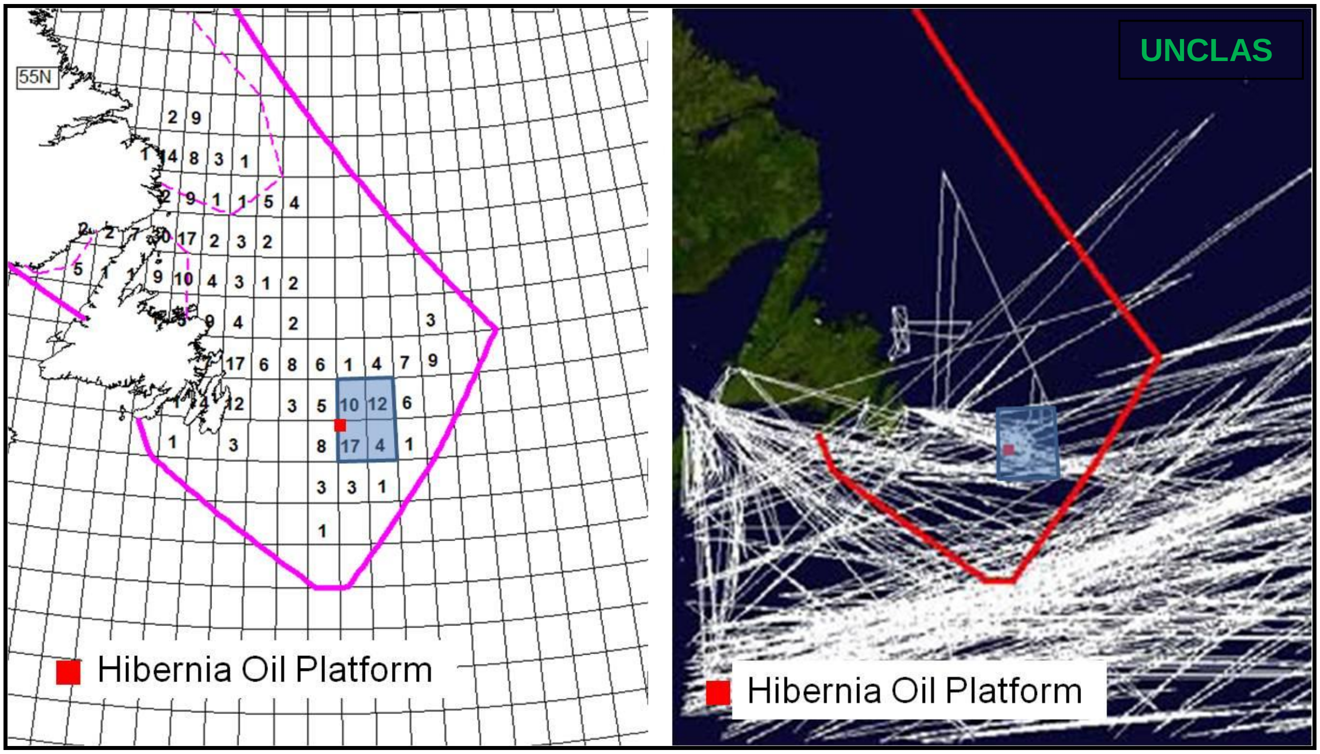

Figure 7: NAIS Iceberg Limit (left panel) and excerpt from MIFC LANT Analysis for 14-16 May 2012 (right panel).

While it appears that there is significant vessel traffic remaining outside of the iceberg limit and a high traffic density between the Hibernia platform and St. John's, it is difficult to state with any certainty the motivation for vessels to sail through the warning area without further analysis. To improve understanding of customer behavior, IIP has contracted Shearwater, LLC during FY 2012 to better identify customers and obtain insight into their behavior. Results of this study will be available after the 2013 season.

Canadian Support

The Canadian Government continued to provide excellent support, particularly in continued product and process harmonization efforts. CIS freely shared valuable reconnaissance data, environmental data from the Canadian Meteorological Centre, iceberg and information reports from Canadian Coast Guard and Canadian Forces assets, and their expertise regarding icebergs and sea ice.

Additionally, CIS has significantly contributed to developing criteria for the iceBerg Analysis and Prediction System (BAPS) replacement. Both IIP and CIS rely on this modeling software to estimate where icebergs are located during the periods between reconnaissance. The BAPS replacement project is discussed further in **Appendix D**.

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 U.S. Coast Guard Air Station Elizabeth City (ECAS). During the 2012 Ice Season, eleven IRDs deployed to observe and report icebergs, sea ice, and oceanographic conditions on and near the Grand Banks of Newfoundland. CIS also provided reconnaissance data from the Transport Canada aircraft, while PAL provided iceberg information for both CIS and Department of Fisheries and Oceans flights. All observations were transmitted to the IIP Operations Center where they were entered into BAPS and processed for incorporation into the model and iceberg products. The NAIS reconnaissance strategy is discussed further in **Appendix C**.

Throughout the 2012 Ice Season, IRDs operated out of the IIP's base of operations in St. John's, Newfoundland for a total of 93 days conducting 28 iceberg patrols. The first IRD departed on 30 January to conduct training and official meetings with IIP partners in Elizabeth City, North Carolina and St. John's. Furthermore, the deployment determined the early season iceberg distribution. The last IRD returned on 11 July to conclude IIP deployments to St. John's. There were 23 flights cancelled due to weather, 9 flights cancelled due to maintenance, and 8 days in which the IRD did not fly due to crew status or scheduled meetings. A summary of IRD operations is provided in **Table 1**.

IRD	Deployed Days	Iceberg Patrols	Transit Flights	Logistics Flights	Flight Hours
1	9	2	3	0	25.9
2	13	1	3	0	15.7
3	9	1	2	0	25.6
4	8	3	2	0	25.4
5	9	3	2	0	21.1
6	7	2	2	0	21.1
7	9	2	2	0	22.6
8	8	4	2	0	38.1
9	7	4	2	0	37.5
10	7	4	2	0	39.5
11	7	2	3	0	21.7
Total	**93**	**28**	**25**	**0**	**294.2**

Table 1. Summary of IRD operations.

Aerial Iceberg Reconnaissance

Due to frequent poor weather in IIP's area of responsibility, detecting and classifying targets was an ongoing challenge for IRD personnel. Therefore, the use of radar was critical to IIP operations and was relied on as the primary means of classifying targets in reduced or no visibility conditions. The majority of 2012 aerial iceberg reconnaissance operations were conducted using HC-130J, long-range reconnaissance aircraft with cold weather capabilities provided by ECAS. 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 AIS receiver as an integrated component of the HC-130J mission system used to assist in differentiating vessels from icebergs. During IRD #2, IIP used the HC-144A medium-range reconnaissance aircraft provided by U.S. Coast Guard Aviation Training Center (ATC) Mobile. The HC-144A aircraft is equipped with a Telephonics APS-143 360° Radar capable of detecting and classifying surface targets. It is also equipped with an AIS receiver in a similar configuration as the HC-130J.

IRDs conducted 28 patrols with 176.1 patrol hours and experienced only 0.6 hours of mission system down time and no visual only patrols. This means that the IRD patrolled without a mission system for only 0.4% of actual patrol time. This is a decrease from the 2011 ice season with a total of 3.6 hours of mission system down time.

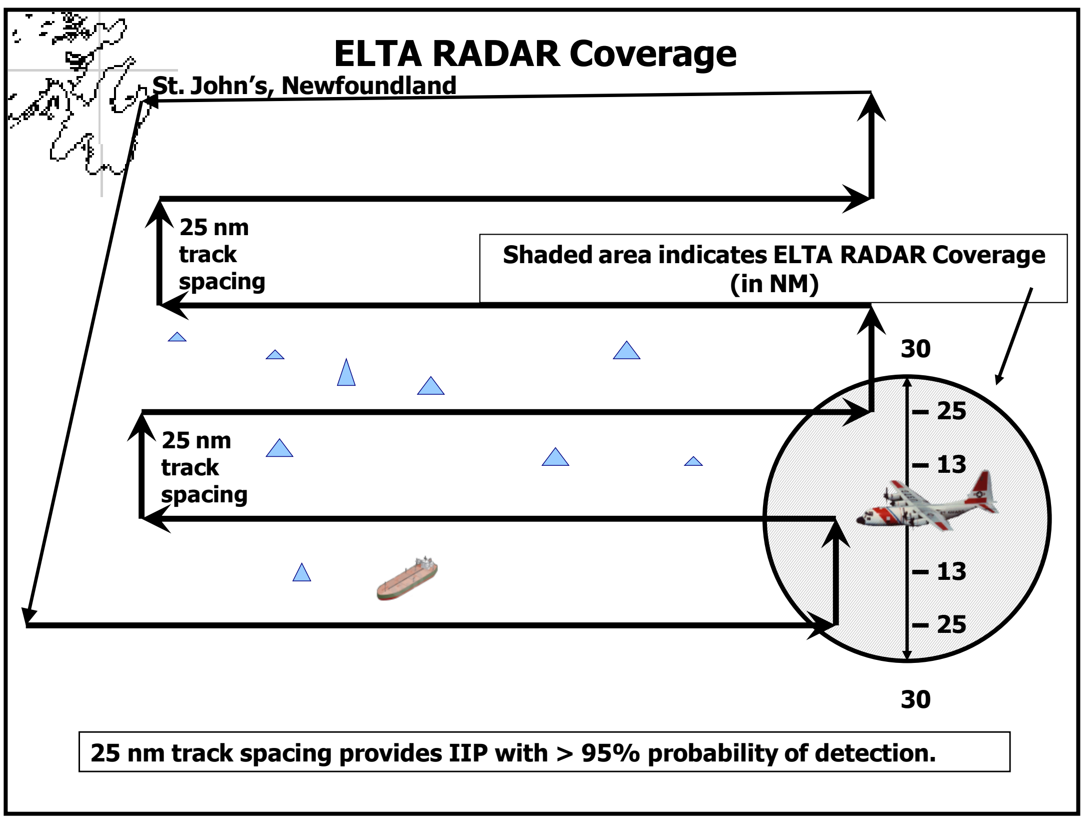

Figure 8. Radar reconnaissance plan.

The 360° coverage provided by the ELTA radar allows IIP to use 25 NM track spacing (**Figure 8**). This is based on the results of the HC-130J Ice Patrol Suitability Test Report dated 20 February 2009. This report determined that the ELTA radar detects small icebergs of 15 meters or longer with greater than 95% cumulative probability of detection within 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 testing of the ELTA radar is conducted. IIP plans to conduct tests for increased track spacing in 2013. In 2012, IRD personnel detected a total of 834 icebergs. Icebergs are detected in one of three ways: (1) combination of radar and visual, (2) radar only, or (3) visual only. This year, 47% of the icebergs were detected by a combination of radar and visual sightings. The remaining icebergs were either detected only by radar (10 %) or only by visual sighting (43 %) (**Figure 9**). The number of visual only sightings is larger than in previous years (15% in 2011) due to a greater presence of sea ice. Ice observers are invaluable when sea ice conditions are present.

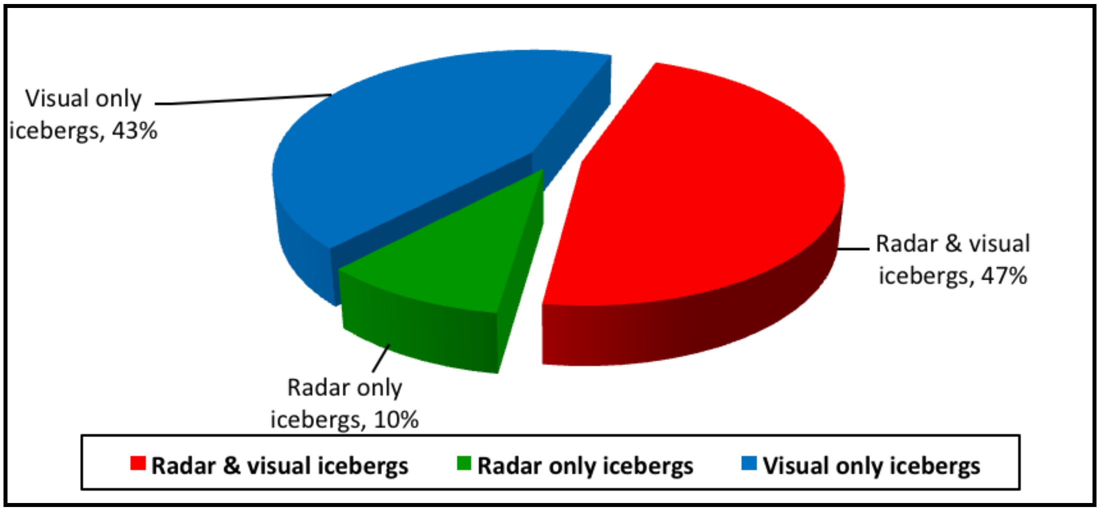

Figure 9. Breakdown of Icebergs by detection method.

2012 Flight Hours

In addition to the 28 iceberg patrols flown during the 2012 Ice Season, ECAS and ATC Mobile conducted 25 transit flights to and from St. John's. One of those flights was on the first IRD to facilitate training and meetings with ECAS in preparation for the Ice Season. The HC-144A conducted three transit flights during IRD #2: (1) Mobile to Groton, (2) Groton to St John's, and (3) return flight from St. Johns to U.S. Coast Guard Air Station Cape Cod. The numbers depicted in **Figure 10** are the breakdown of the 294.2 flight hours used during the 2012 Ice Season for IIP operations. The flight hours are broken down into three categories; transit hours, patrol hours, and logistics hours. Transit hours are hours the aircraft transited to and from specific locations in support of the IIP mission. Patrol hours are hours used to patrol for icebergs. Logistics hours are hours that were used to support the overall mission of IIP, but do not fall into the previous two categories. Logistics hours are generally used to transport parts for an aircraft that has been designated for use in the execution of the IIP mission. In 2012, there were no requests to conduct concurrent Northwest Atlantic Fisheries Organization sightings from the First Coast Guard District. A comparison of flight hours to number of icebergs that drifted south of 48°N from 2008 to 2012 is shown in **Figure 11**.

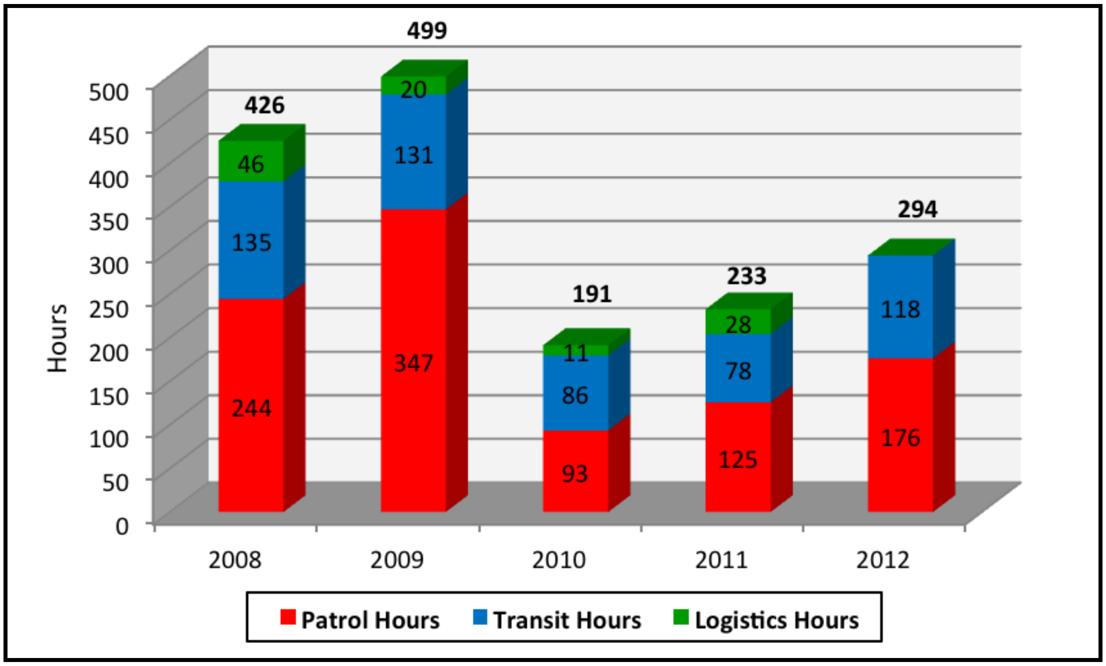

Figure 10. Summary of flight hours (2008-2012).

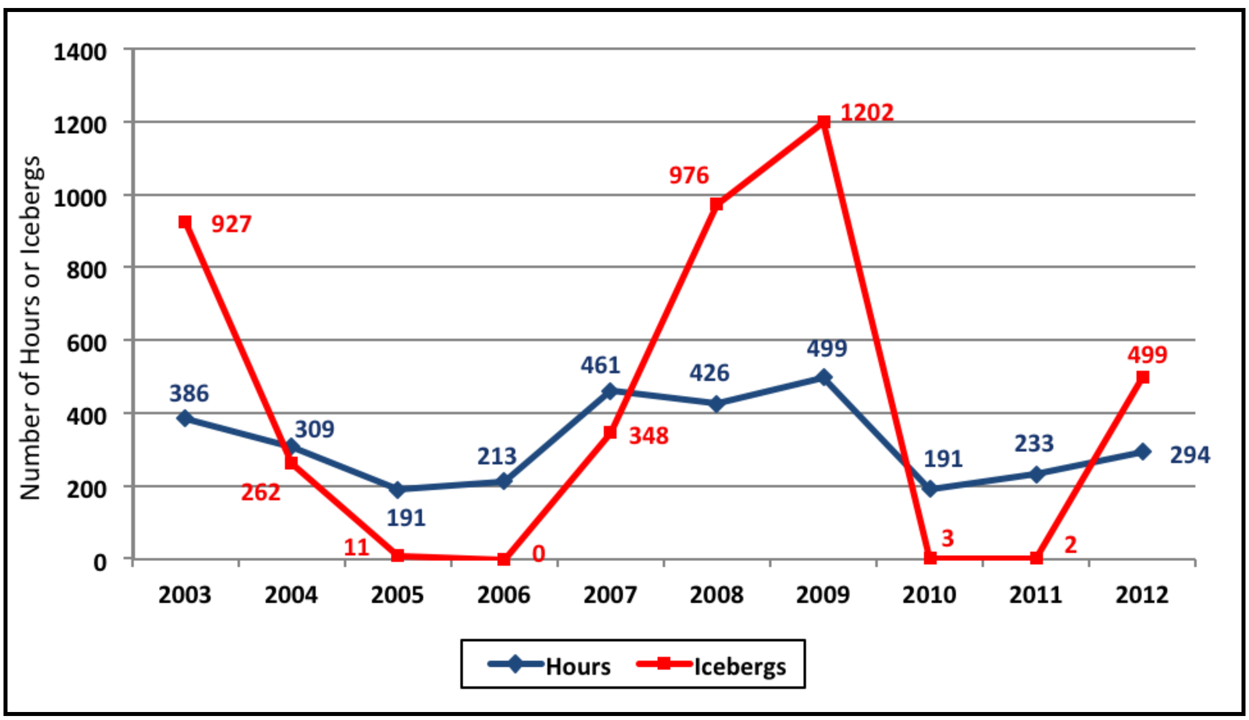

Figure 11. Flight hours and icebergs south of 48°N (2003-2012).

Reconnaissance Challenges

The Grand Banks are a productive fishing ground frequented by fishing vessels, ranging from 20 meters 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. When a radar image does not present a distinguishable feature, the IRD classifies the contact as a radar target (R/T) in hopes of being able to identify it on a subsequent pass or patrol. During the 2012 Ice Season 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, further complicating target identification. This difficulty is mitigated by iceberg information reports generated from passing ships, aircraft, and drilling platforms which greatly aid IIP in the creation of an Iceberg Limit that is as accurate and reliable as possible.

In 2012, the HC-144A was unable to perform any successful patrols. While this platform's limitations in range and cargo weight were identified and well documented in previous missions, the lack of cold weather testing was a severe detriment in 2012. The HC-144A's cold weather limitations were evident during IRD #2, from 14 to 26 February. IRD #2 was scheduled for 11 days; four transit days and seven patrol days. From the seven days allotted for ice reconnaissance, there were only two days in which weather conditions were favorable for conducting patrols with the HC-144A. The results from these two days were as follows:

18 February: Forecasted weather conditions were satisfactory for a successful patrol; however, the on-scene weather did not progress as expected. Ceilings were 1100 feet above ground level and the flight was cancelled due to the HC-144A limitations on in-flight de-icing; specifically, instrument flight rules conditions present directly after takeoff.

20 February: The aircraft departed St. John's successfully; however, weather conditions in the search area were less than ideal. Again, the conditions called for the aircraft to employ de-icing measures and the rest of the search pattern was in areas conducive to icing. The HC-144A's de-icing measures would not have been able to mitigate the ice accumulation on the airframe. The Aircraft Commander cancelled the flight due to unsafe conditions.

In summary, IRD #2 resulted in only 1.8 hours of actual patrol time. The HC-144A's cold weather capabilities were restricted due to its limited de-icing capabilities. If the HC-130J had been used for IRD #2, it is estimated that the IRD would have been able to fly approximately 11 patrol hours. While it is difficult to predict the weather on the Grand Banks or weather conditions that may arise during a particular IRD, the HC-144A does not appear suited for early season reconnaissance missions. It is better suited for late season missions when the iceberg limit extent is potentially smaller and the weather conditions, while still unpredictable, are generally less extreme.

Oceanographic Operations

Throughout the iceberg season, IIP deployed deploys drifting buoys on and near the Grand Banks of Newfoundland. The drifters provided near real-time ocean current information that were used to modify the historical current database within BAPS, improving the accuracy of the model-calculated drift for each iceberg. The drifters also provided sea surface temperature (SST) information that was incorporated into an SST analysis product developed by the U. S. Navy. BAPS used both the current data and SSTs along with other environmental data to forecast the drift and deterioration of icebergs on and near the Grand Banks of Newfoundland.

IIP used drifters based on the World Ocean Circulation Experiment/Surface Velocity Program (WOCE/SVP) design. The buoys deployed in 2012 differed only in the location of the holey sock drogue. The first type of buoy had a drogue centered at 50m, and the second at 15m. The drifters with drogues centered at 50m were 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, were 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 prepared by IIP and ECAS personnel. Air deployments are typically much more expensive than ship deployments because of lost reconnaissance time and the cost of air-drop packages. Therefore, air-drops are generally conducted in areas not normally frequented by vessel traffic. Ship deployments are usually conducted near the Grand Banks through a cooperative arrangement with Canadian Coast Guard vessels operating out of St. John's.

In 2012, IIP deployed fifteen WOCE/SVP drifting buoys. Three 50m buoys were air-deployed from the IIP reconnaissance aircraft north of the Grand Banks of Newfoundland in the offshore branch of the Labrador Current. An additional twelve buoys were deployed from Canadian CG vessels: nine 15m and three 50m buoys. IIP has traditionally used the Argos system to track buoy positions and transmit data to the IIP Operations Center. During this season, IIP experimented with four GPS buoys that used the Iridium satellite system to transmit buoy positions and SST data.

All fifteen WOCE/SVP buoys were deployed successfully and without incident. Thirteen buoys functioned properly and transmitted oceanographic data for sufficient durations. However, data from the Iridium buoys were not incorporated into the current update process. IIP is working with the buoy manufacturer to resolve data gaps observed in the GPS position data from these buoys. Pending resolution of this issue, IIP will consider incorporating Iridium tracked buoys into future operations. Of the Argos processed buoys, two were omitted from the current update process and were not forwarded to the Global Telecommunications System for use by the World Meteorological Organization. Both buoys were ship deployed. The first was transmitting suspicious temperature and position data and the second washed ashore along the Avalon Peninsula of Newfoundland shortly after deployment. All buoys eventually drifted out of IIP's area of interest.

Figure 12 shows 2008-2012 air and ship WOCE/SVP drifting buoy deployments. **Figure 13** depicts composite drift tracks for the WOCE/SVP drifting buoys deployed in 2012.

Detailed WOCE/SVP drifting buoy information is provided in IIP's 2012 WOCE Buoy Track Atlas, available upon request from IIP.

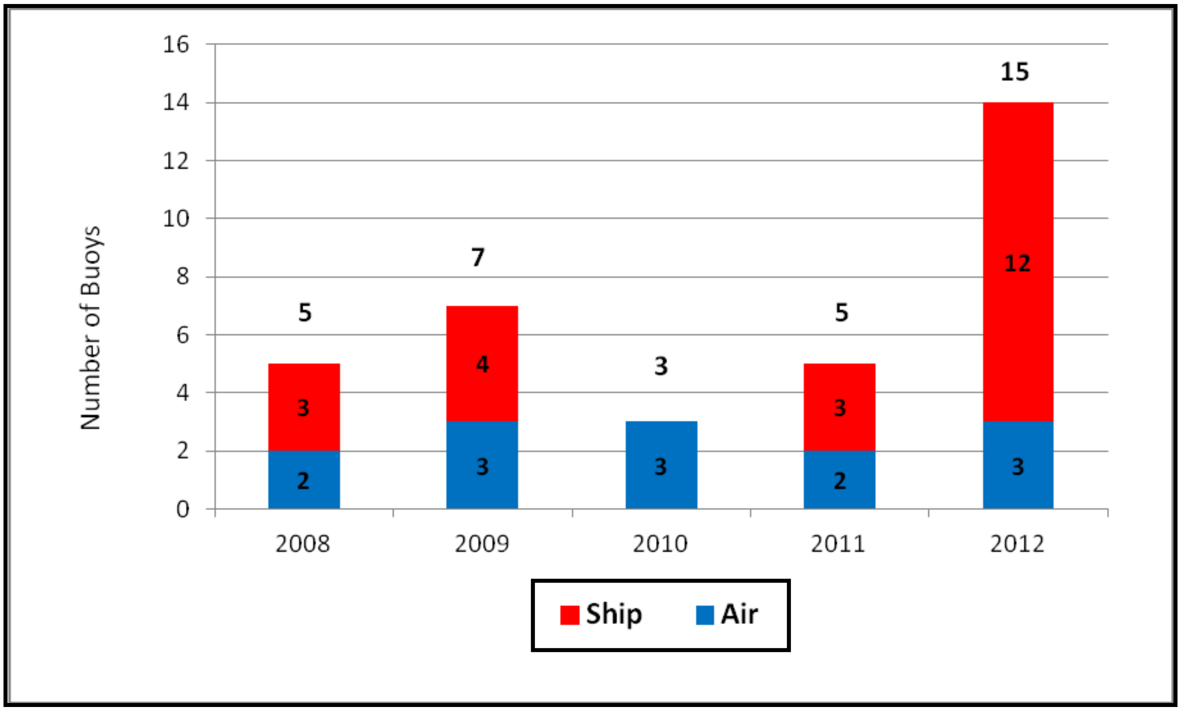

Figure 12. WOCE drifting buoy deployments (2008-2012).

Commemorative Wreath Drops

Each year, IIP drops commemorative wreaths in conjunction with reconnaissance operations. 2012 was the centennial anniversary of the sinking of RMS *Titanic* and several commemorative wreaths and rose petals were dropped during IRD #6. IIP coordinated and participated in multiple memorial events for the Titanic Centennial. Please see **Appendix E** for information on these events.

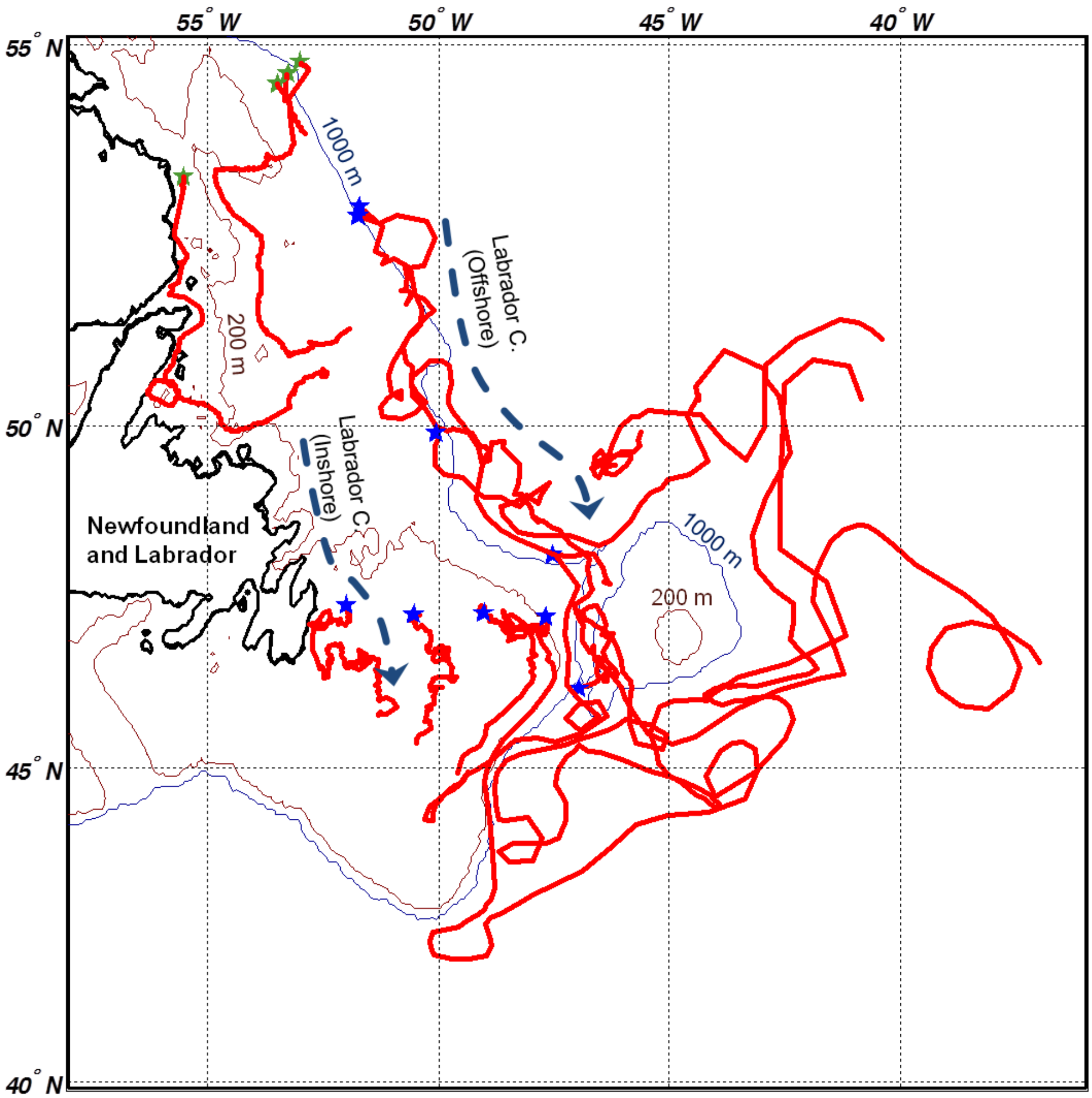

Figure 13. Composite buoy tracks. Blue stars indicate ARGOS-tracked WOCE/SVP buoy deployment positions. Green stars indicate Iridium-tracked WOCE/SVP buoy deployment positions. Red tracks indicate individual WOCE/SVP buoy paths.

Ice and Environmental Conditions

Introduction

The 2012 ice year (October 2011-September 2012) began with warmer than normal air temperatures throughout southern Labrador and Newfoundland. A brief cooling period in late November initiated sea ice growth that was approximately 1.5 weeks ahead of normal conditions. More pronounced cold periods in southern Labrador during January, February and March coupled with predominantly offshore winter-time winds supported sea ice growth that promoted the drift of 499 icebergs south of 48° N into the transatlantic shipping lanes. This number is slightly above the average number of icebergs that have crossed 48° N from 1900-2011 (474) and classified the 2012 ice season as a "moderate" year based on this count (IIP, 1994). However, compared to the previous two seasons, when only one and three icebergs drifted south of 48° N for 2010 and 2011 respectively, the icebergs transiting Flemish Pass via the offshore branch of the Labrador Current posed a significant hazard to both transatlantic shipping and to the oil production facilities on the Grand Banks. A rapid retreat of the sea ice in early April coupled with the presence of a relatively warm, persistent protrusion of the North Atlantic Current near the Tail of the Grand Banks limited the southward extent of the iceberg limit, mitigating the risk to transatlantic shipping.

This section describes the progression of the 2012 ice year and the accompanying environmental conditions. The following narratives are summarized by quarter beginning in October 2011 with the presence of a significant population of ice island fragments in Notre Dame Bay just west of Fogo Island and continuing as new ice began forming in the bays along the Labrador and Newfoundland coasts (**Figure 14**). This summary continues through the summer of 2012.

The narrative draws from several sources, including sea-ice and iceberg analyses provided by the Canadian Ice Service and the U. S. National Ice Center; sea-surface temperature anomaly plots provided by the National Oceanic and Atmospheric Administration's National Weather Service (NOAA/NWS, 2012a); and summaries of the iceberg data collected by the International Ice Patrol.

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 112 years (1900 through 2011) of IIP records (IIP, 2011). 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, 2012).

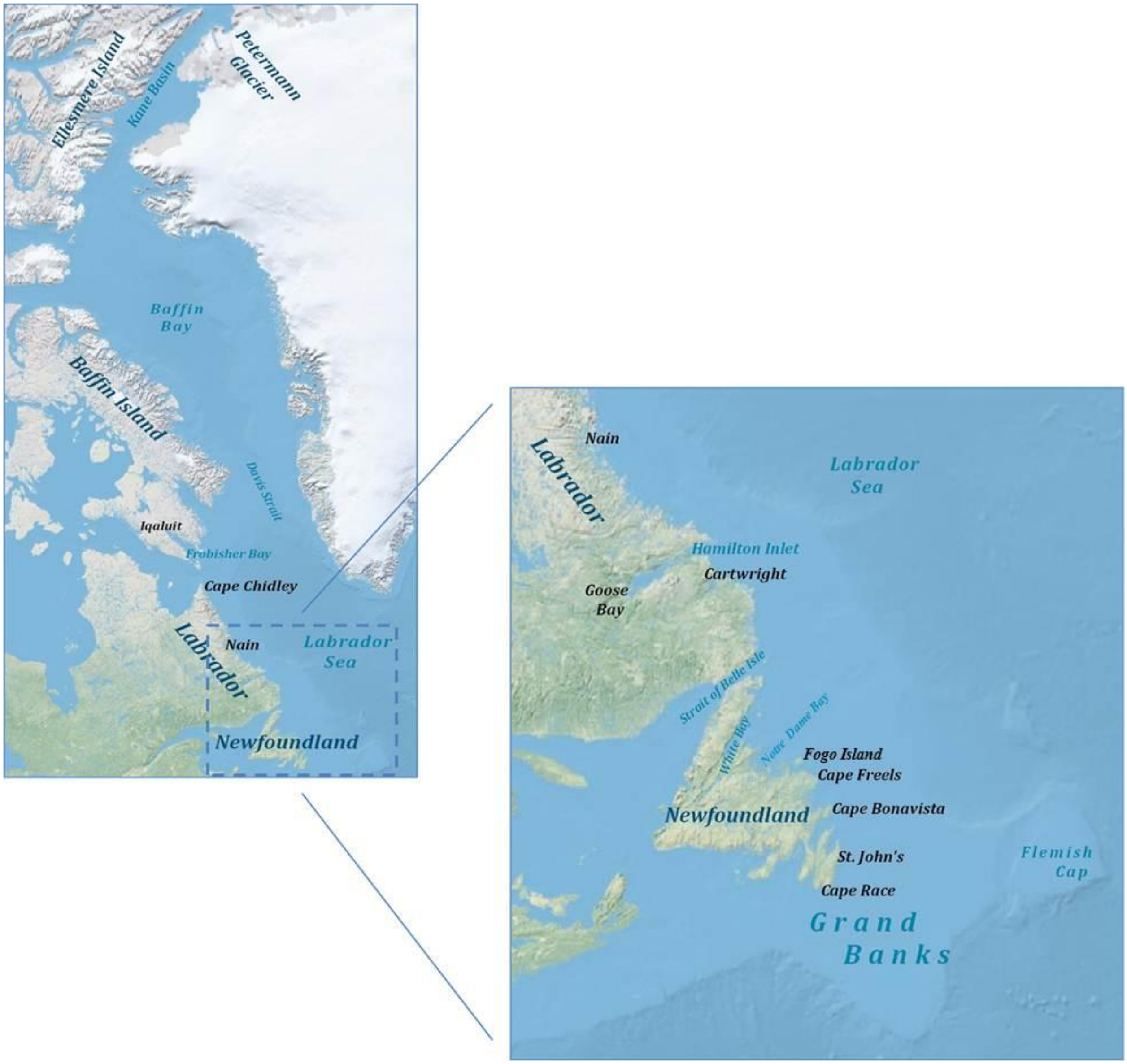

Figure 14. NAIS area of responsibility (dashed box).

Pre-season Predictions

On 01 December 2011, the Canadian Ice Service issued a pre-season forecast that predicted the “expected pattern, timing, and extent of ice growth” for the Gulf of St. Lawrence and East Newfoundland Waters (CIS, 2011b). For this outlook, CIS analyzed SSTs and meteorological conditions during the preceding summer and then applied forecasted December wind and temperatures to develop sea ice growth projections. Episodes of colder than normal air temperatures and near normal water temperatures were observed along the Newfoundland and Labrador coasts through the end of November. By the end of November, new and grey ice formation along the Labrador coast was more than a week ahead of normal. These observations coupled with forecasted normal to below normal air temperatures over the Labrador coast, supported the following ice forecast for the 2012 ice year:

- New and grey ice will be present along the Labrador coast northwest of Belle-Isle extending 10-20 NM off the southern coast of Labrador by the end of December.
- By the end of January, the ice edge will extend into the Strait of Belle Isle and extend 40 NM off of the southern Labrador coast and Northern Peninsula.
- By the end of February, the main pack ice will reach Fogo Island and Cape Bonavista and extend over 70 NM east of Cape Freels.
- Ice concentration and coverage will diminish throughout March and will retreat “at faster than normal pace” from late March through mid-April.

Quarterly Environmental Summaries

Conditions affecting sea ice growth and iceberg distribution are summarized below. Much of the early ice growth was influenced by mean air temperature fluctuations along with changes of the mean wind speed and direction in central and southern Labrador early in the year and over Newfoundland as the year progressed. **Figure 15** shows the temperature fluctuations from November 2011 through October 2012. Of note, **Figure 15** shows four colder than normal periods in blue. The extended cold periods in late January through mid-February and then again in late February through late March were responsible for much of the ice growth during the 2012 season. Dramatically warmer than normal conditions that began in mid-April contributed to the rapid deterioration of ice throughout the remainder of the year.

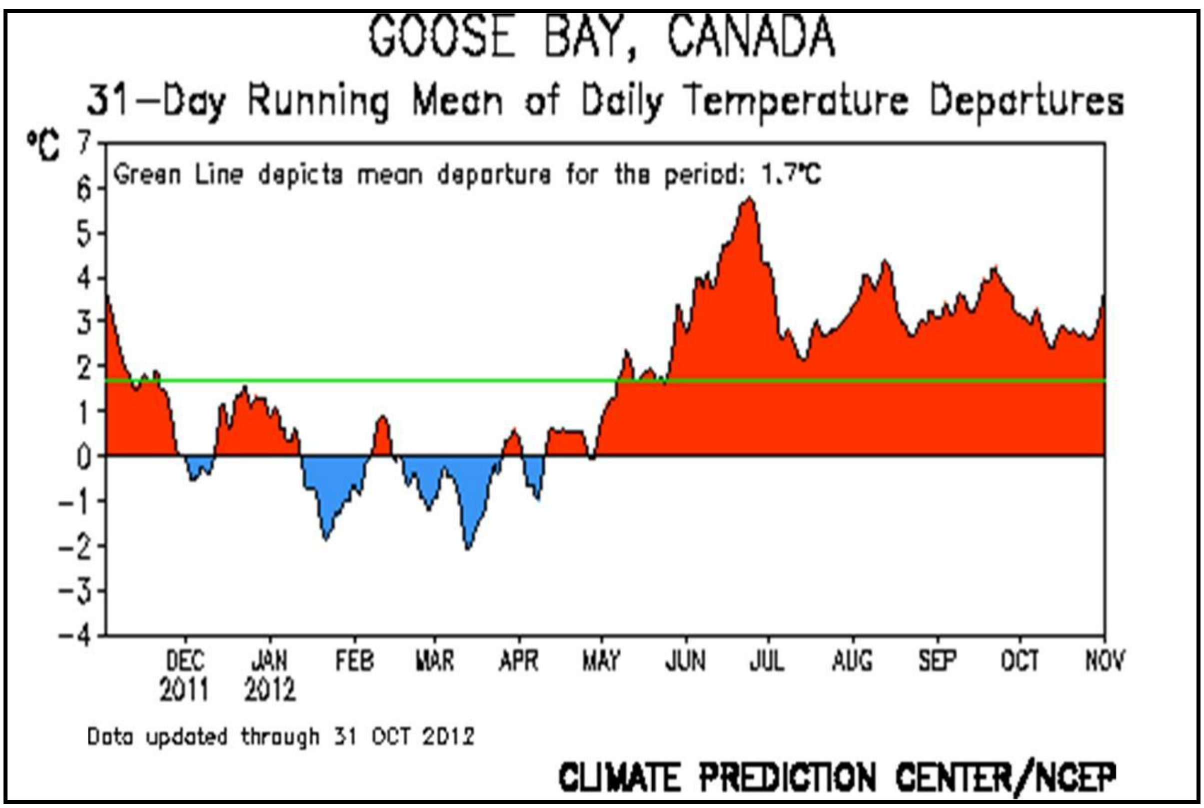

Figure 15. 31-day running mean temperature departures (^{o} C) for Goose Bay, Labrador, Canada. Courtesy of the National Center for Environmental Prediction (NCEP), Climate Prediction Center. (NCEP, 2012)

October – December 2011

Cooler than normal air temperatures in late November in southern Labrador caused faster than normal ice growth along the Labrador coast, particularly, with respect to the previous two years. Sea surface temperatures were slightly above normal off the Newfoundland coast and near normal along the Labrador coast. The air temperature and sea surface temperature anomalies for the region were near normal leading to sea ice growth that was slightly faster than normal (CIS, 2012a).

A large population of 165 ice island fragments remained in Notre Dame Bay at the beginning of the 2012 ice year. This population slowly diminished throughout November and December with only two remaining by 31 December 2011. **Figure 16** shows the location of the iceberg population on 01 October 2011. While an iceberg population near Newfoundland at this early stage of the ice year is unusual, it is not unprecedented (IIP, 2011) and did not pose a hazard to transatlantic shipping.

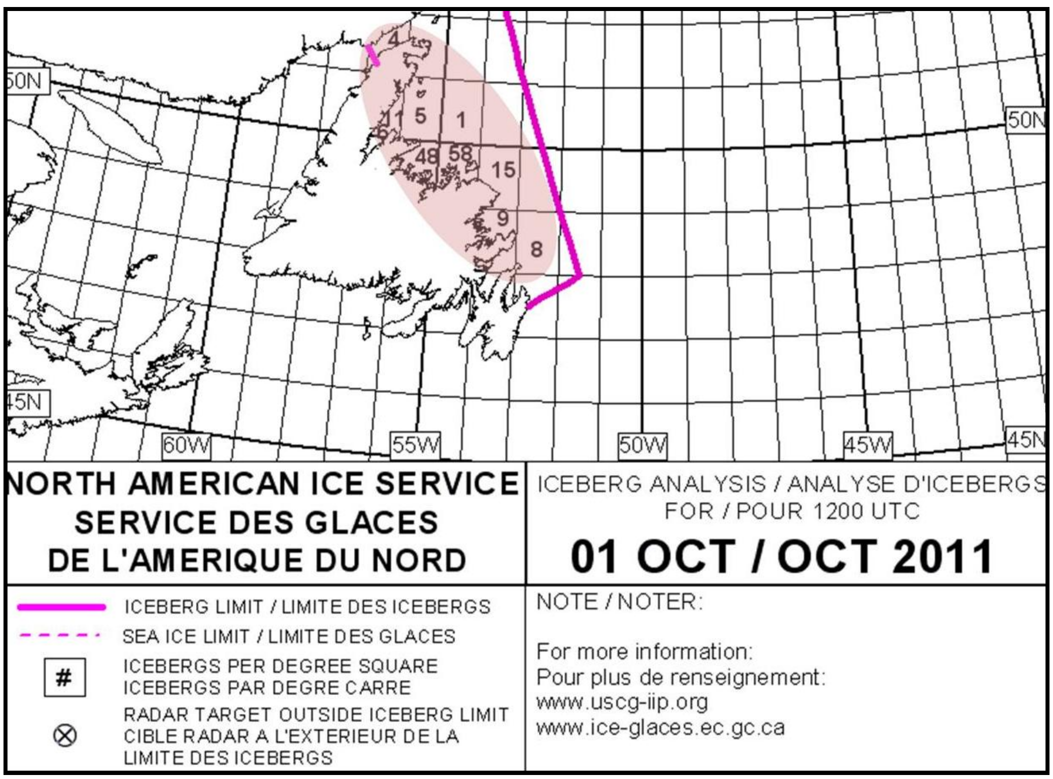

Figure 16. Excerpt from NAIS Iceberg Limit Chart for 01 October 2011. The red shaded area indicates the location of 2010 Petermann Ice Island fragments.

January – March 2012

While sea ice growth began in earnest during December, above normal mean air temperatures in southern Labrador slowed ice growth in January by approximately 1 week compared to normal conditions (CIS, 2012a). By the end of January, the ice edge had covered the Strait of Belle Isle and had advanced to approximately 50^{o}N but had not yet reached Fogo Island. The ice edge extended approximately 75 NM east of the northern arm of Newfoundland. Although the daily ice analysis depicted significant sea ice coverage, the majority of ice south of 54°N was all new ice (largely less than 30 cm thick) (Desjardins, 2012a). The ice depicted along the northern arm of Newfoundland was likely formed along the northern Labrador coast and forced southward i.e., the ice was not being formed locally. In general, the observed sea ice concentration for January was significantly below normal conditions. This situation is depicted by the red and pink shading indicating sea ice departures from normal conditions in **Figure 17**.

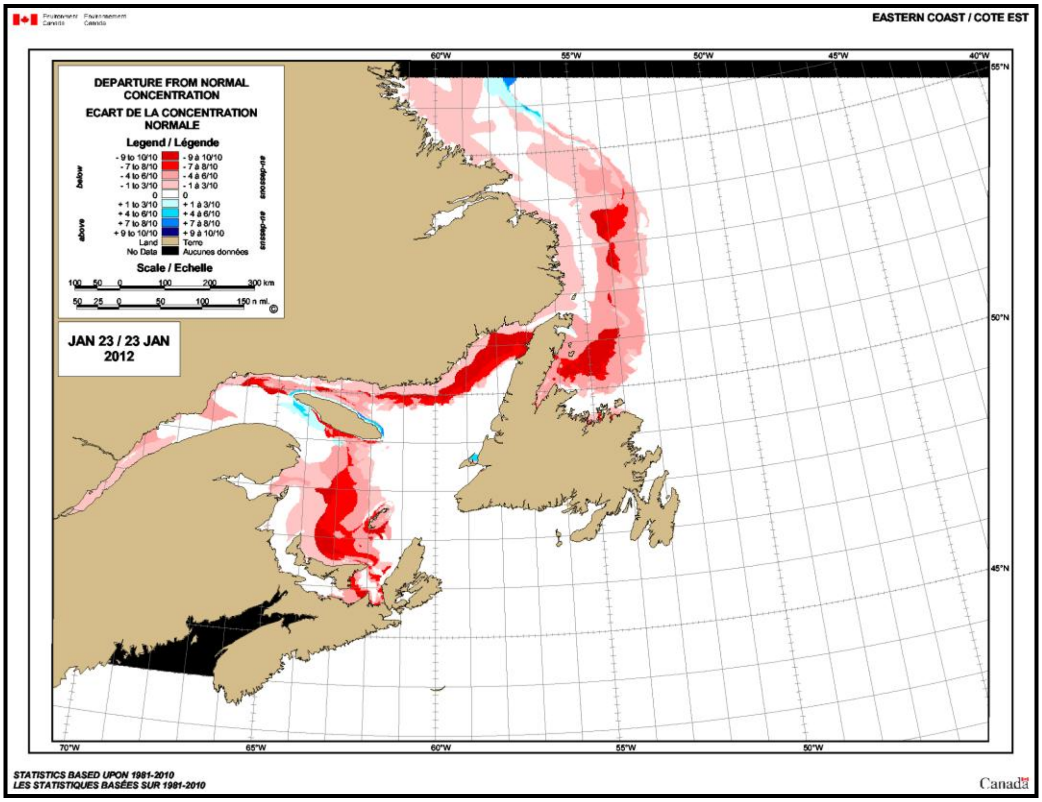

Figure 17. Sea ice concentration departure from normal conditions for 23 January 2012. (CIS, 2012b)

IIP conducted its first reconnaissance for 2012 with two flights on 03 and 06 February. The first IIP patrol straddled the 1000 m depth contour to assess iceberg conditions up to 55°N in the offshore branch of the Labrador Current; this patrol did not detect any icebergs. The second IIP flight focused efforts inshore of the 1000 m contour between 51°N and 55°N detecting 30 icebergs all within the sea ice limit and north of 50°N. Provincial Aerospace LTD (PAL), a commercial provider of ice monitoring services to the CIS and the offshore oil and gas industry, began iceberg reconnaissance flights on 22 February. This flight was sponsored by the CIS and located 18 icebergs off of the Northern Arm of Newfoundland. These early reconnaissance flights located a sizable iceberg population all of which were north of 50°N and within the sea ice limit.

Cold air temperatures in southern Labrador at the end of January into February (**Figure 15**) caused an expansion in the sea ice coverage. At its southernmost limit, the ice edge was approximately 80 NM east of Cape Freels off of the central Newfoundland coast (CIS, 2012a). Although the sea ice coverage for the Labrador coast was significantly higher than the previous two seasons (20% coverage vice 13% and 5% for 2011 and 2010, respectively), it still lagged median coverage for 1980-2011 by approximately 5%. By the end of February, IIP was tracking 86 icebergs all within the sea ice. No icebergs had drifted south of 48^{o}N by this time.

As shown in **Figure 15**, a third period of below-normal air temperatures in southern Labrador caused continued ice expansion to its maximum southern extent around 27 March 2012. At its maximum southern boundary, the sea ice edge extended to 46^{o}- 40'N and approximately 180 NM east of St. John's, Newfoundland. An image from the Moderate Resolution Imaging Spectroradiometer (MODIS) on the Terra Satellite provides an excellent, nearly cloud-free view from space of the extent and concentration of the sea ice on 15 March 2012 in **Figure 18** (NASA/GSFC, 2012). This image has a 1 km resolution and is displayed in true color.

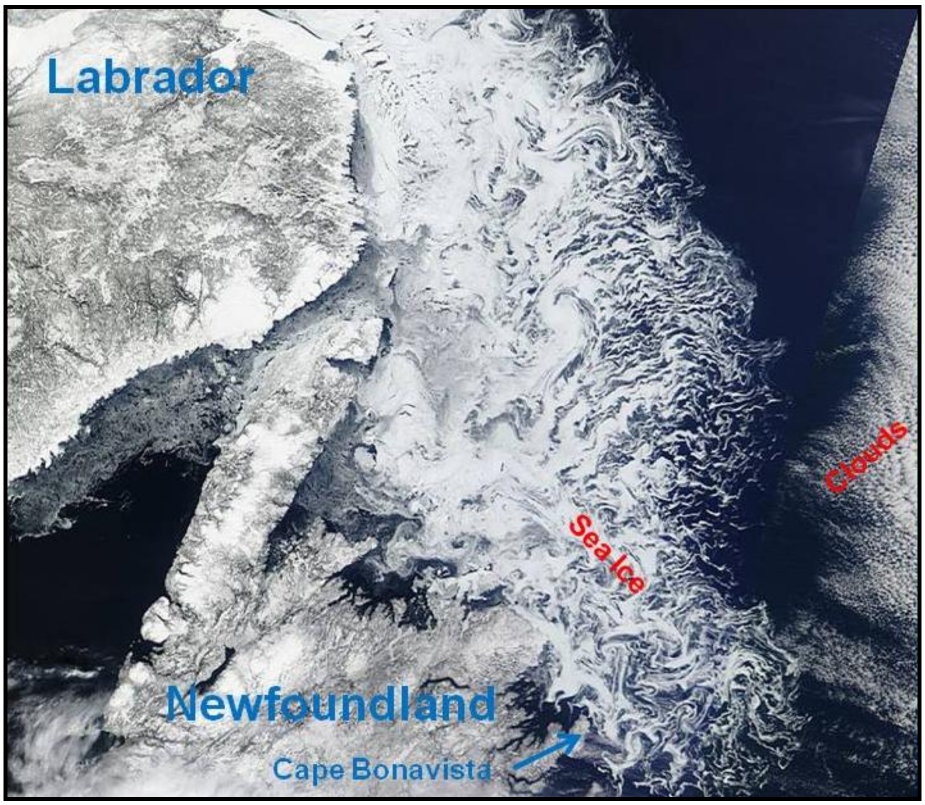

Figure 18. MODIS image over Newfoundland taken from the Terra Satellite on 15 March 2012 in True Color with 1 km resolution. Courtesy of the NASA/GSFC, Rapid Response System. (NASA/GSFC, 2012)

At the beginning of the March, IIP focused its reconnaissance efforts along the 1000 m contour between 53^{o}N and 58^{o}N to assess the iceberg population up stream. IIP's focus shifted offshore and south toward Flemish Pass as well as the inshore branch of the Labrador Current near Newfoundland. PAL conducted one reconnaissance flight that was sponsored by CIS and seven additional flights for industry during March. Most of the icebergs seen by both IIP and PAL reconnaissance were confined to the inshore branch of the Labrador Current with only a few reported in Flemish Pass.

On 31 March, IIP was tracking 192 icebergs with approximately 93 icebergs passing south of 48°N during the month. For the 112 year period from 1900-2011, the average number of icebergs passing south of 48°N for the month of March is 60.

Although observed sea ice coverage in East Newfoundland waters exceeded predictions for the end of March (**Figure 19**), the forecast for a rapid retreat of the ice edge proved accurate, particularly in the presence of several powerful low pressure systems and a blocking high in the central Atlantic. While there was no iceberg census nor severity prediction performed for 2012, this observed sea ice coverage pattern favored the presence of a moderate number of icebergs entering the shipping lanes during the 2012 ice year.

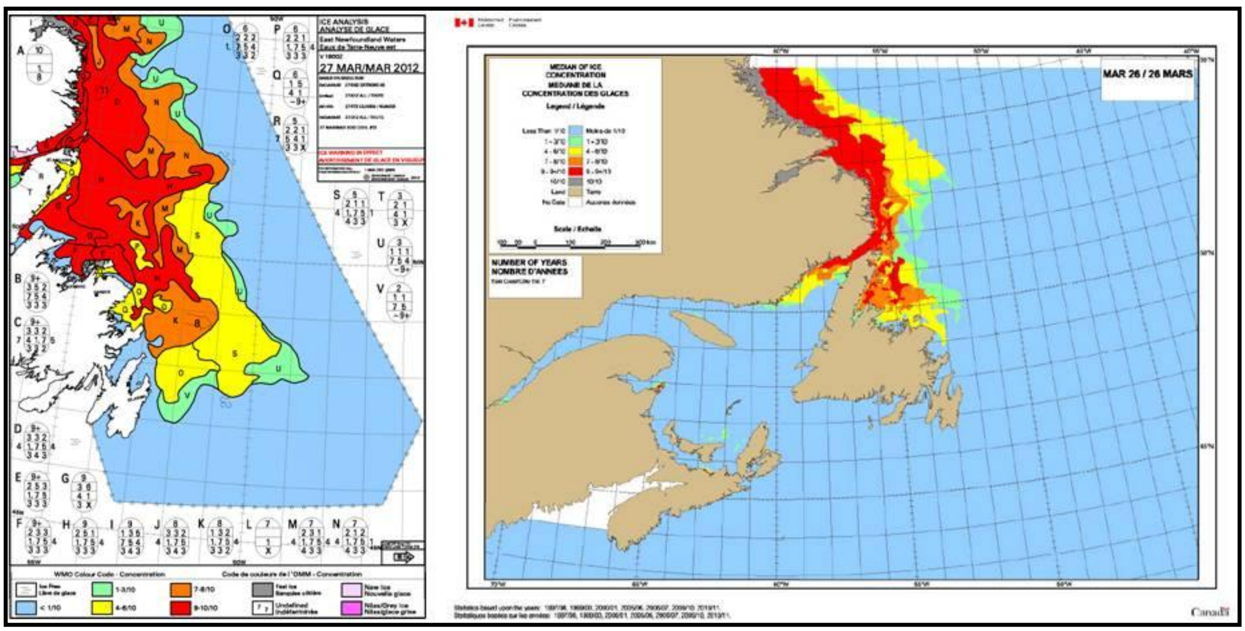

Figure 19. Observed sea ice conditions on 27 March at its maximum extent (left) compared with predicted coverage from the CIS Seasonal Outlook (right). (CIS, 2012a)

April - June 2012

The sea ice edge continued to move eastward reaching its furthest eastern extent of 47°-20'W in early April. Dramatic changes in the sea ice coverage occurred after the first week of April when a series of strong low pressure systems caused significant ice destruction with easterly winds forcing high ice concentrations in the Newfoundland bays and the Strait of Belle Isle. On 05 April 2012, an intense storm system (with 976 mb central pressure) moved across Newfoundland and along the Labrador coast. The track of this system was influenced by a strong blocking high pressure system in the central Atlantic (**Figure 20**).

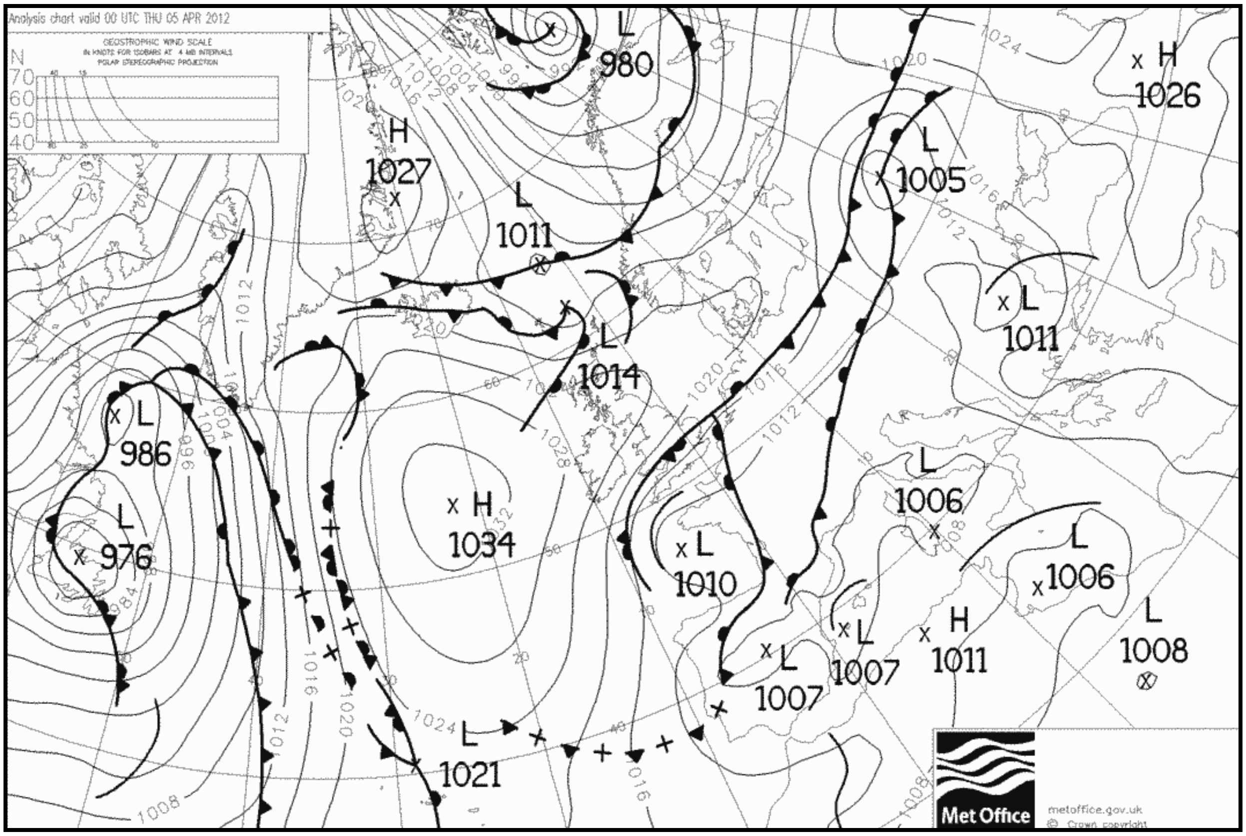

Figure 20. Surface pressure analysis for 05 April 2012. (UKMO Met Office, 2012)

This system, combined with the presence of warmer than normal SSTs for waters east of Newfoundland resulted in a dramatic retreat of the sea ice edge after the first week of April which continued throughout the remainder of the month. The absence of sea ice in IIP's patrol area exposed icebergs in both the inshore and offshore branches of the Labrador Current to the open sea which hastened their ultimate destruction through April and into May. Average Newfoundland air temperatures were significantly above normal throughout the month of April with St. John's, NL recording temperatures 3.9^{o}C above normal for the period (NCEP, 2012). The sea ice edge had receded to the north of 50^{o}N by the end of April.

IIP reconnaissance continued through April patrolling for icebergs alternately near the Newfoundland coast (southwest iceberg limit) and the Flemish Pass (southeastern iceberg limit). IIP conducted five sorties that located over 130 icebergs in both areas. Of note, IIP detected several ice island fragments that were likely associated with the Peterman Ice Island that calved in 2010. Dates, locations and example photographs are presented below. Throughout the month, PAL increased reconnaissance flight frequency from every other day in the beginning of the month to multiple daily flights by the end of April. PAL flew three flights in April that were sponsored by the CIS, which focused primarily on the southern Labrador and northern Newfoundland waters. Toward the end of April, the iceberg population in the offshore branch of the Labrador Current had progressed into Flemish Pass. As a significant iceberg population approached the oil production facilities on the Grand Banks, PAL reconnaissance focused most of their efforts in this area. Accordingly, the majority of PAL flights (~20) were sponsored by the oil and gas industry focusing on the area northwest of Flemish Pass between the 200 m and 1000 m contour (Young, 2012).

On 30 April, IIP was tracking 467 icebergs with approximately 136 icebergs passing south of 48^{o}N for the month. For the 112-year period from 1900-2011, the average number of icebergs passing south of 48^{o}N for the month of April is 123.

By this time, no icebergs had drifted south of 46^{o}N latitude. This observation is likely related to the strong warm SST anomaly that persisted throughout the 2012 season (**Figure 21**) and a pronounced warm meander of the North Atlantic Current that minimized the number of icebergs flowing south of this latitude. This oceanographic situation is described further in the discussion section.

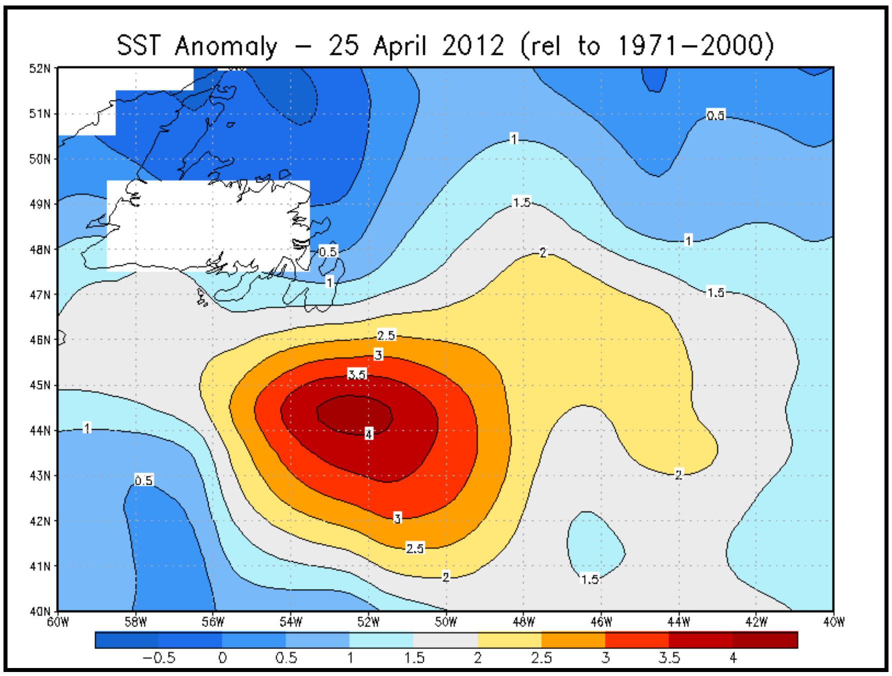

Figure 21. Mean SST anomaly for 25 April 2012. (NOAA/NWS, 2012a)

Air temperatures in southern Labrador began to rise above normal conditions throughout the remainder of the summer (**Figure 15**). By mid-May the ice extent had receded north of 53^{o}N.

Throughout the first part of May, icebergs began to drift south in Flemish Pass slowly in a relatively weak Labrador Current. The iceberg limit reached south of 45^{o}N during early May but in general a relatively small number of icebergs set the limit throughout the month. IIP conducted eight iceberg reconnaissance flights during May, shifting the focus of patrols southward toward the Tail of the Grand Banks with the iceberg movement. The vessel MSC Alyssa reported seven radar targets “during night time in dense fog” at 43^{o}-12’N, 49^{o}-30’W on May 16. These reports could not be confirmed as icebergs but IIP retained the reports as radar targets on the NAIS iceberg limit product until their projected melt date on May 26.

Hazardous iceberg conditions in the vicinity of Grand Banks oil production facilities throughout May required daily PAL flights in the Flemish Pass area between 46^o N and 47^{o}N. PAL conducted three flights for CIS, two that were south of Flemish Pass and one along the Newfoundland coast. Again, most of PAL flights in May (57) were flown in support of the oil industry and were focused near the rigs.

On 09 May, the Canadian Coast Guard Regional Operations Center in St. John's, Newfoundland reported that the tug M/V Atlantic Raven moved the drill rig Henry Goodrich from the oil field to a position approximately 35 NM off or St. John's due to the high number of icebergs in the vicinity. M/V Atlantic Raven returned Henry Goodrich to the oil field on 15 May after the iceberg threat subsided.

The total number of icebergs on the Grand Banks and Labrador coast decreased through the month such that on 31 May, IIP was tracking 316 icebergs with approximately 256 icebergs passing south of 48^{o}N for the month. For the 112 year period from 1900-2011, the average number of icebergs passing south of 48^{o}N for the month of May is 147.

While southern and central Labrador continued to exhibit warmer than normal mean temperatures during the month of June (**Figure 15**), the sea ice edge continued its rapid retreat northward throughout the remainder of the season. By the end of June, the edge of the main ice pack had retreated to Cape Chidley (~60^{o}N) with only a small patch of ice near Nain, Labrador. This retreat was approximately 2 weeks ahead of the 30-year median (CIS, 2011a).

IIP flew four reconnaissance flights from 6-11 June. Reconnaissance focused on the southern iceberg limit toward the Tail of the Grand Banks, the Flemish Pass area out to Sackville Spur and north along the 1000 m contour up to 52^{o}N. Patrols detected only one iceberg in Flemish Pass and nine others that were all north of 50^{o}N. These patrols provided radar and visual confirmation that a very small number of icebergs remained in the transatlantic shipping lanes.

Iceberg density diminished throughout the Grand Banks in June. The iceberg limit reached its southern-most extent on 6 June and eastern & western-most limits on 10 June. On 11 June IIP reported a significant reduction of the iceberg limit up to 45^o-30'N. **Table 2** provides a summary of the extreme iceberg sightings, sources and modeled positions for the 2012 ice year.

Extreme Bergs	Source	Sighted			Modeled		
		Date	Lat	Long	Date	Lat	Long
Southern	Provincial Aerospace Ltd.	1-Jun-12	43-11.0N	049-11.6W	6-Jun-12	42-32.5N	049-41.4W
Eastern	IIP C130 Reconnaissance	28-May-12	45-58.0N	045-49.0W	10-Jun-12	46-52.9N	040-44.6W
Western	IIP C130 Reconnaissance	24-May-12	50-25.4N	059-34.2W	10-Jun-12	50-12.0N	059-55.7W

Table 2. Extreme iceberg sightings and modeled positions.

By 30 June, IIP was tracking 228 icebergs with approximately 14 icebergs passing south of 48°N for the month. For the 112 year period from 1900-2011, the average number of icebergs passing south of 48°N for the month of June is 88.

July - Sep 2012

With continued seasonal warming throughout Labrador and Newfoundland, the iceberg population on the Grand Banks diminished rapidly; the last day an iceberg was reported south of 48°N was on 02 July. IIP conducted its final two flights of the season in July: one of the southern iceberg limit up to 53°N confirming that there was not a significant iceberg population remaining to pose a threat to shipping and another survey flight along the Labrador coast to approximately 54°N to support a satellite under-flight comparison on 08 July. By the end of July, IIP was tracking 48 icebergs with 0 icebergs passing south of 48°N for the month. The average number of icebergs passing south of 48°N for the month of July is 29. **Figure 22** summarizes the number of icebergs passing south of 48°N by month for the 2012 ice year.

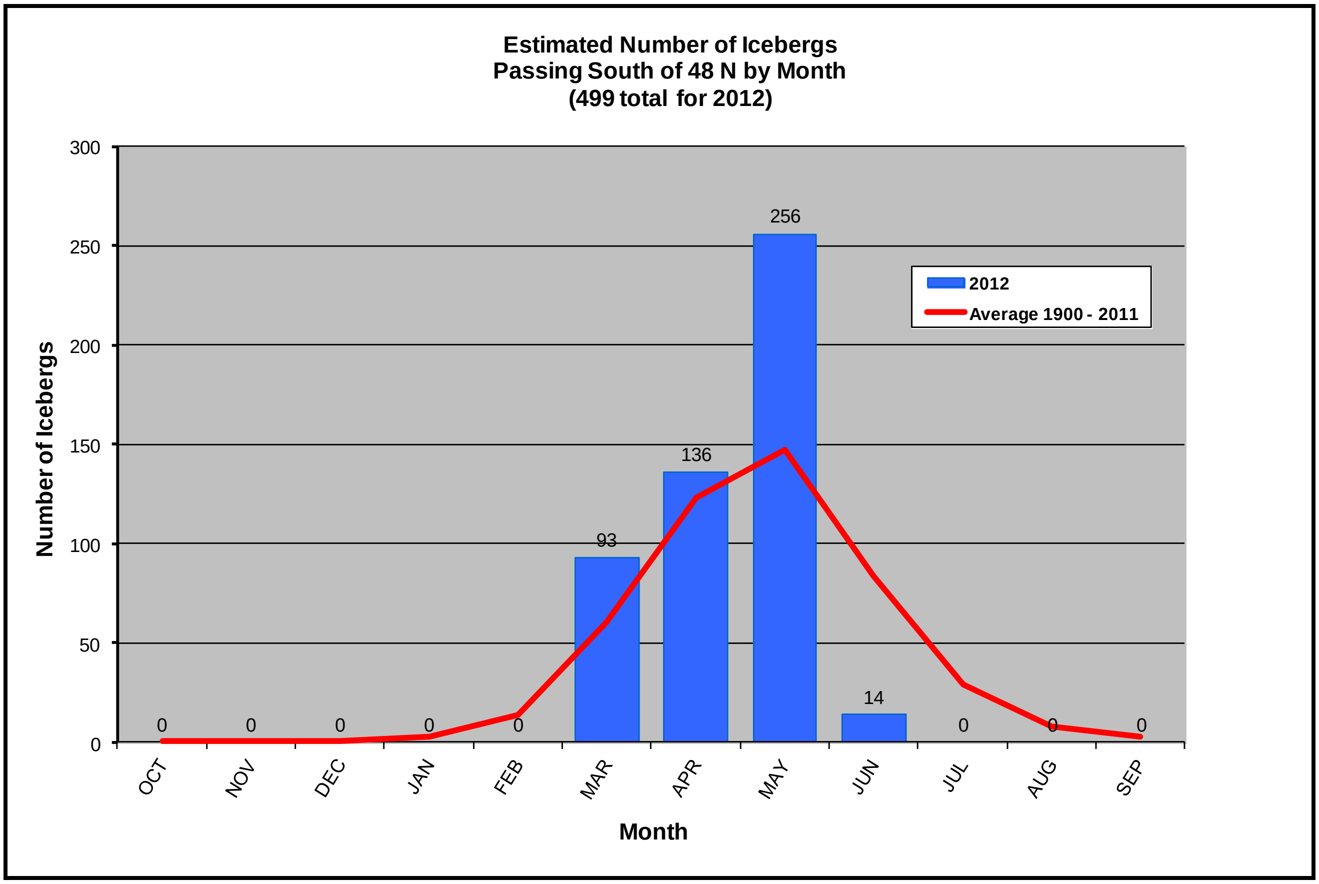

Figure 22. Number of icebergs passing south of 48°N by month.

Petermann Ice Island

During 2012, IIP detected several very large (length>200 m) and large (length between 120-200 m) tabular icebergs that had drifted south of 48°N and became hazards to transatlantic shipping. With the benefit of continued CIS tracking analysis, these ice hazards were likely associated with the 2010 Petermann Glacier event (Desjardins, 2012b). Of note, during the 15 and 16 April flights, IIP located two very large tabular bergs near 48°N at the northern entrance to Flemish Pass and one large berg approximately 12 NM northeast of Cape St. Francis on the Avalon Peninsula. **Figure 23** shows a photograph of the inshore ice island fragment estimated to be about 200 m in length. IIP detected another very large tabular berg (~450 m in length) on 10 May (**Figure 24**). The berg sighted on 10 May was on the edge of the Grand Banks approximately 135 NM south-southwest of the Terra Nova oil production facility. This is likely the southernmost Petermann Ice Island sighting for 2012.

Figure 23. Large tabular iceberg (length ~200 m) photographed by IIP reconnaissance on 15 April 2012 at approximately 1000 ft altitude near the Avalon Peninsula in position 47-54N 52-32W.

Figure 24. Very large tabular iceberg (length ~450 m) photographed by IIP reconnaissance on 10 May 2012 at approximately 1000 ft altitude on the Grand Banks in position 44-17N, 49-17W, ~135 NM SSW of Terra Nova.

On July 16, 2012 another massive ice island calved from the Petermann Glacier (**Figure 25)**. The 2012 Petermann Ice Island (PII-2012) was estimated to be approximately twice the size of Manhattan (~45 NM^2) by CIS analysts. CIS continued to track remnants from the PII-2010 in addition to these new PII-2012 fragments as they moved north through the Nares Strait and into Kane Basin and Baffin Bay (Desjardins, 2012b). While approximately half the size of the PII-2010 event, these new ice islands will likely become the subject of IIP reconnaissance during the 2014 season.

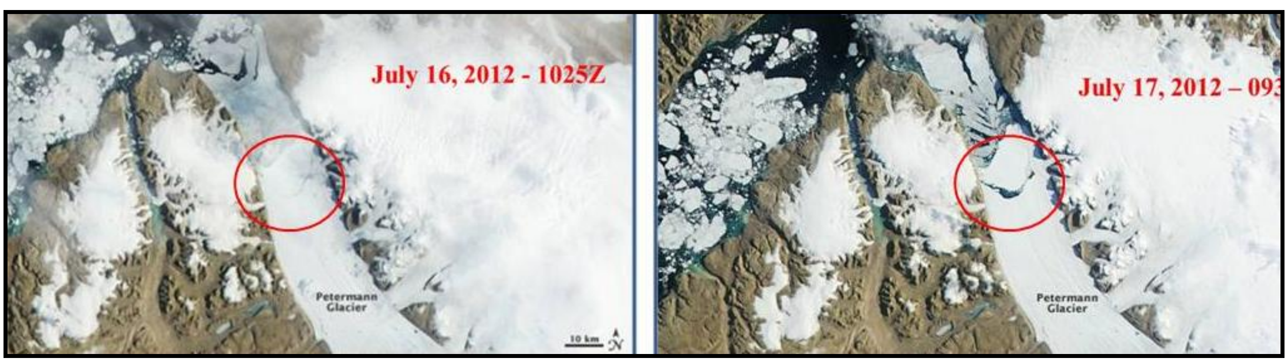

Figure 25. MODIS image taken from the Aqua satellite acquired 16-17 July 2012. Red circles indicate the 2012 Petermann Ice Island. (NASA/GSFC, 2012)

Atmospheric and Oceanographic Discussion

The number of icebergs that drift south of 48°N is closely related to sea ice coverage during the winter months. Sea ice coverage depends not only on air and sea surface temperature but also on the predominant wind direction over IIP's operating area during the winter months (December-March). The southern extent of the iceberg limit further depends on both the number of icebergs that reach the northern Grand Banks after the sea ice retreats and also on the strength and position of the Labrador Current south of Flemish Pass. The following paragraphs discuss how wintertime wind patterns (using the North Atlantic Oscillation index as an indicator) supported close-to-average sea ice coverage favoring an average number of icebergs crossing 48°N. While the iceberg 'season' (i.e., the number of days in which IIP tracked icebergs south of 48°N) can be described as 'moderate', the relatively low density of icebergs that reached the Tail of the Grand Banks was tempered by the presence of a relatively warm protrusion of the North Atlantic Current that impeded the southward flow of the Labrador Current.

While not a predictive tool, the North Atlantic Oscillation (NAO) index provides insight into the mechanisms influencing the number of icebergs moving into the offshore branch of the Labrador Current. The NAO index has been associated with the iceberg season severity in terms of the number of icebergs reaching the shipping lanes via the Labrador Current. The NAO represents the dominant pattern of winter atmospheric variability in the North Atlantic, fluctuating between positive and negative phases. NAO dynamics have been extensively described by Hurrell et al. (2003). Persistent offshore winds in Labrador during winter are characteristic features of a positive phase of the NAO (**Figure 26**).

The winter time 2012 NAO Index (December 2011 through March 2012) was strongly positive at 3.17 (Hurrell, 2012). This value, called the winter station-based NAO index, is calculated using the difference in normalized sea-level atmospheric pressure between Lisbon, Portugal and Stykkisholmu/Reykjavik, Iceland. The NAO index during these winter months has shown some correlation to the severity of the iceberg season. Both 2010 and 2011 winter time NAO indices were strongly negative, consistent with very light iceberg conditions with one and three icebergs south of 48° N, respectively.

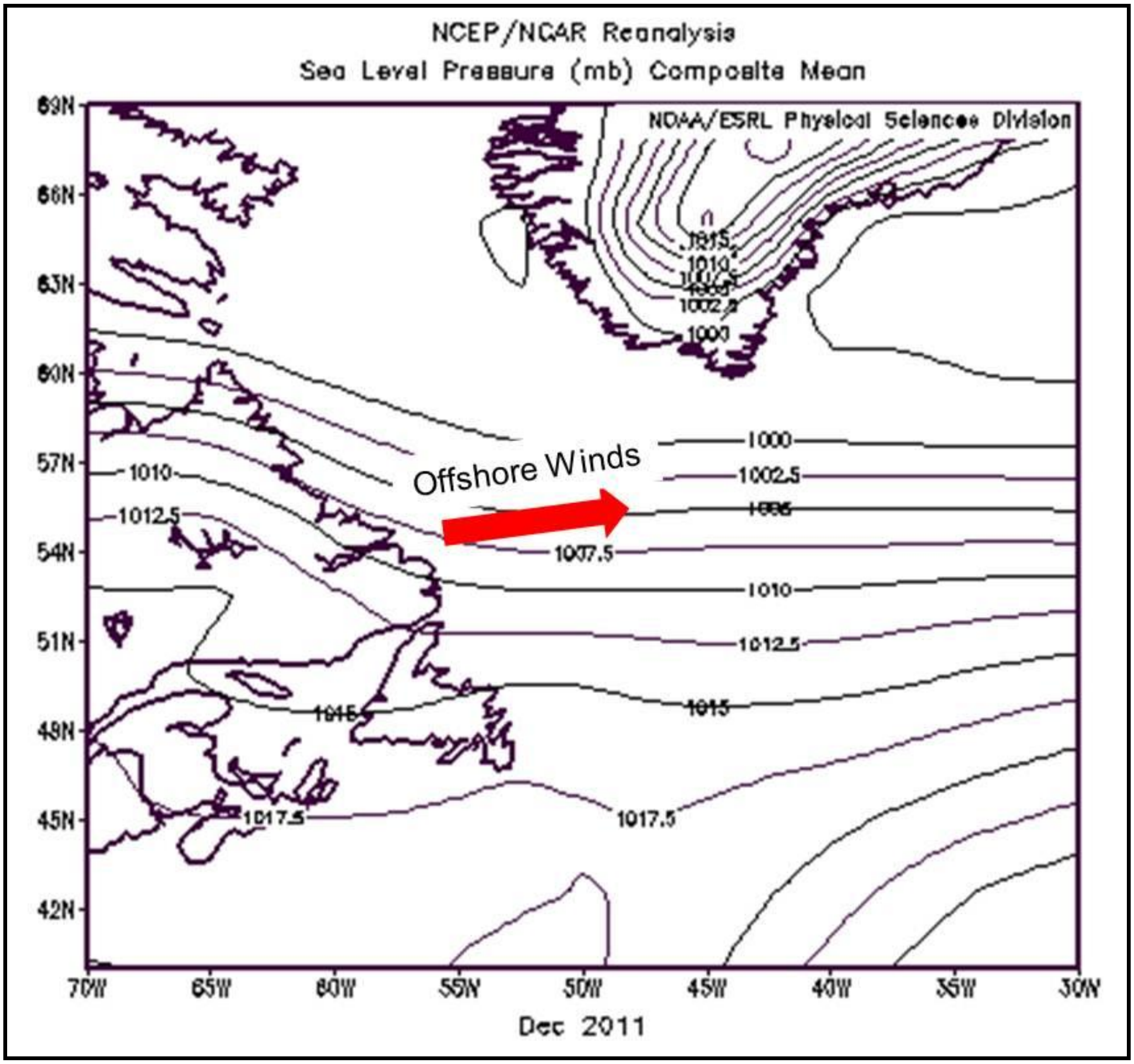

Figure 26. Mean sea-level pressure for 1 to 31 December 2011. Image provided by the NOAA/ESRL Physical Sciences Division, Boulder Colorado. Red arrow indicates approximate prevailing wind direction based on isobars shown. (NOAA/ESRL, 2012)

The positive NAO index is also consistent with the observed sea ice coverage during the 2012 season. Weekly sea ice coverage for East Newfoundland waters for the 2012 season are shown in **Figure 27** as blue columns. Percentage of coverage is based on the amount of ice present relative to red rectangular area shown in the inset map in the upper left corner of the plot. The average coverage for 1980 through 2011 is also plotted as a red line in this figure. **Figure 27** shows that the ice coverage for 2012 was within approximately 5% of average with the peak coverage occurring during the week of 26 March (approximately two weeks delay compared to the average peak).

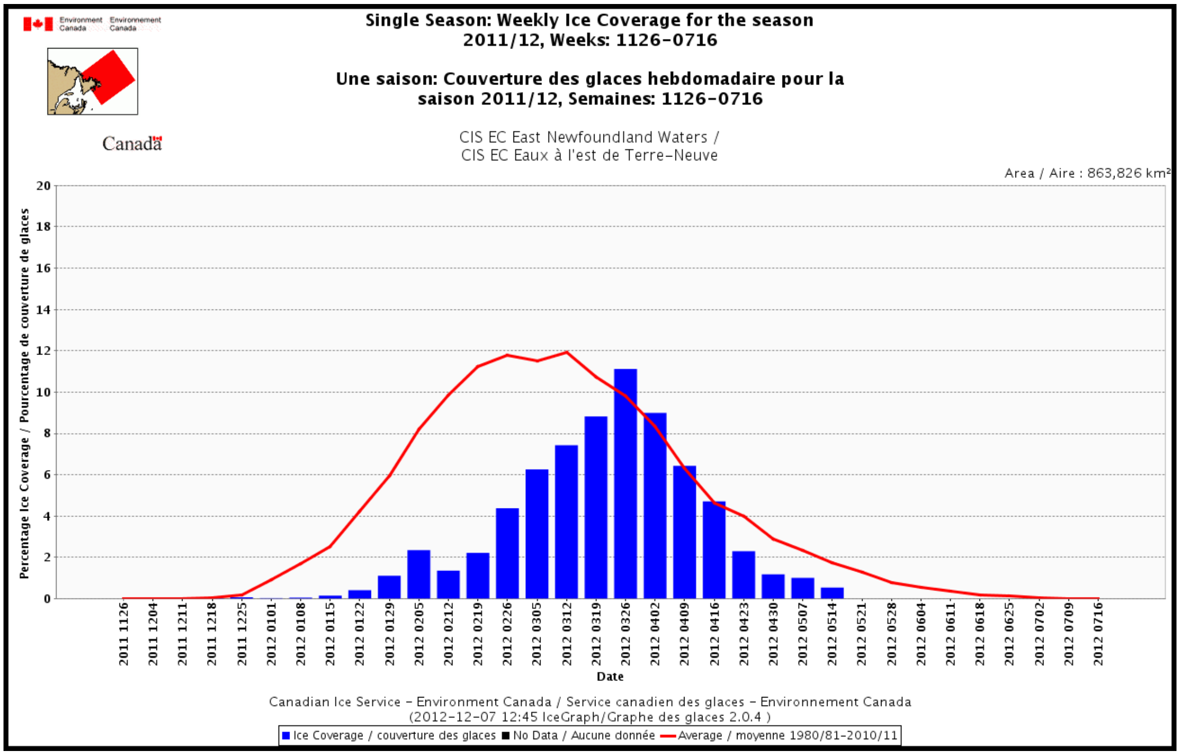

Figure 27. Weekly ice coverage for East Newfoundland Waters. The percent coverage is relative to the area shaded in red in the upper left map of this figure. (CIS, 2012c)

While the positive NAO index and observed sea ice coverage favored a higher number of icebergs on the Grand Banks compared to the previous two seasons, analysis of IIP drifting buoy trajectories and SSTs derived from Advanced Very High Resolution Radiometer (AVHRR) imagery provided insight into the relatively sparse population of icebergs that survived south of 45°N. **Figure 28** shows positions and trajectories for three IIP drifting buoys for the period from 6-16 May. The northernmost buoy shows an eastward drift toward the top of Flemish Cap. While this track suggests a mechanism to transport icebergs north of Flemish Cap and out to the eastern extent of IIP's operating area, IIP detected no icebergs north of the Cap throughout the season. The trajectory of the central buoy in **Figure 28** shows a circular path implying that the buoy was not in the main branch of the Labrador Current and more likely was on the boundary of a meander of the North Atlantic Current. The trajectory of the southernmost buoy in **Figure 28** shows a dramatic turn to the east.

A rare glimpse at the SSTs from an AVHRR image acquired on May 12th provides tremendous insight into the oceanographic complexities affecting buoy and iceberg drift near the Tail of the Grand Banks (**Figure 29**). This image was obtained through John Hopkins University, Applied Physics Laboratory Ocean Watch program (JHU, 2012) and revealed the presence of a strong, east-west oriented thermal gradient (4°C–11°C) at approximately 46°N near the southern extremity of Flemish Pass and explains the dramatic buoy drift toward the east. This warm feature, associated with the North Atlantic Current persisted throughout May and created an extraordinarily complex ocean environment that ultimately acted as a barrier to the southward progression of icebergs for the 2012 season and thereby mitigating the risk to transatlantic shipping.

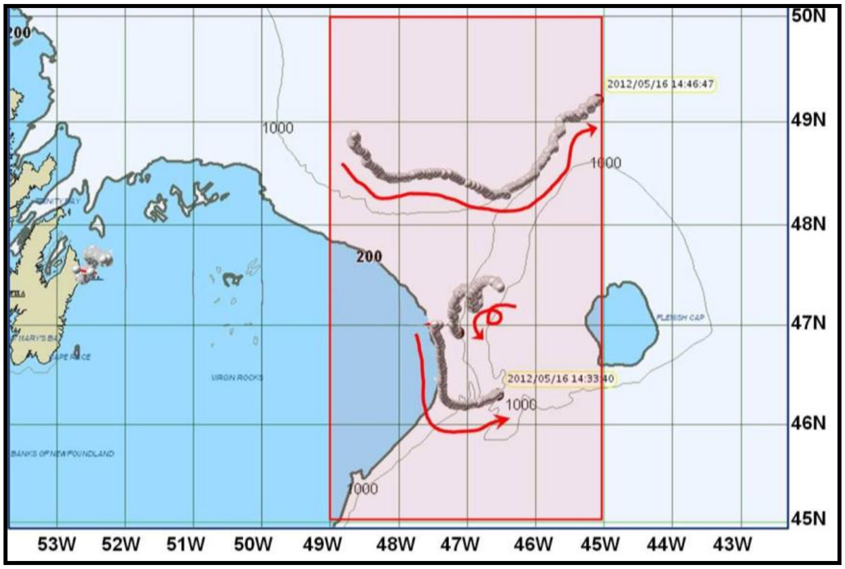

Figure 28. IIP drifting buoy trajectories for a ten day period from May 06-16. Circles are individual buoy locations, red arrows provide general drift patterns.

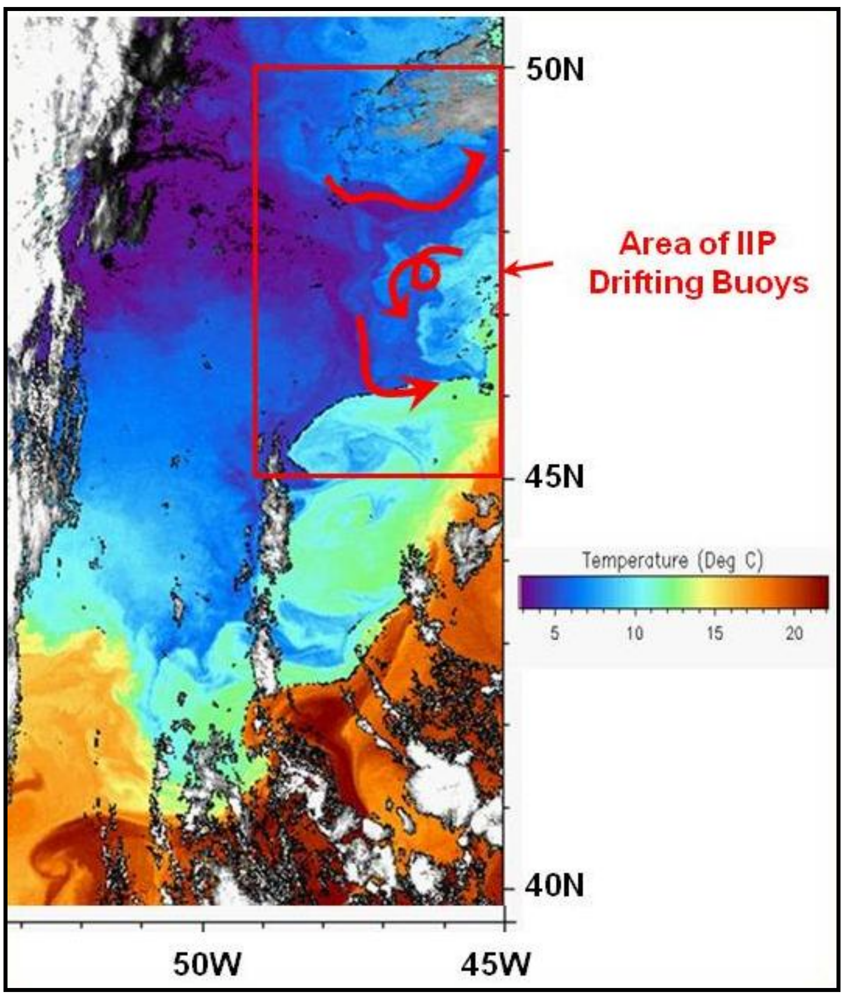

Figure 29. Water surface temperature from Channel 2 NOAA-15 AVHRR image for May 12, 2012 at 19:36 UTC. Image annotated with approximate locations of IIP drifting buoys during the time of the image. (JHU, 2012)

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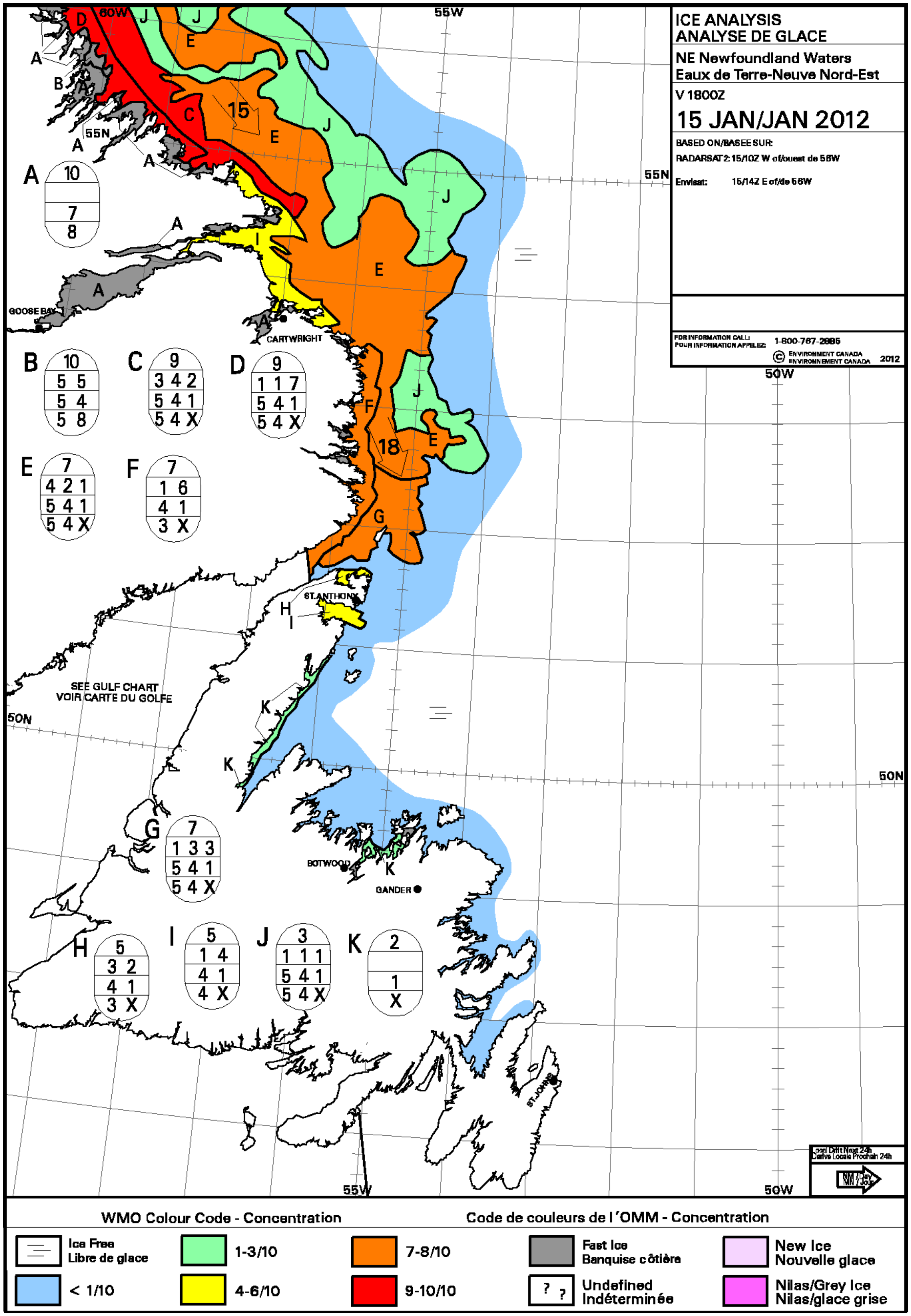
Monthly Sea-Ice Charts

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

Sea ice symbols are in accordance with the World Meteorological Organization.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NE Newfoundland Waters
Eaux de Terre-Neuve Nord-Est
V 1800Z
15 JAN/JAN 2012
BASED ON/BASEE SUR:
RADARSAT2: 15/10Z W of/ouest de 56W
Envisat: 15/14Z E of/de 56W
1-800-767-2885
ENVIRONMENT CANADA
ENVIRONNEMENT CANADA
2012
GOOSE BAY
CARTWRIGHT
ST.ANTHONY
SEE GULF CHART
VOIR CARTE DU GOLFE
BOTWOOD
GANDER
ST.JOHNS
55N
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60W
56W
50W
55W
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
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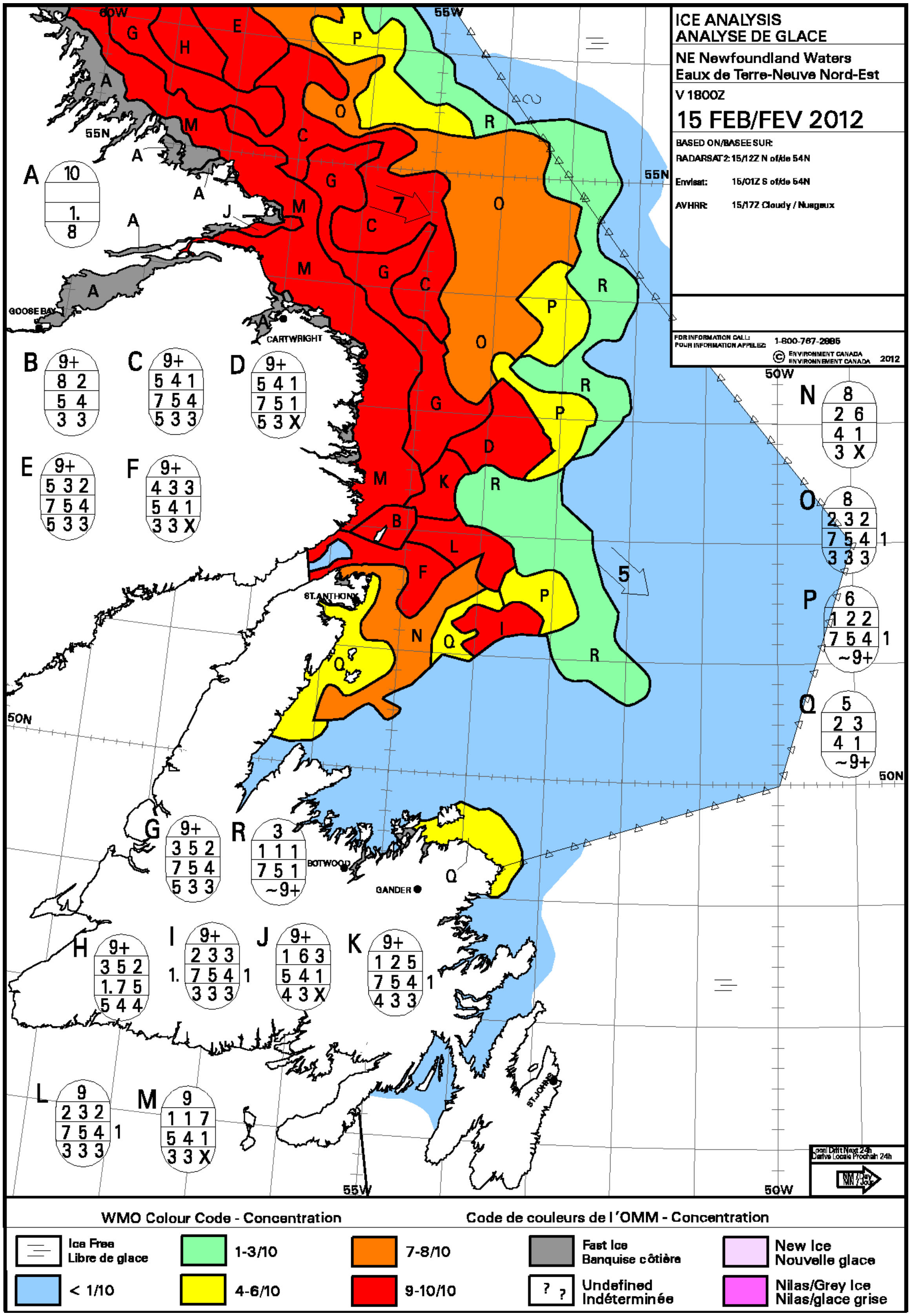
Banquise côtière
Undefined
Indéterminée
New Ice
Nouvelle glace
Nilas/Grey Ice
Nilas/glace grise



ICE ANALYSIS
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Eaux de Terre-Neuve Nord-Est
V 1800Z
15 FEB/FEV 2012
BASED ON/BASEE SUR:
RADARSAT 2: 15/12Z N of/de 54N
Envisat: 15/01Z S of/de 54N
AVHRR: 15/17Z Cloudy / Nuageux
FOR INFORMATION CALL: POUR INFORMATION APPELEZ: 1-800-767-2885
© ENVIRONMENT CANADA ENVIRONNEMENT CANADA 2012
60W
55W
50W
55N
50N
GOOSE BAY
CARTWRIGHT
ST.ANTHONY
BOTWOOD
GANDER
ST.JOHN'S
WMO Colour Code - Concentration
Code de couleurs de l'OMM - Concentration
Ice Free
Libre de glace
< 1/10
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7-8/10
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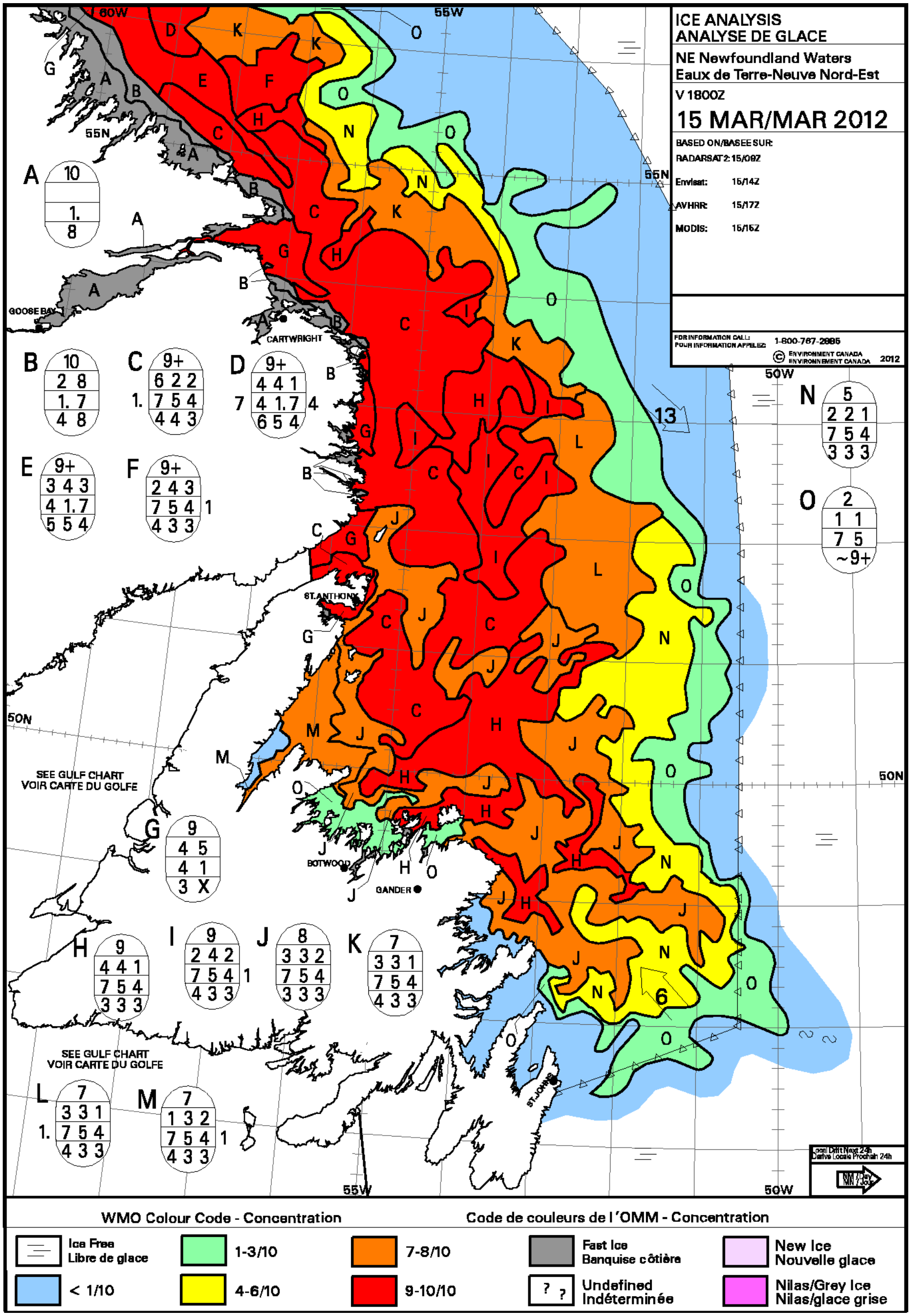
New Ice
Nouvelle glace
Nilas/Grey Ice
Nilas/glace grise


ICE ANALYSIS
ANALYSE DE GLACE
NE Newfoundland Waters
Eaux de Terre-Neuve Nord-Est
V 1800Z
15 MAR/MAR 2012
BASED ON/BASEE SUR:
RADARSAT2: 15/09Z
Envisat: 15/14Z
AVHRR: 15/17Z
MODIS: 15/15Z
FOR INFORMATION CALL: POUR INFORMATION APPELEZ: 1-800-767-2885
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GOOSE BAY
CARTWRIGHT
ST. ANTHONY
BOTWOOD
GANDER
ST. JOHNS
SEE GULF CHART
VOIR CARTE DU GOLFE
60W
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Local Drift Next 24h
Dérive Locale Prochain 24h
WMO Colour Code - Concentration
Code de couleurs de l'OMM - Concentration
Ice Free
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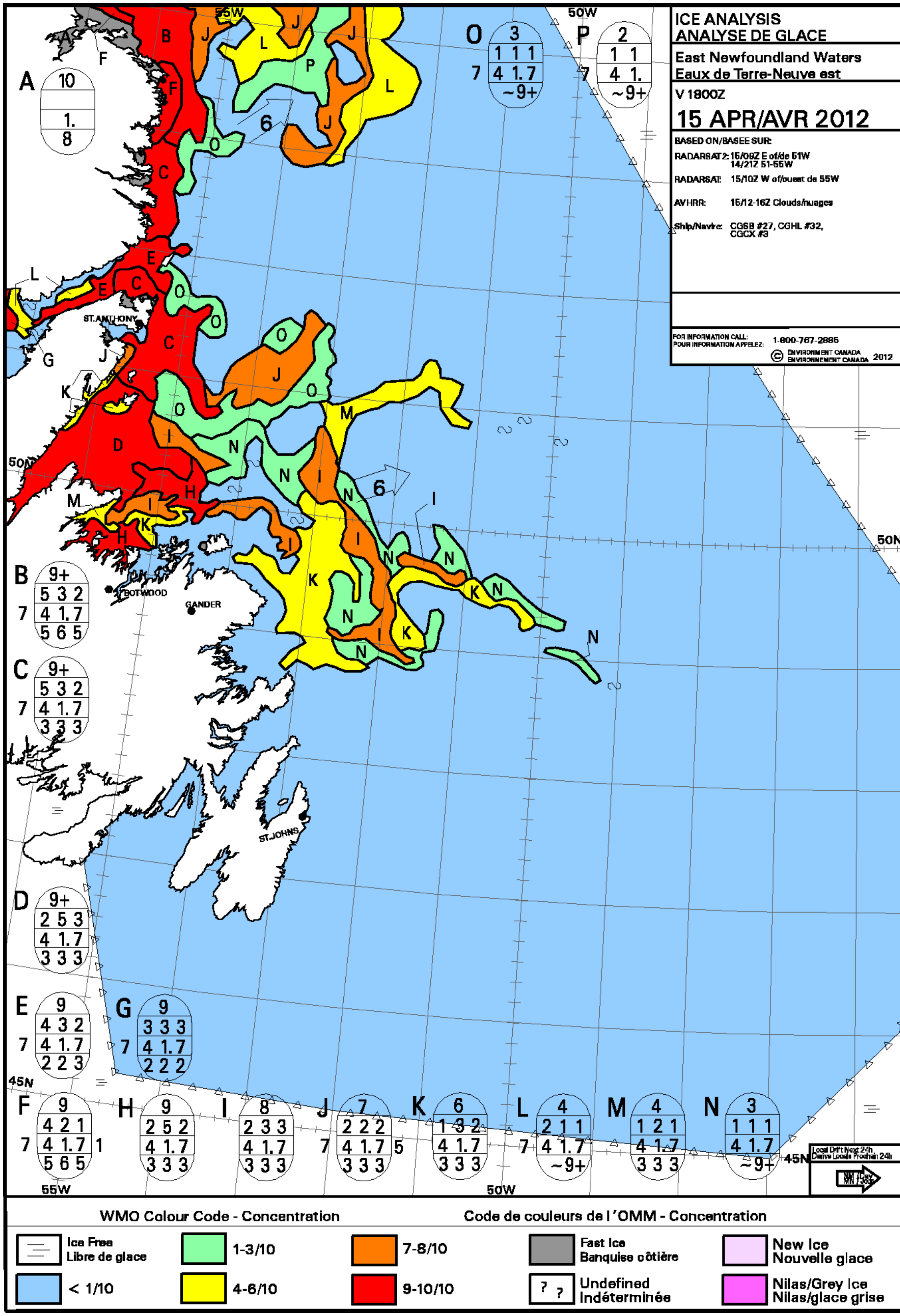
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ANALYSE DE GLACE
East Newfoundland Waters
Eaux de Terre-Neuve est
V 1800Z
15 APR/AVR 2012
BASED ON/BASEE SUR:
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14/21Z 51-55W
RADARSAT: 15/10Z W of/ouest de 55W
AVHRR: 15/12-16Z Clouds/nuages
Ship/Navire: CGSB #27, CGHL #32, CGCX #3
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ST.ANTHONY
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GANDER
ST.JOHNS
55W
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WMO Colour Code - Concentration
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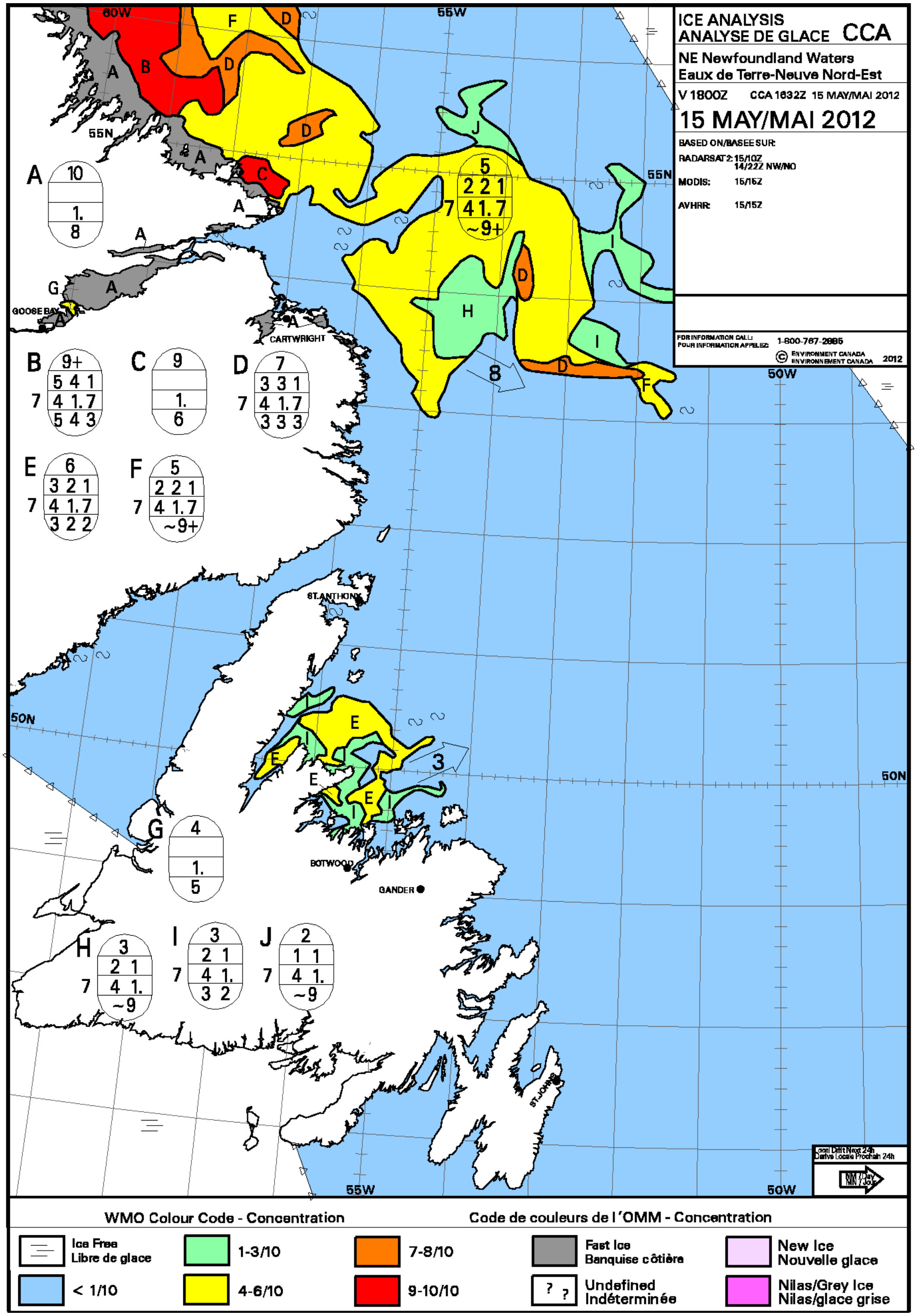
ICE ANALYSIS
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NE Newfoundland Waters
Eaux de Terre-Neuve Nord-Est
V 1800Z CCA 1632Z 15 MAY/MAI 2012
15 MAY/MAI 2012
BASED ON/BASEE SUR:
RADARSAT 2: 15/10Z 14/22Z NW/NO
MODIS: 15/15Z
AVHRR: 15/15Z
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60W
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GOOSE BAY
CARTWRIGHT
ST.ANTHONY
BOTWOOD
GANDER
ST.JOHNS
Local Drift Next 24h
Dérive Locale Prochain 24h
WMO Colour Code - Concentration
Code de couleurs de l'OMM - Concentration
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Fast Ice
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Semimonthly Iceberg Charts

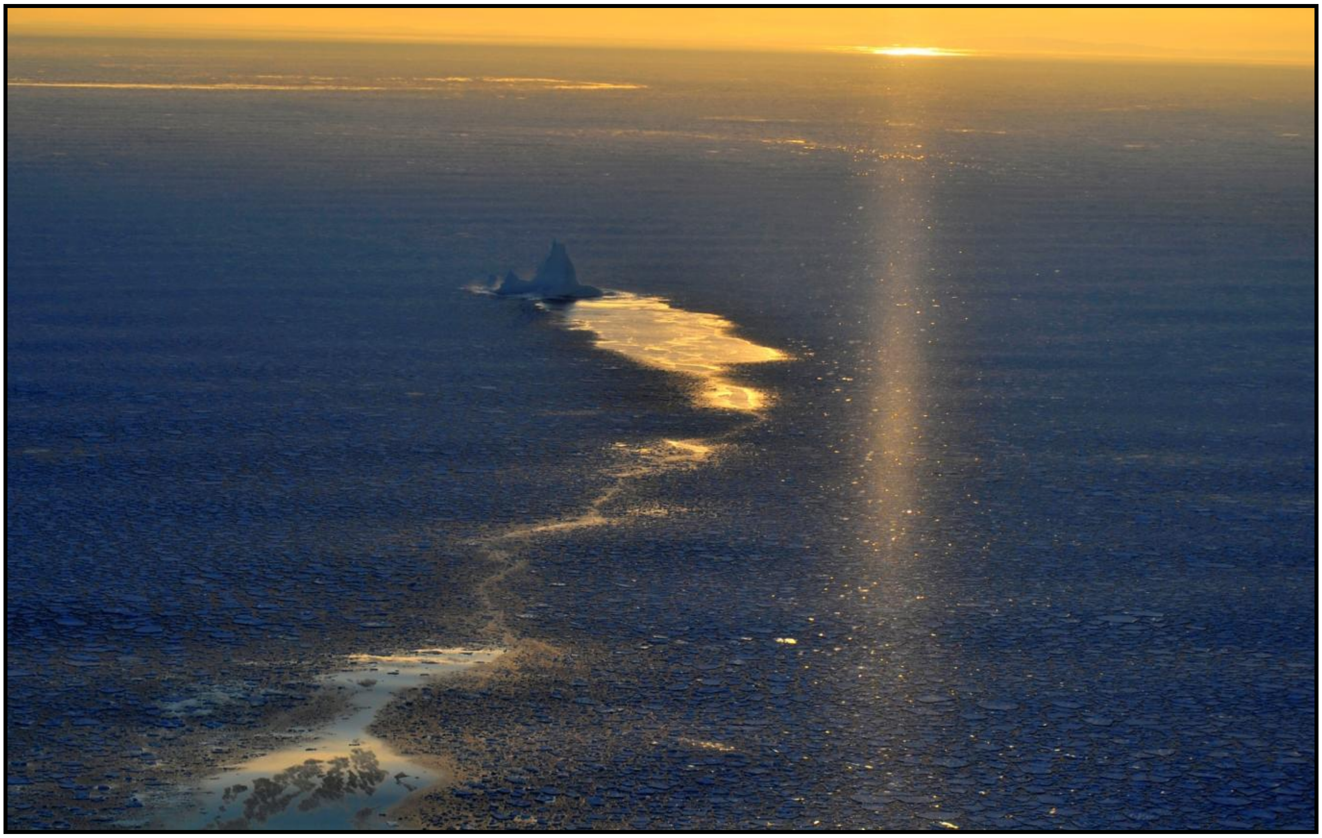
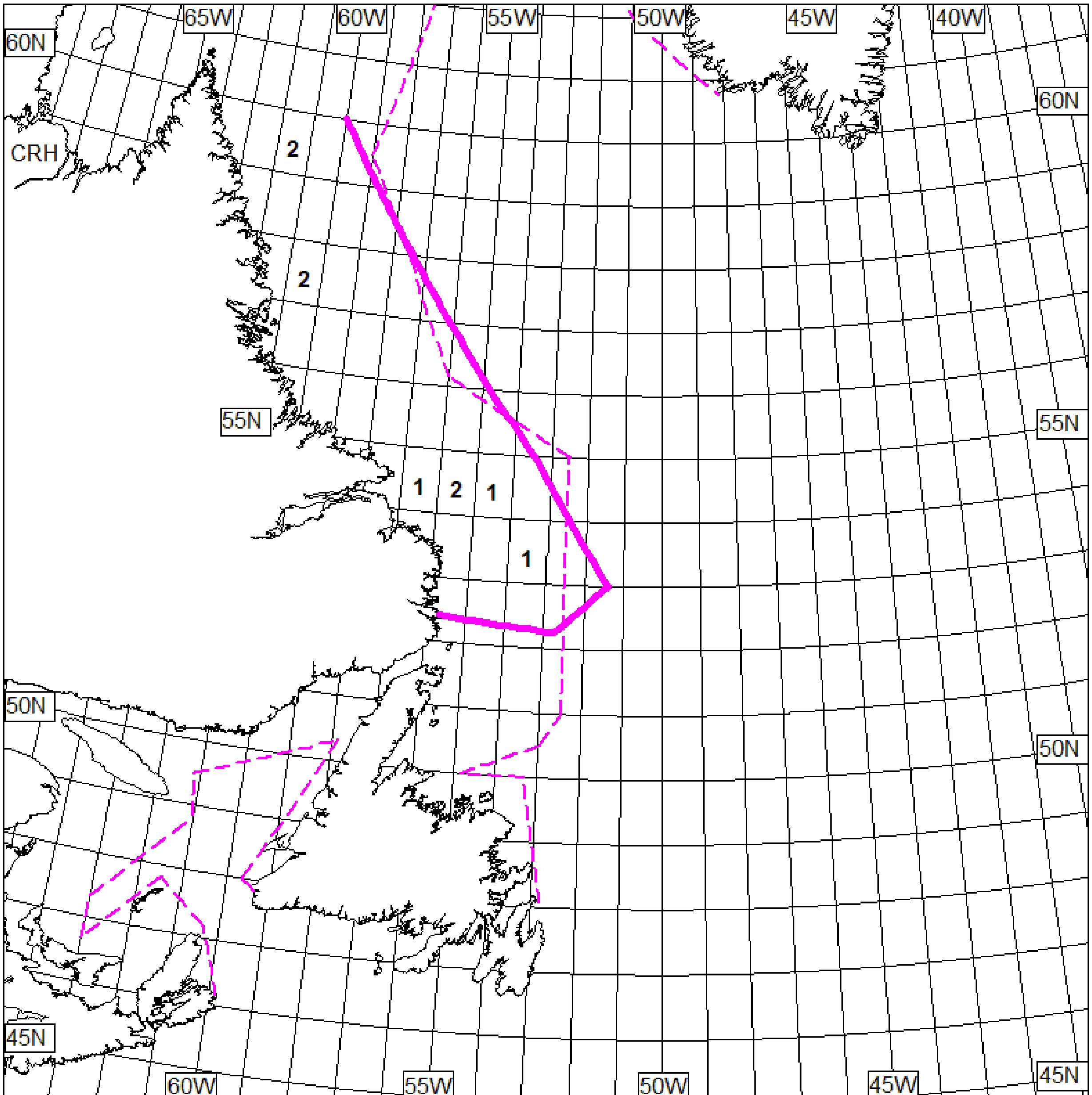


Photo by PA1 Thomas McKenzie, U.S. Coast Guard.



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DE L'AMERIQUE DU NORD

ICEBERG ANALYSIS / ANALYSE D'ICEBERGS
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01 FEB / FEV 2012

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SEA ICE LIMIT / LIMITE DES GLACES

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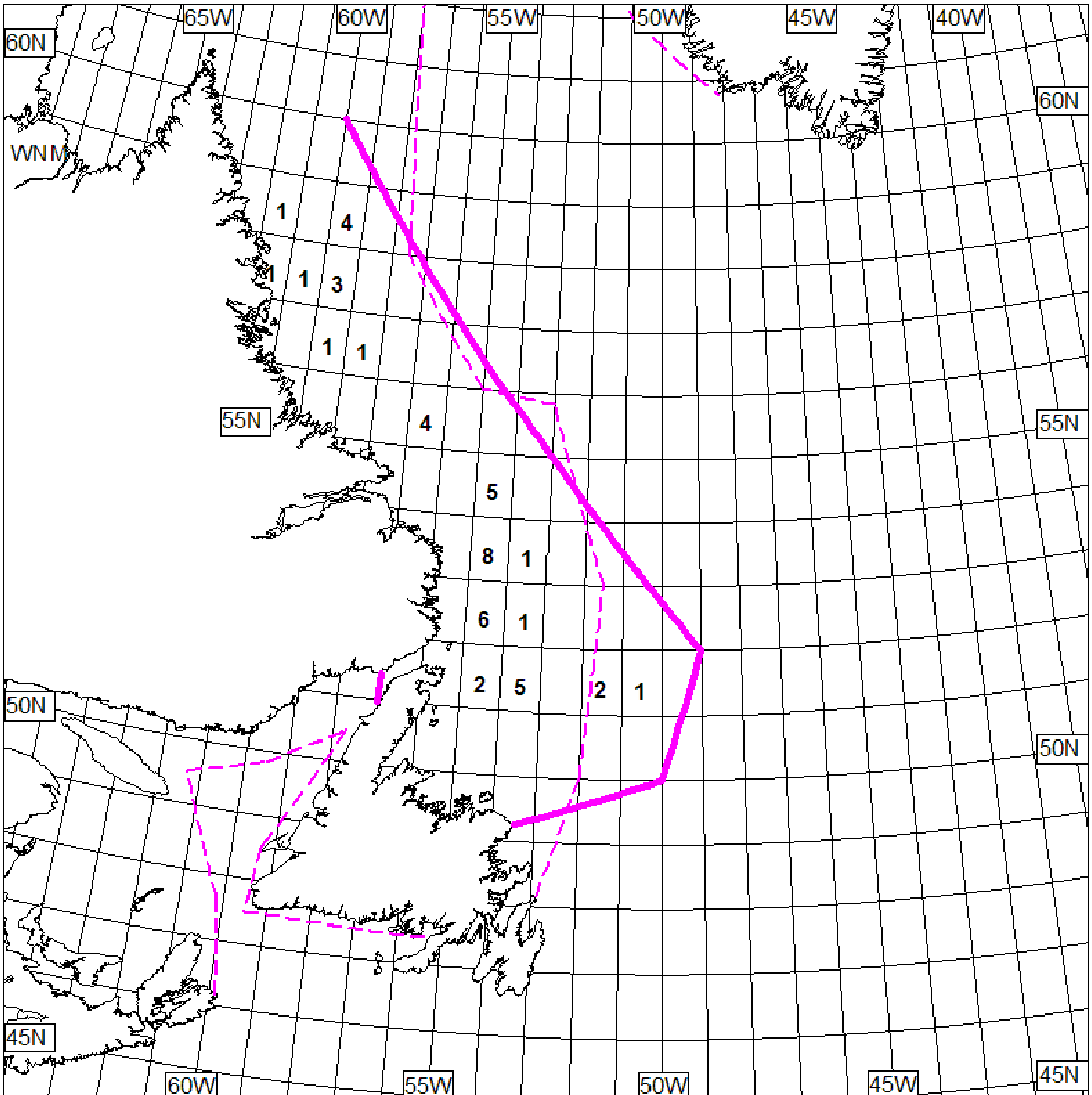

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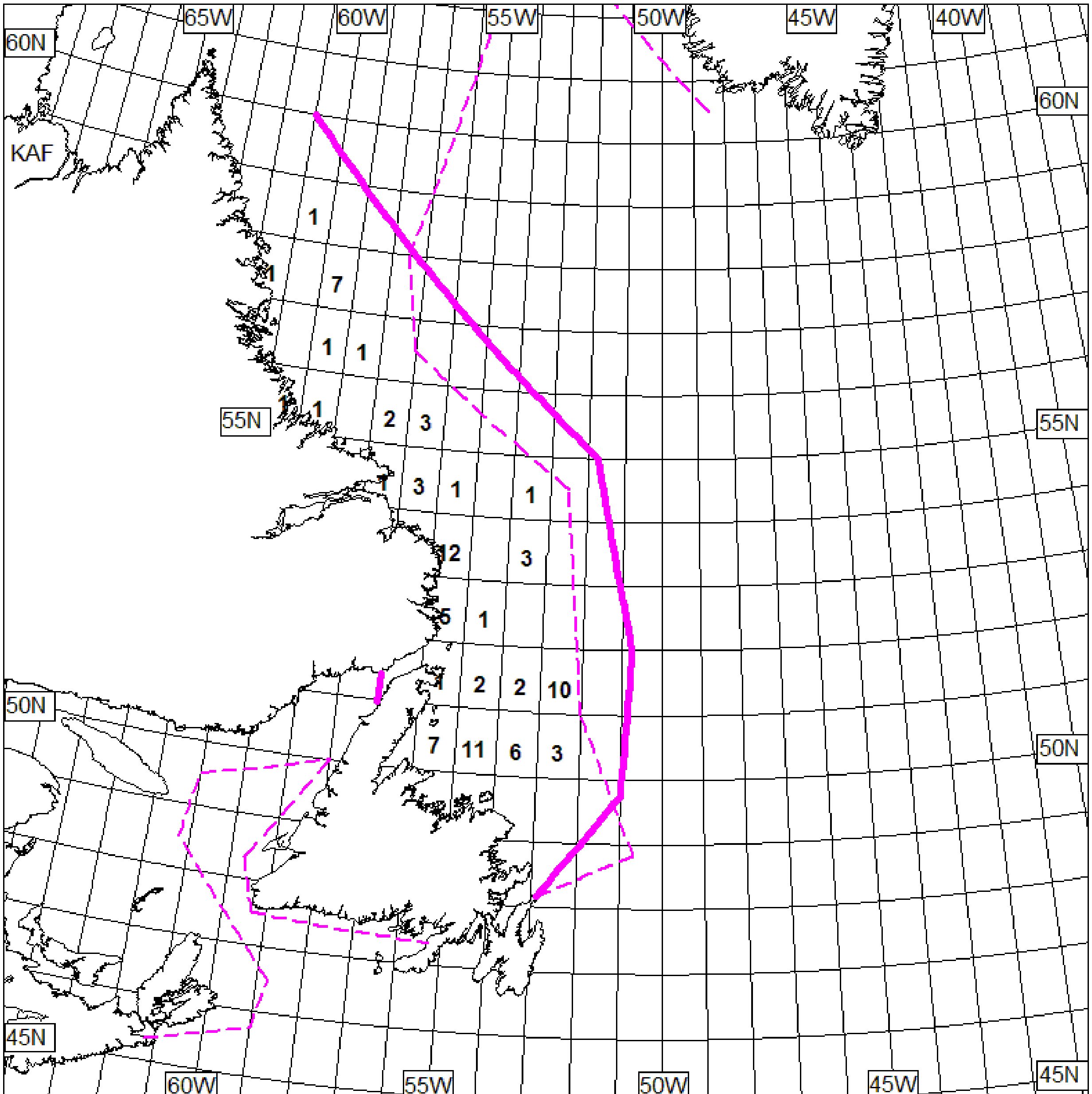

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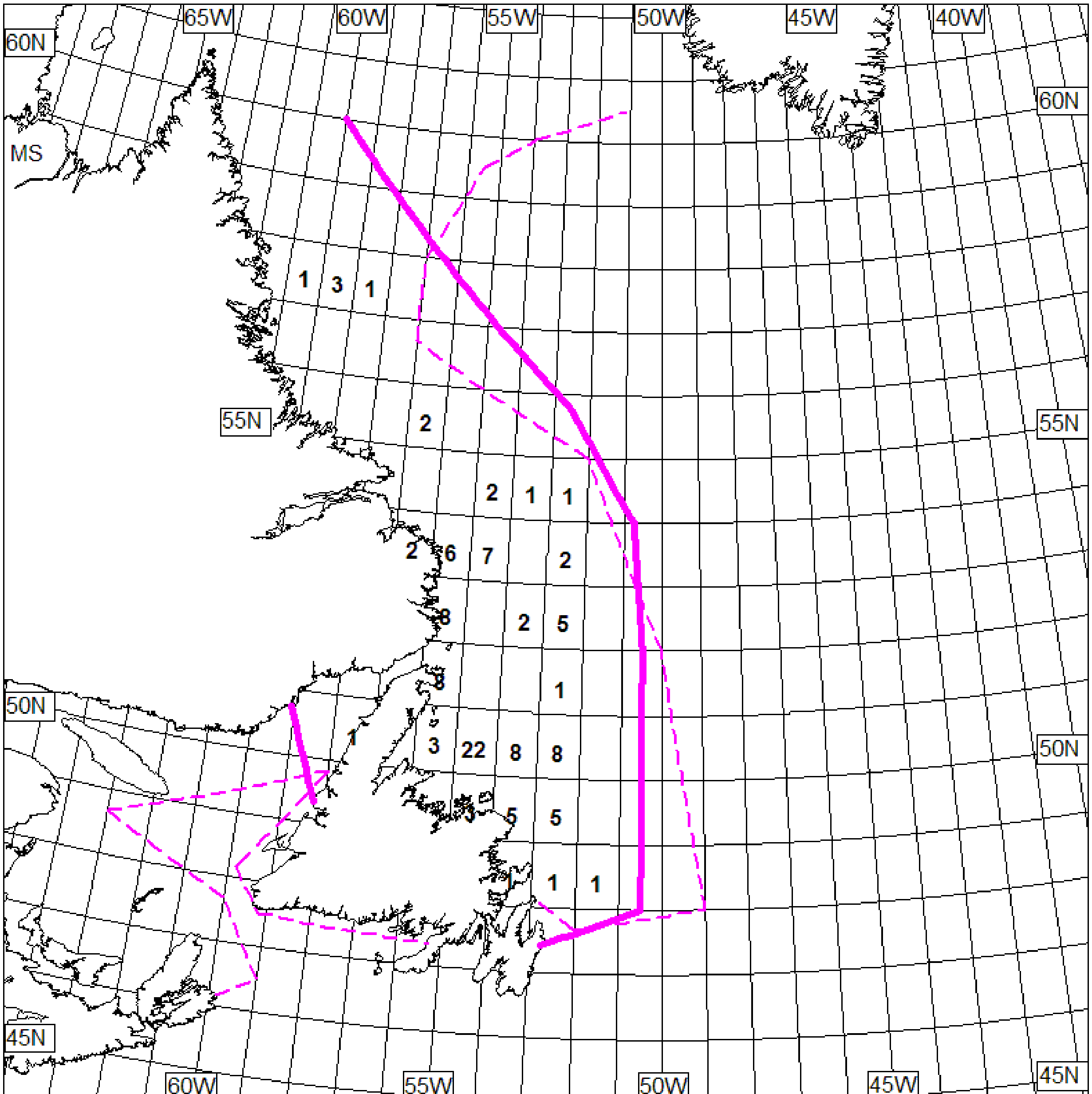

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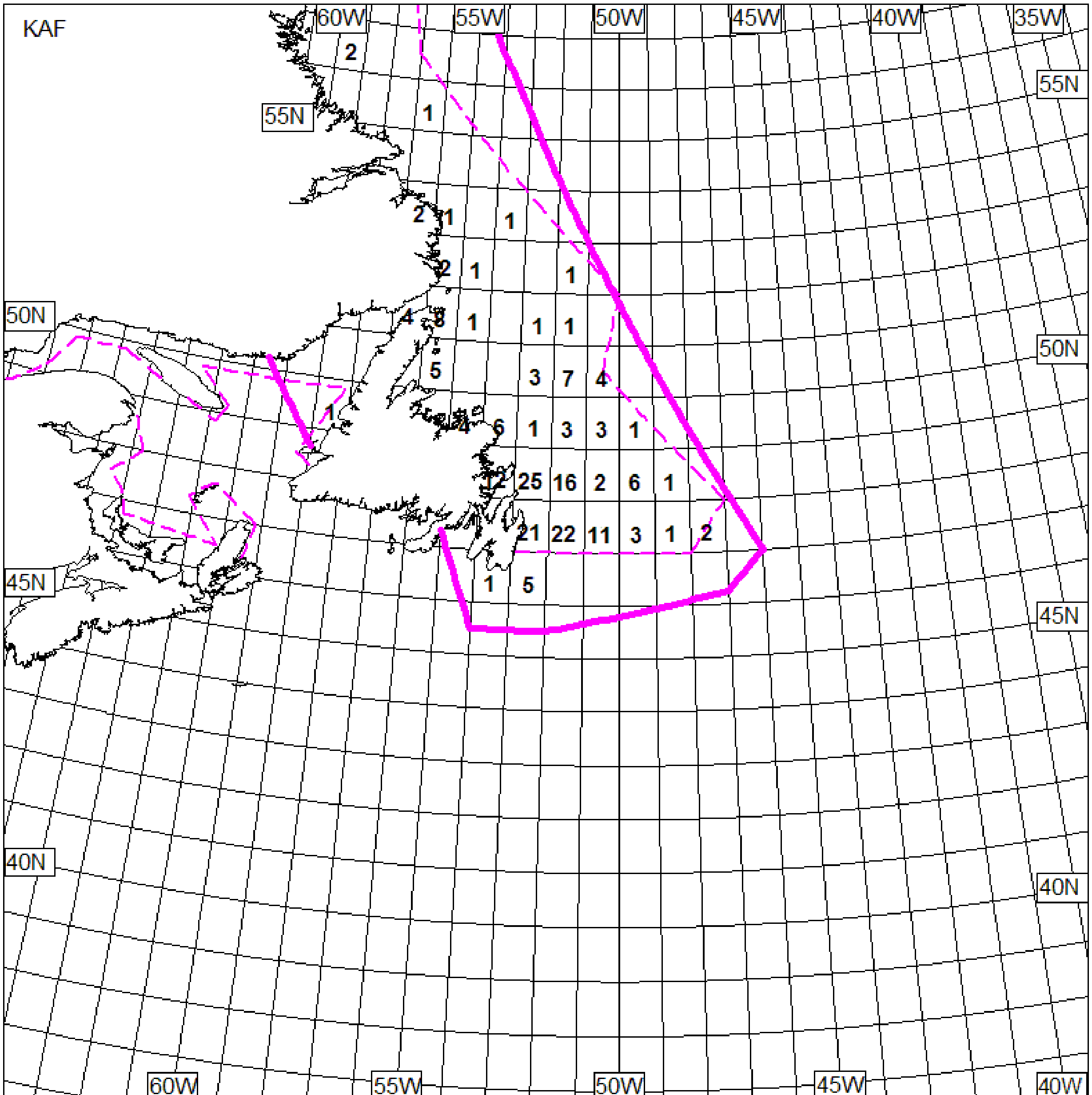

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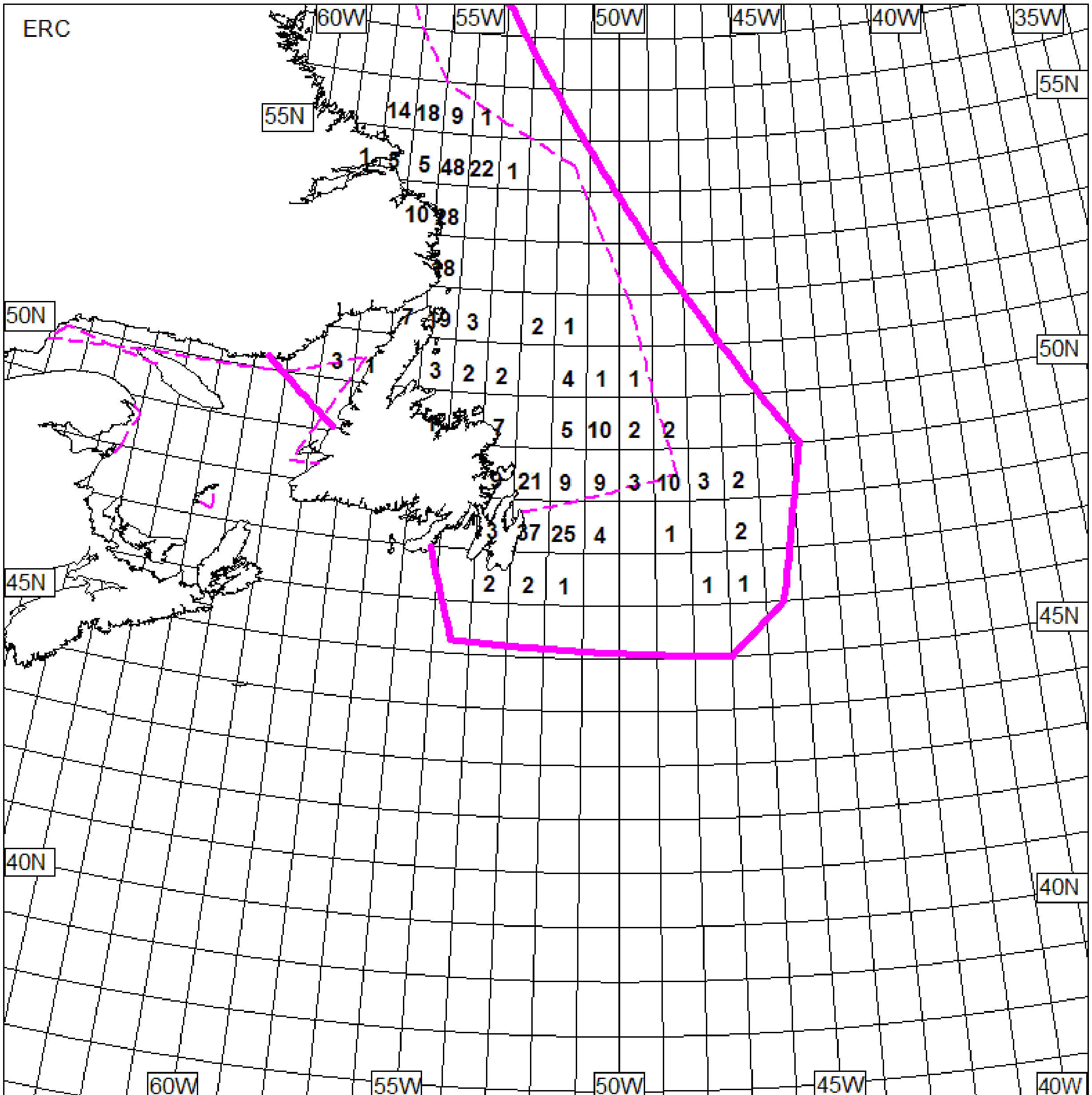

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SEA ICE LIMIT / LIMITE DES GLACES

ICEBERGS PER DEGREE SQUARE / ICEBERGS PAR DEGRE CARRE

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

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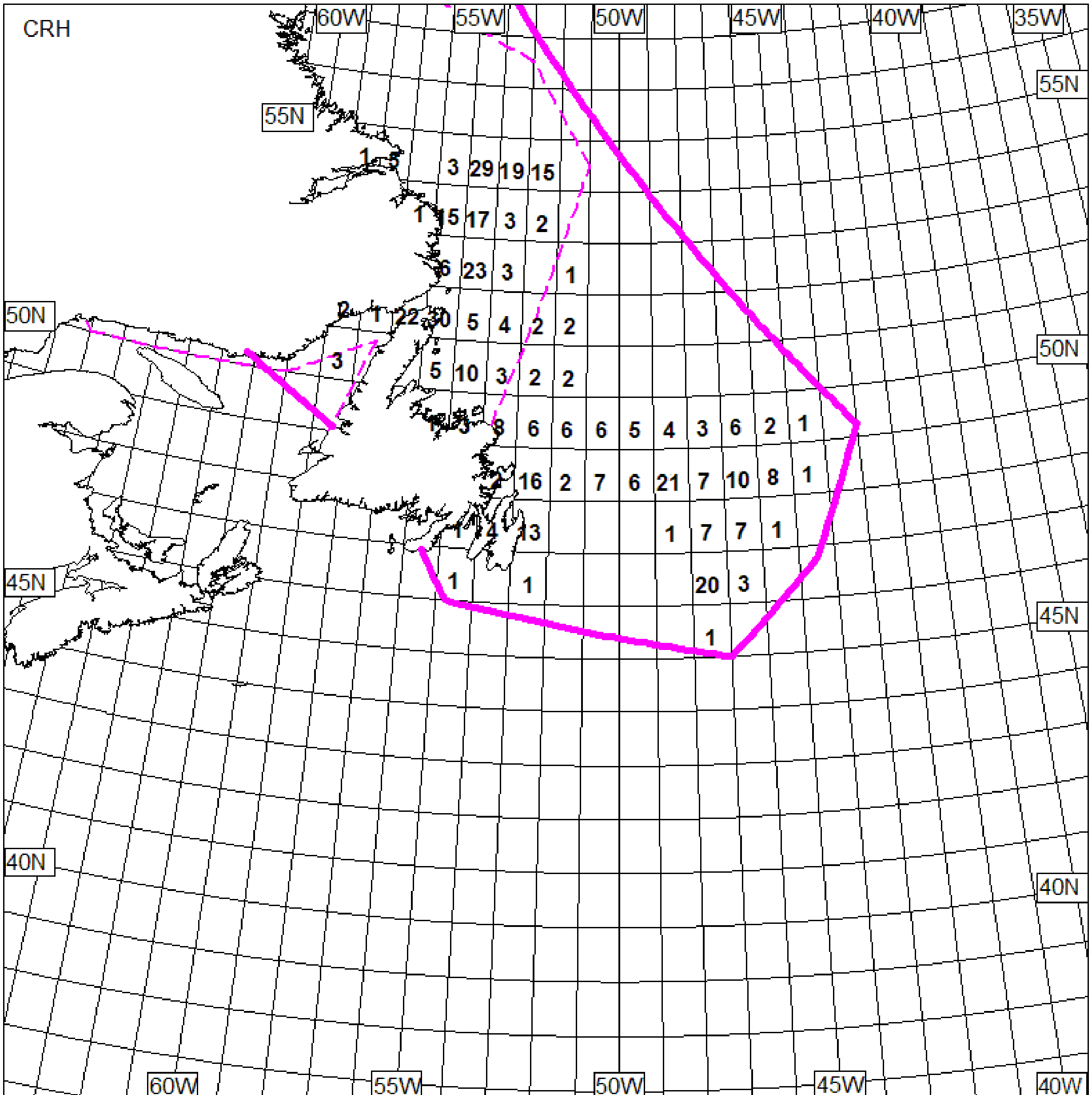
AUJOURD'HUI EST SOULIGNÉ LE 100IÈME ANNIVERSAIRE DU NAUFRAGE DU TITANIC



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ICEBERG ANALYSIS / ANALYSE D'ICEBERGS
FOR / POUR 0000 UTC

01 MAY / MAI 2012

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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

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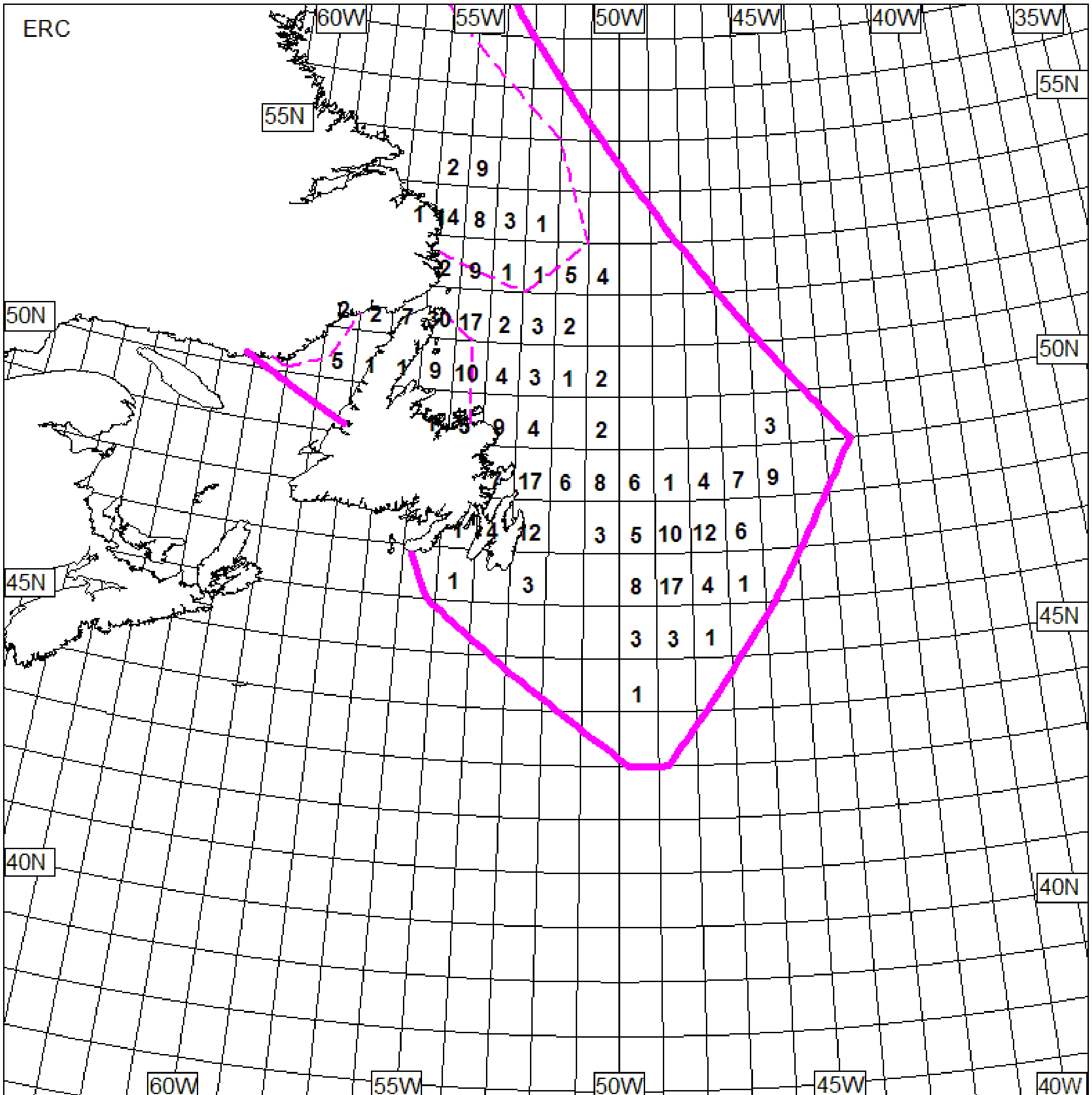

NORTH AMERICAN ICE SERVICE
SERVICE DES GLACES
DE L'AMERIQUE DU NORD

ICEBERG ANALYSIS / ANALYSE D'ICEBERGS
FOR / POUR 0000 UTC

15 MAY / MAI 2012

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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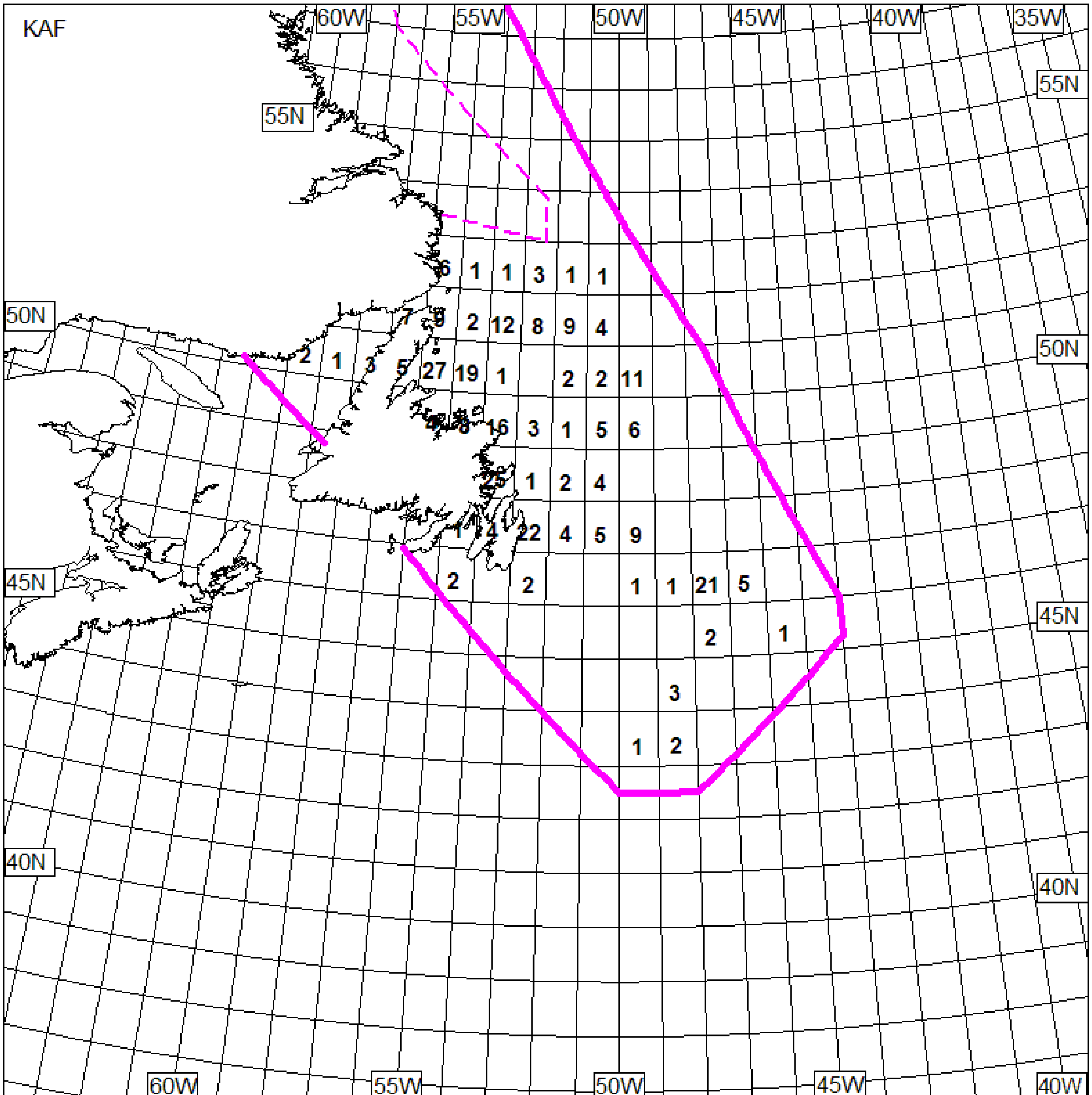

NORTH AMERICAN ICE SERVICE
SERVICE DES GLACES
DE L'AMERIQUE DU NORD

ICEBERG ANALYSIS / ANALYSE D'ICEBERGS
FOR / POUR 0000 UTC

01 JUN / JUN 2012

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:
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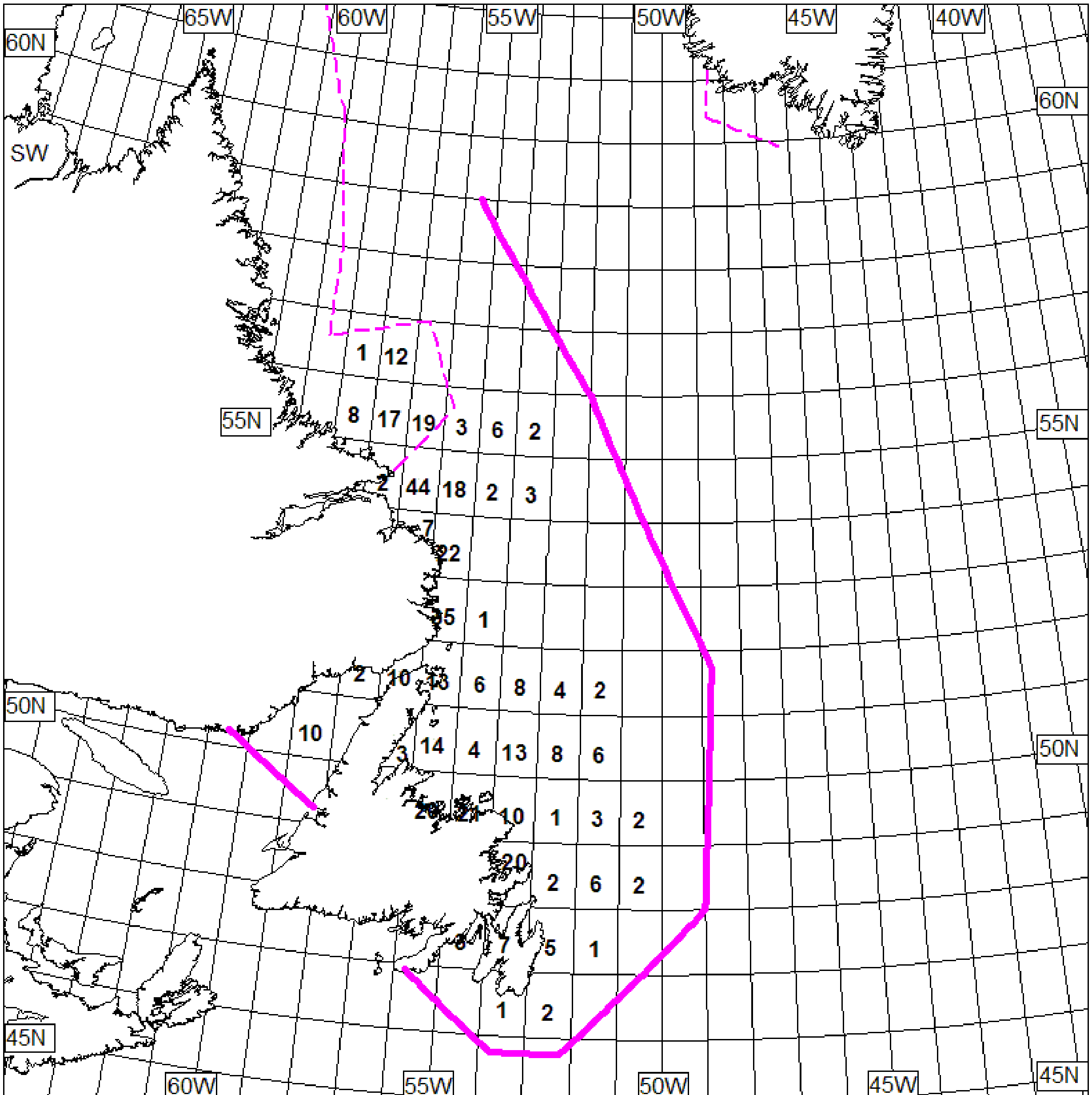
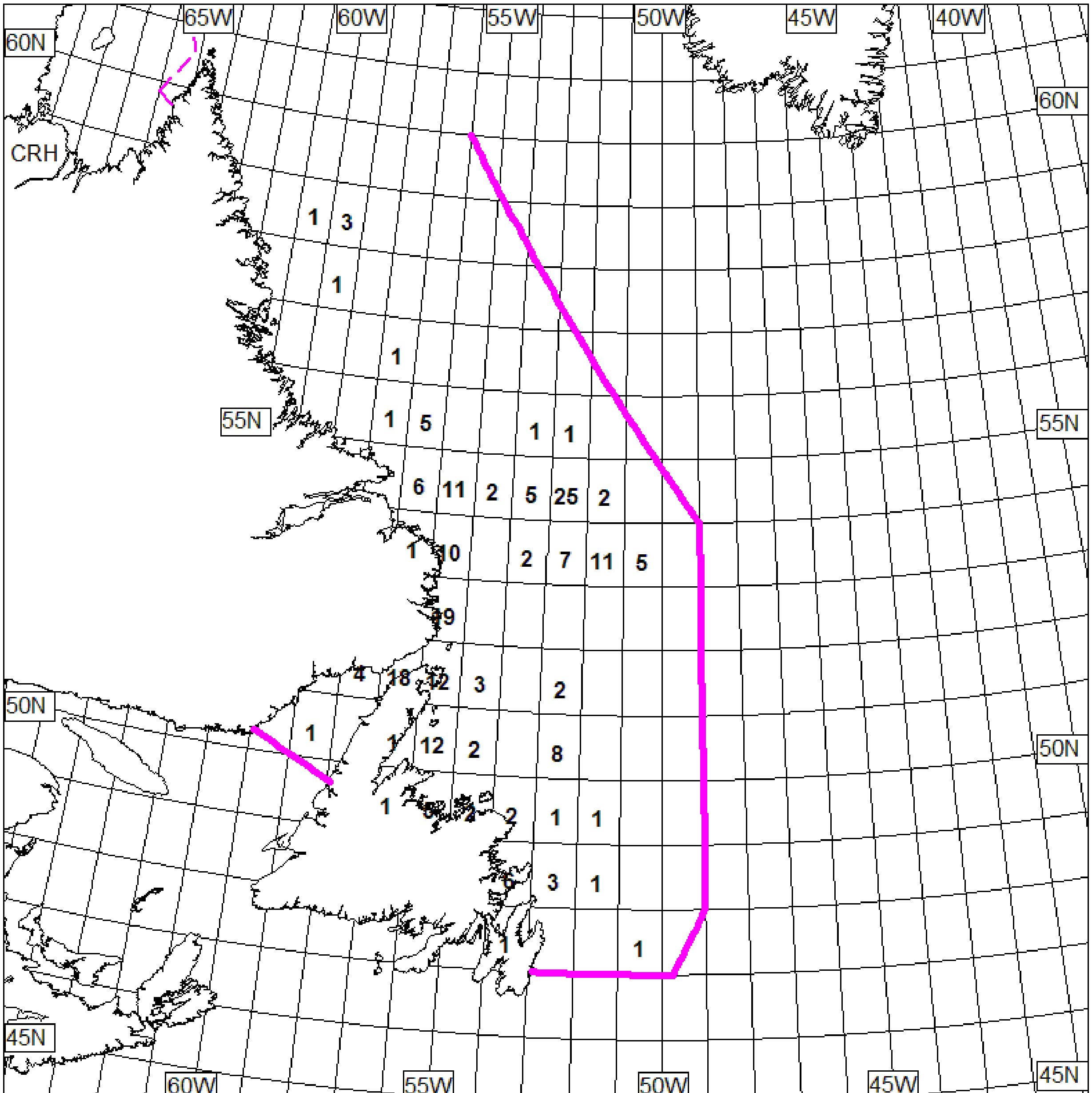
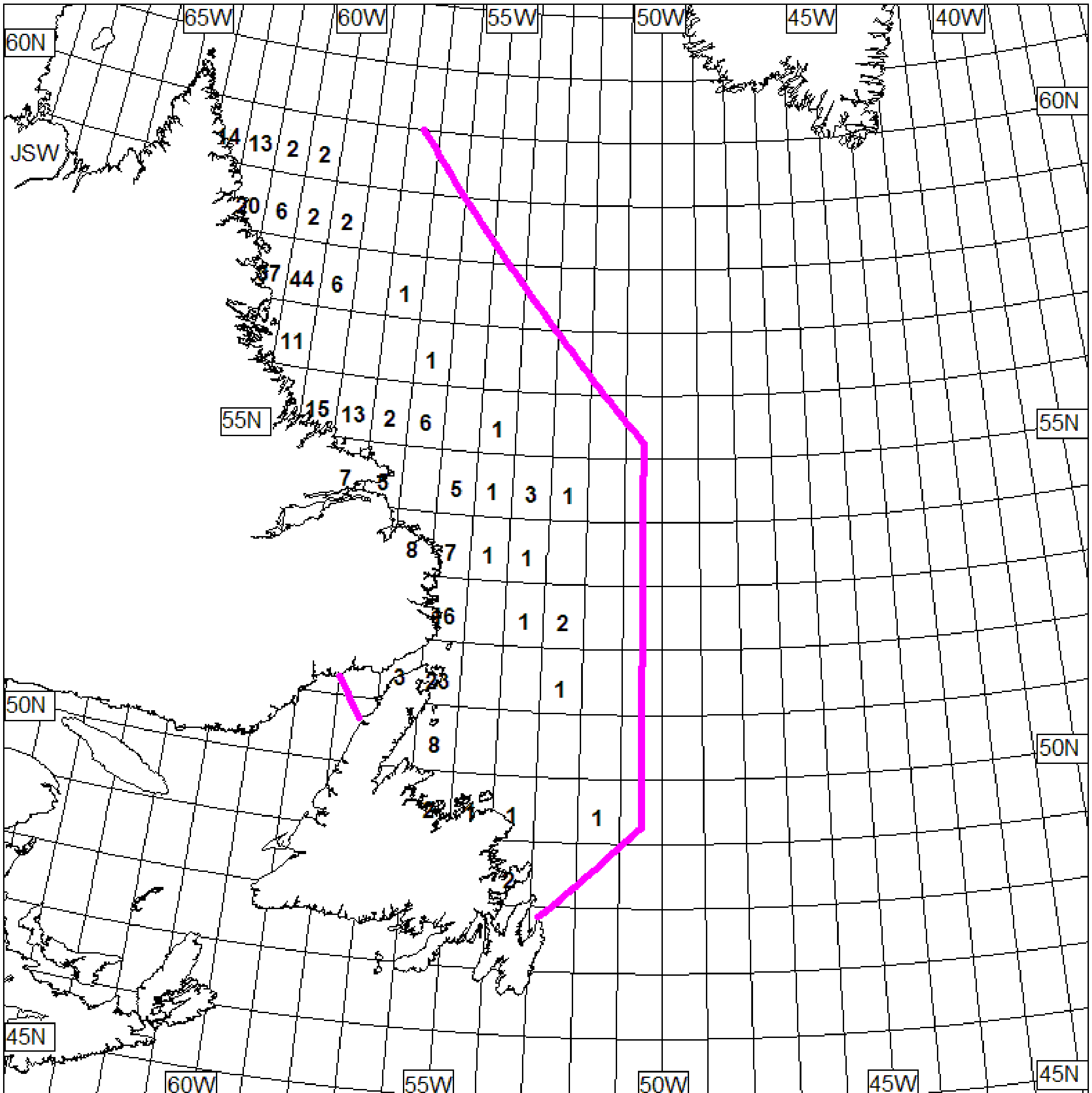


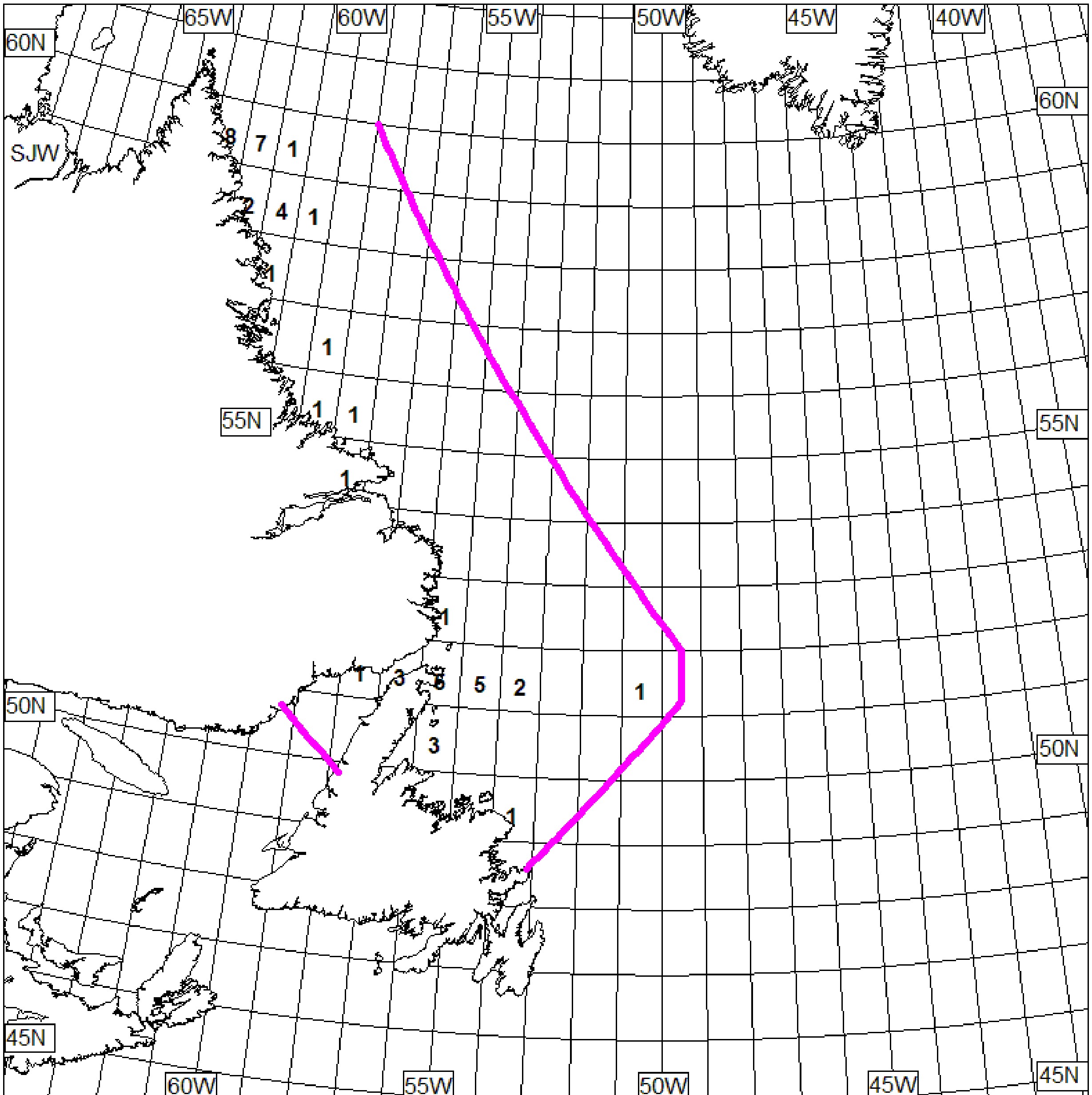
NORTH AMERICAN ICE SERVICE SERVICE DES GLACES DE L'AMERIQUE DU NORD	ICEBERG ANALYSIS / ANALYSE D'ICEBERGS FOR / POUR 0000 UTC **15 JUN / JUN 2012**
ICEBERG LIMIT / LIMITE DES ICEBERGS SEA ICE LIMIT / LIMITE DES GLACES # ICEBERGS PER DEGREE SQUARE ICEBERGS PAR DEGRE CARRE ⊗ RADAR TARGET OUTSIDE ICEBERG LIMIT CIBLE RADAR A L'EXTERIEUR DE LA LIMITE DES ICEBERGS	NOTE / NOTER: FOR MORE INFORMATION: POUR PLUS DE RENSEIGNEMENT: WWW.NAVCEN.USCG.GOV/IIP WWW.ICE-GLACES.EC.GC.CA



NORTH AMERICAN ICE SERVICE **SERVICE DES GLACES** **DE L'AMERIQUE DU NORD**	ICEBERG ANALYSIS / ANALYSE D'ICEBERGS FOR / POUR 0000 UTC **01 JUL / JUI 2012**
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.NAVCEN.USCG.GOV/IIP WWW.ICE-GLACES.EC.GC.CA



NORTH AMERICAN ICE SERVICE **SERVICE DES GLACES** **DE L'AMERIQUE DU NORD**	ICEBERG ANALYSIS / ANALYSE D'ICEBERGS FOR / POUR 0000 UTC **15 JUL / JUI 2012**
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.NAVCEN.USCG.GOV/IIP WWW.ICE-GLACES.EC.GC.CA



NORTH AMERICAN ICE SERVICE
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ICEBERG ANALYSIS / ANALYSE D'ICEBERGS
FOR / POUR 0000 UTC

01 AUG / AOU 2012

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

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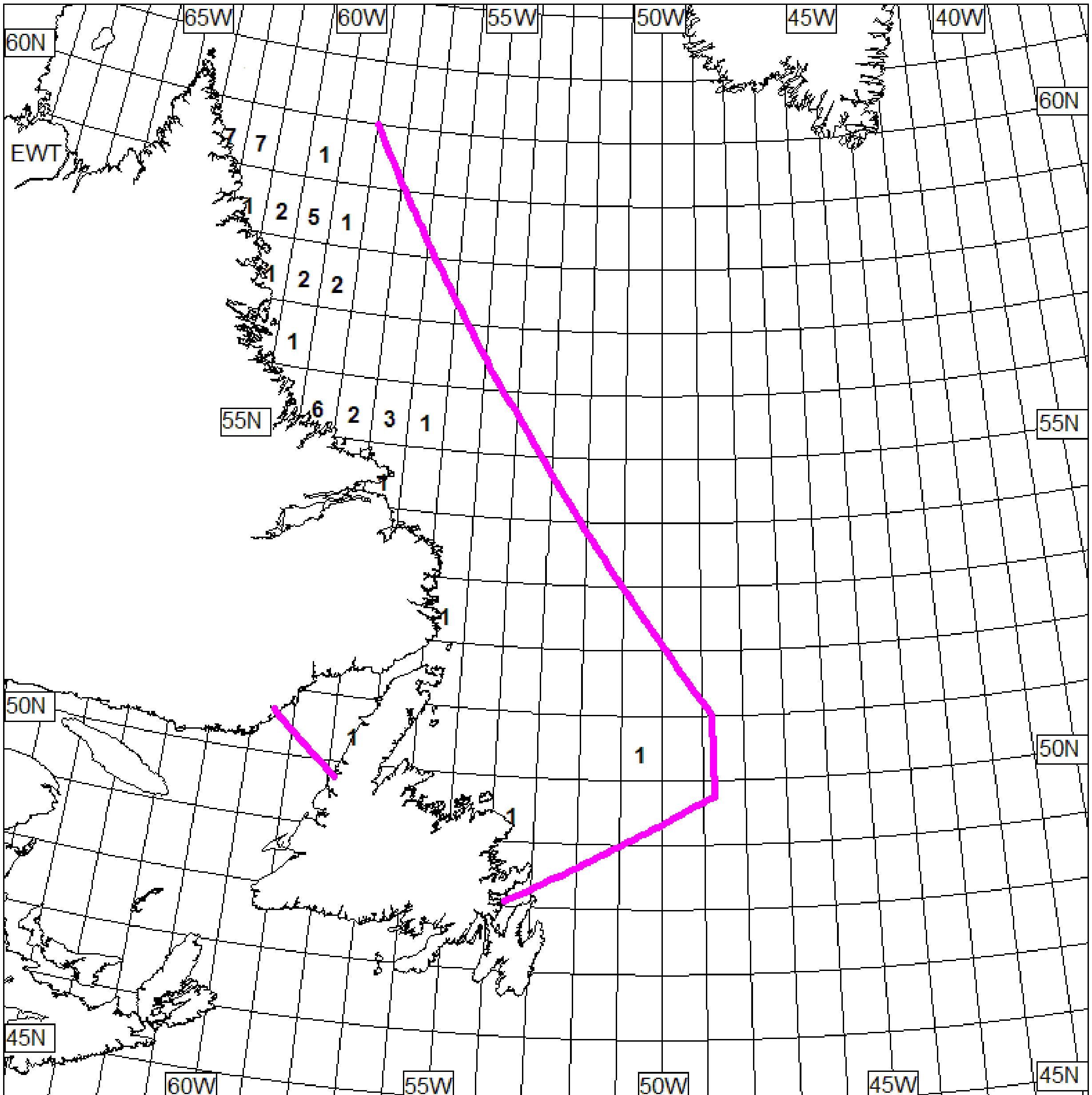

NORTH AMERICAN ICE SERVICE
SERVICE DES GLACES
DE L'AMERIQUE DU NORD

ICEBERG ANALYSIS / ANALYSE D'ICEBERGS
FOR / POUR 0000 UTC

15 AUG / AOU 2012

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:
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Acknowledgements

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

Canadian Coast Guard
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Provincial Aerospace Limited
German Federal Maritime and Hydrographic Agency
National Geospatial-Intelligence Agency
National Ice Center
National Weather Service
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 Staff
U. S. Coast Guard Headquarters Staff
U. S. Coast Guard Maritime Fusion Intelligence Center Atlantic
U.S. Coast Guard Navigation Center
U. S. Coast Guard Operations Systems Center
U. S. Coast Guard Research and Development 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 2012 Ice Season:

CDR L. K. Mack
LCDR J. S. Worst
Dr. D. L. Murphy
Mr. M. R. Hicks
Mrs. B. J. Lis
LCDR J. L. Cass
LT E. R. Christensen
MSTCS J. C. Luzader
YN1 I. O. Gonzalez
MST1 K. A. Farah
MST1 E. E. Lee
MST2 G. J. Woolverton
MST2 S. J. Weitkamp
MST2 C. R. Hendry
MST2 W. N. Moran
MST2 T. V. Withers
MST2 D. M. Morrisey
MST3 M. M. Sanks

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

Appendix A

Ship Reports for Ice Year 2012

Ships Reporting By Flag	Reports
ANTIGUA AND BARBUDA	
REYKJAFOSS	5
BAHAMAS	
JAWOR	2
MIEDWIE	1
BERMUDA	
MILAN EXPRESS	1
CANADA	
ARCTIC (*Carpathia* Award Winner)	14
GEORGE R. PEARKES	11
MATTEA	6
UMIAK 1	6
ICEBERG HUNTER	2
ATLANTIC TEAK	1
CABOT	1
MARIA DESGAGNES	1
CYPRUS	
FEDERAL ELBE	3
GERMANY	
EMDEN	2
HONG KONG	
OOCL MONTREAL	4
FEDERAL SETO	2
FEDERAL HUDSON	1
FEDERAL WELLAND	1
OOCL BELGIUM	1
IRISH REPUBLIC	
CELTIC EXPLORER	1
MARSHALL ISLANDS	
FEDERAL MACKINAC	1
NETHERLANDS	
MARIETJE MARSILLA	1
MARIETJE DEBORAH	1
JUMBO VISION	1
PANAMA	
NORDIC ODYSSEY	2
OCEAN DREAM	1
MSC ALYSSA	1
TURKEY	
MINANUR CEBI 1	1
UNKNOWN	
SHIP	3

Appendix B

NAIS Iceberg Product Harmonization

Introduction

This Appendix is a continuation of Appendix C, NAIS Iceberg Chart Harmonization, of the Report of the International Ice Patrol, 2011 Season. On 01 February 2011, after a concerted effort with the Canadian Ice Service (CIS) to harmonize iceberg charts between the services, Ice Patrol published the first North American Ice Service (NAIS) Iceberg Chart. Ice Patrol published the NAIS Iceberg Chart through early August and CIS published it for the remainder of the year. This agreement established a temporal responsibility for each service vice the geographic responsibility that existed prior to harmonization (**Figure 1**).

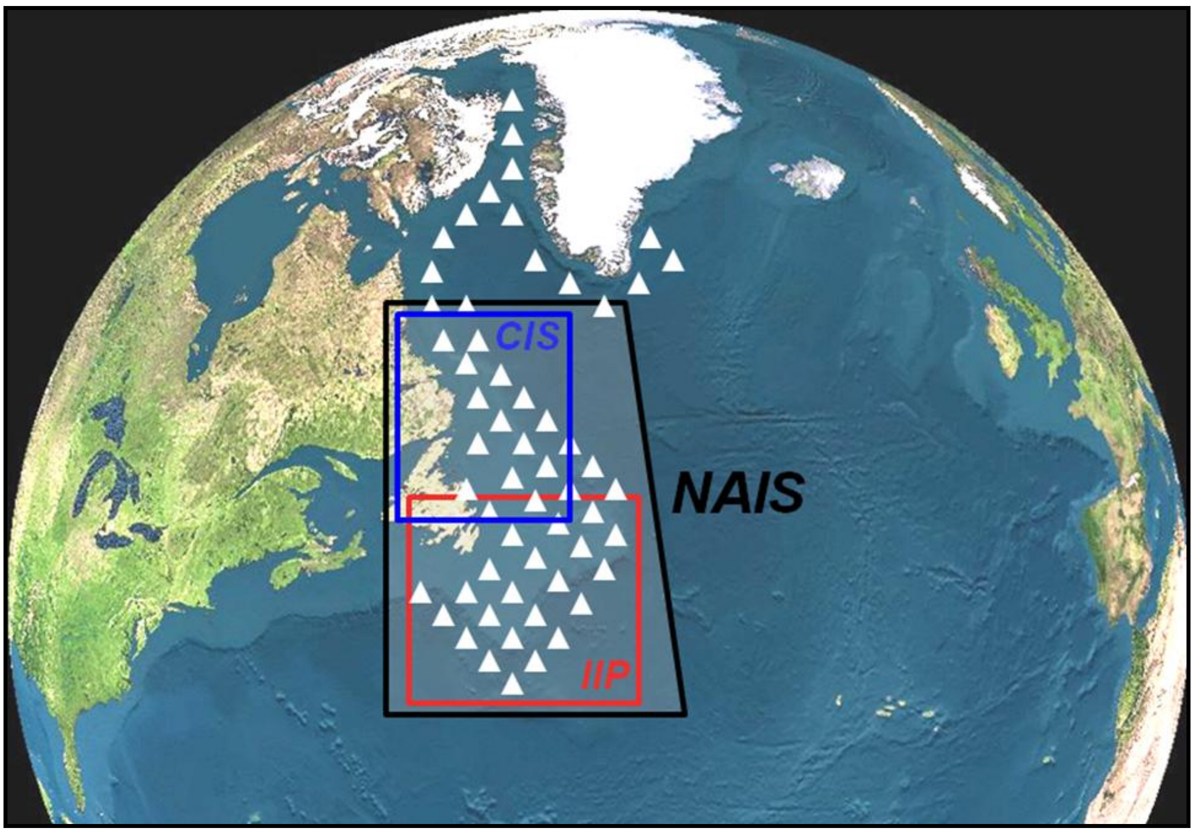


Figure 1. CIS (blue) and IIP (red) traditional areas of responsibility and the new NAIS (black) area of responsibility.

Initial efforts to harmonize iceberg products between the services were limited to the chart due to the perceived simplicity over harmonizing several text products. In part, due to the shift from geographic to temporal responsibility during the 2011 season, several areas of further collaboration including harmonization of the text products were identified. In the fall of 2011, these areas were thoroughly researched and several changes to Ice Patrol processes were introduced. The changes were tested, socialized with participating partners, and implemented on 01 February 2012. This Appendix describes the major changes in the order of the sequence of steps recommended for harmonization (**Figure 2**). The Summary of Operations section briefly describes additional details.

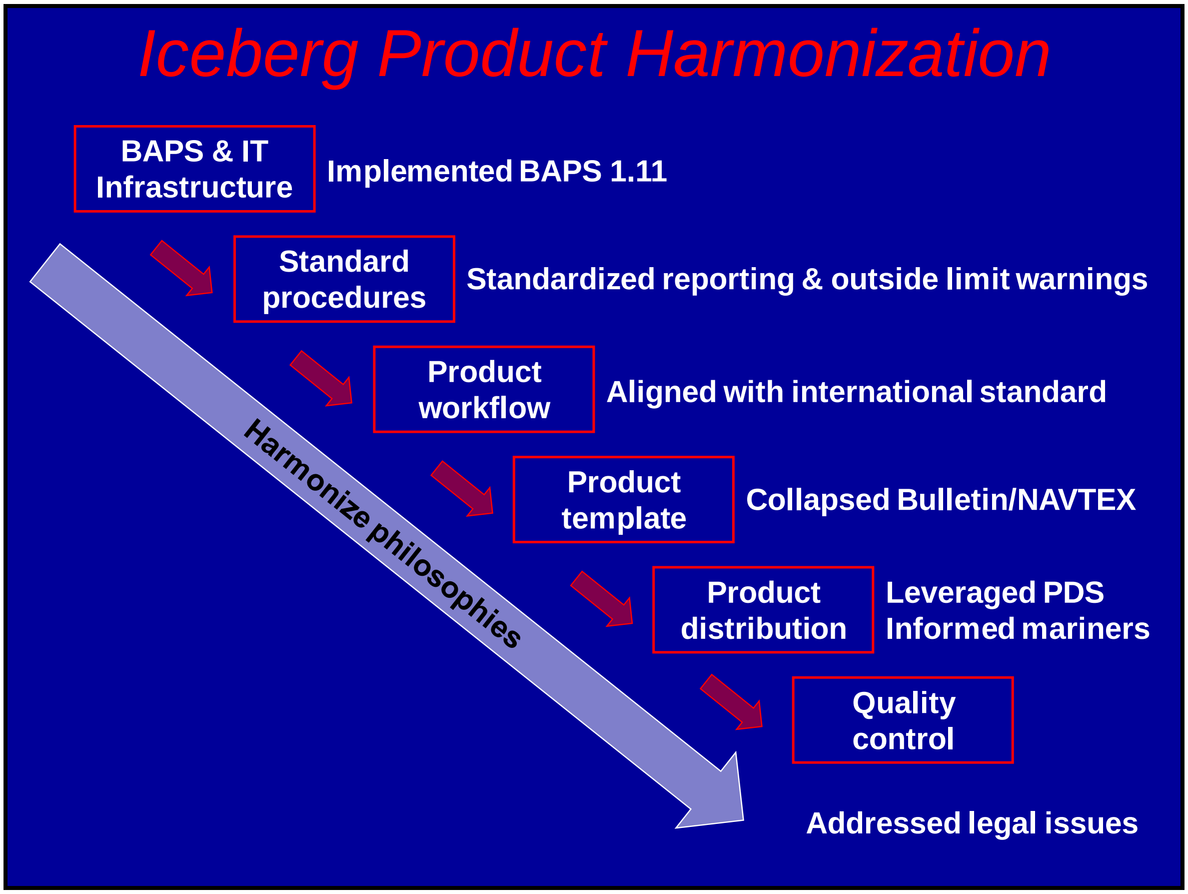


Figure 2: Sequence of steps recommended for harmonization (boxes). Major changes in 2012 shown to the right of the boxes.

Major Changes

1. BAPS & IT Infrastructure - Implemented BAPS 1.11

One of the first priorities of harmonization was to use a common BAPS and IT Infrastructure. In February of 2012, CIS and Ice Patrol were running two different versions of the iceberg analysis and prediction system (BAPS) software. Ice Patrol was running v1.9 and CIS was running v1.11 and v1.9 required several manual actions that were not required in v1.11. This created some difficulty in aligning work processes at each service. Due to technical difficulties, v1.11 was not installed and running properly at Ice Patrol until June. Now that both services are running the same software, creating products will be close to identical and troubleshooting will be much more manageable. Running the same version also allows for greater continuity of operations between the services.

2. Standard Procedures

Standardized Iceberg Reporting

One of the first areas of further collaboration identified was iceberg reporting by mariners. Previously, mariners were requested to report iceberg sightings to Ice Patrol when in season (producing daily products) and CIS when not in season (not producing daily products). Additionally, Ice Patrol was not staffed for 24-hour operations so relied on the U.S. Coast Guard First District Command Center to receive reports after working hours. Aligning iceberg reporting would provide one receiver of reports for mariners and was expected to minimize the exchange of reports. CIS used the Canadian Coast Guard Marine Communications and Traffic Services (MCTS) to receive iceberg reports under their Ice Information Services Partnership Agreement. Ice Patrol approached CCG to adopt this method of receiving iceberg reports for both CIS and IIP. MCTS St. John's agreed to receive all iceberg reports and to relay them for all MCTS stations to CIS and IIP. This included reports via Inmarsat sent under a special code (42) that does not charge for reporting. Ice Patrol still receives a copy of Inmarsat reports at the Operations Center but all reports are routed through MCTS St. John's.

Standardized Iceberg Outside the Limit Warnings

A second area of further collaboration also involved MCTS St. John's. CIS' process for notification of icebergs reported outside of or near the published limit was to have the Canadian Coast Guard issue a Notice to Shipping (NOTSHIP) distributed via several communication methods. This process was not aligned with Ice Patrol's process that distributed a text product called a "Safety" via several communication methods. Ice Patrol proposed to use the NOTSHIP as the basis for all other notifications of icebergs reported outside or near the published limit. MCTS St. John's was amenable to this change as it did not significantly change the process on their end. Ice Patrol made significant changes to how it handled the notification, primarily to make the first step after verification to engage MCTS St. John's in issuing a NOTSHIP. Working with the National Geospatial-Intelligence Agency (NGA), Ice Patrol established a process to issue an urgent NAVAREA IV warning on receipt of a NOTSHIP. This ensured that the warning was broadcast over SafetyNet in a timely manner at any time of day because it did not require action by Ice Patrol personnel. It also allowed Ice Patrol to limit the active watch to 12 hours per day with robust and reliable coverage by this process for the overnight hours. A process to populate the product section of the webpage with the NOTSHIP is in progress. See **Figure 3** for the distribution for warnings of icebergs or radar targets outside the limit.

3. Product Workflow - Aligned with International Standard

Primary guidance on conduct of the Ice Patrol is provided by the International Convention for the Safety of Life at Sea (SOLAS). Ice Patrol evolved within SOLAS guidance but did not take steps to fully align with the Worldwide Navigation Warning Service (WWMWS) when it was implemented in 1977 or the Global Maritime Distress Safety System (GMDSS) when it was implemented in 1999. As a result of this, Ice Patrol started using SafetyNet, the primary means of long-range navigation warnings in 1998, five years after it was implemented. An analysis of WWNWS and GMDSS requirements clearly indicated the need to align products and distribution with these more modern warning services.

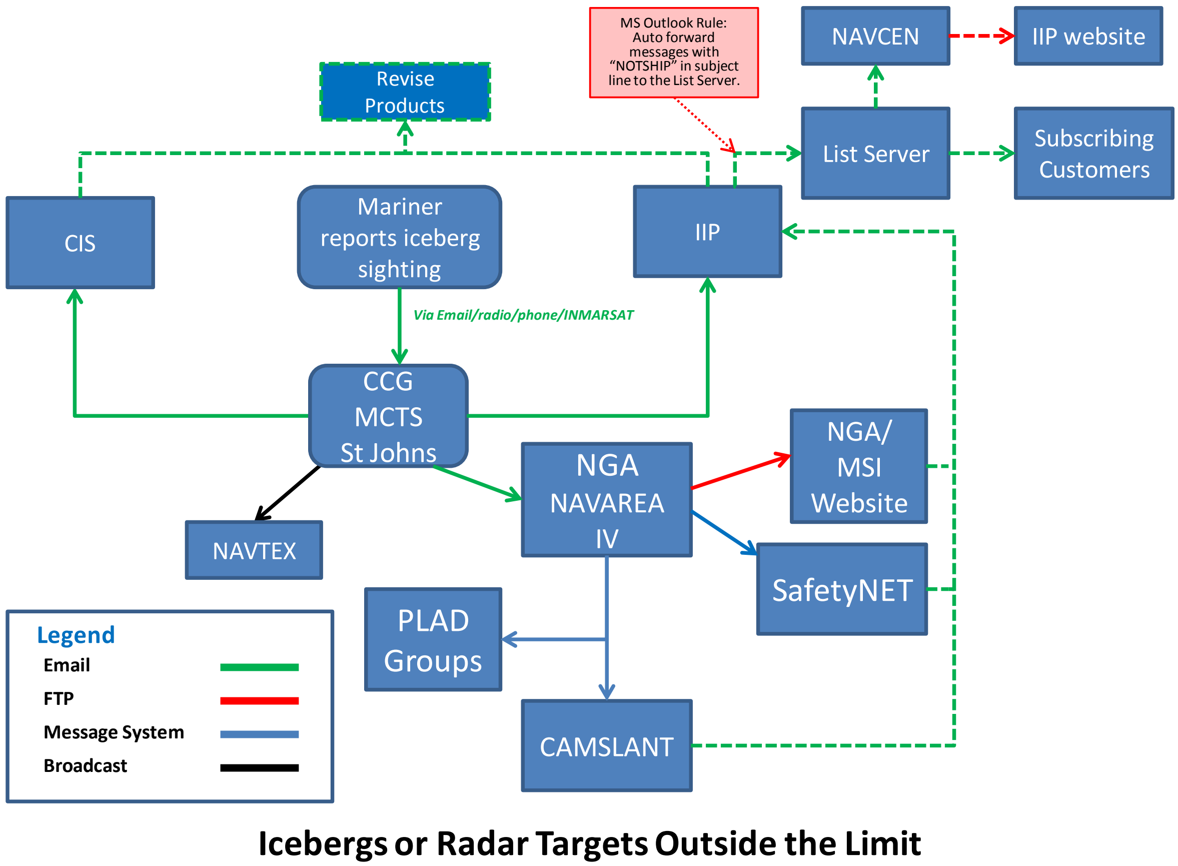


Figure 3: Icebergs or radar targets outside the limit product distribution flowchart.

Ice Patrol had an existing relationship with NGA to provide navigation warnings for icebergs in Navigational Area (NAVAREA) IV when Ice Patrol was not issuing daily products. Ice Patrol approached NGA to convert all products to NAVAREA IV warnings and they agreed. The effort required close coordination to meet the format requirements for NAVAREA IV warnings. In addition, the SafetyNet window for NAVAREA IV warnings required a revision of the valid time of iceberg products and adjusting the workflow at Ice Patrol. The adjustment to the workflow, in turn, required revising the broadcast times of some other products, particularly the high frequency radiofacsimile chart. This change required coordination with Communications Area Master Station Atlantic that transmits the charts and the National Weather Service (NWS) that receives and stores the charts for transmission. The broadcast times were successfully changed and a transmission was added to ensure around-the-clock coverage. The final distribution schematic prior to the 2012 season is depicted in **Figure 4**. Small changes to this schematic were made when IIP transferred responsibility for daily products back to CIS in September 2012 and those will be finalized prior to IIP resuming daily products.

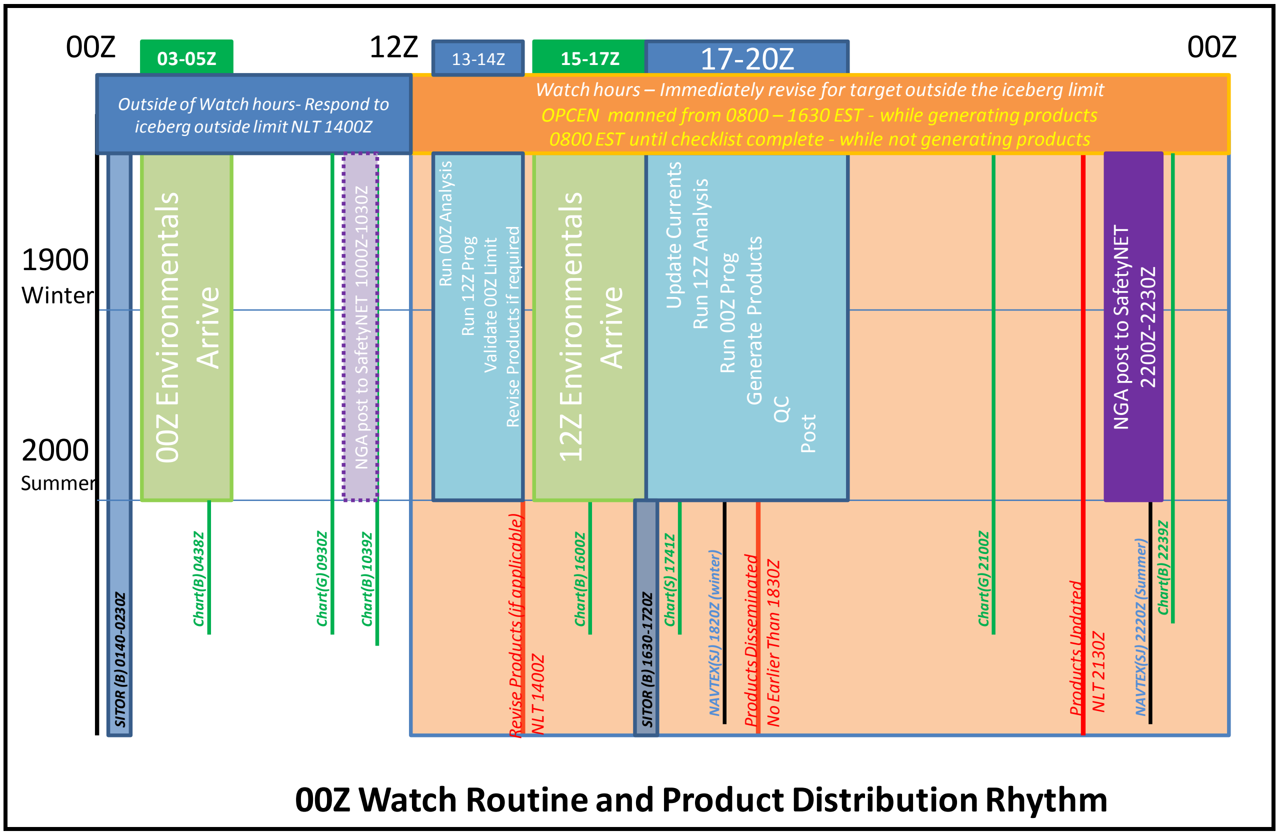


Figure 4: Schematic of product distribution.

4. Product Template - Collapsed Bulletin/NAVTEX Products

During a visit to CIS in the fall of 2011, CIS and Ice Patrol thoroughly investigated iceberg product distribution. Analysis of how Canadian MCTS and U.S. Communications Stations were receiving iceberg products and broadcasting them led to the realization that the text Bulletin and Navigational Text (NAVTEX) products could be collapsed into one product. U.S. NAVTEX products required significant formatting whereas the Canadian product did not. The NAVTEX broadcast from Boston was eliminated due to limited range and not meeting NAVAREA and SafetyNet requirements for content (iceberg limit was not in NAVTEX range of Boston). This action removed the formatting requirements and only one text product was required for all other broadcasts including the NAVTEX broadcast from MCTS St. John's.

In addition, Ice Patrol made efforts to automate production of the Bulletin as much as possible based on the custom software, BULLPREP, at CIS. This eliminated some work for watchstanders, reduced chances of inducing error, and further improved continuity of operations as the Bulletin was being prepared in a similar way at both services.

5. Product Distribution

Leveraged CIS' Product Distribution System (PDS)

In addition to #4 above, the visit to CIS in the fall of 2011 identified another useful tool, CIS' product distribution system (PDS). The PDS is custom software designed to tailor product distribution to customers. The idea of Ice Patrol using CIS' PDS had been evaluated previously but not implemented, but harmonization made this a logical step. Ice Patrol worked with both Operations and IT personnel at CIS to make the changes necessary to distribute products via the PDS. Figures in the Summary of Operations section demonstrate how CIS or IIP can populate the PDS with iceberg products for distribution to the same customer base. This effort greatly automated the previously manually intensive distribution at Ice Patrol and vastly improved continuity of operations between the services.

Informed Mariners of Changes

One of the most important steps in implementing major changes to workflow and product distribution was to inform mariners. Both CIS and Ice Patrol distributed products via their webpages so this was a primary tool of publishing changes. Ice Patrol annually distributed an Announcement of Services that provided information on products and distribution. Ice Patrol also periodically distributed a brochure requesting iceberg reports. For 2012, these two documents were combined into a NAIS Iceberg & Information Services (IIS) brochure published on the webpage and printed for distribution to the traditional recipients of the Announcement of Services. In addition to the NAIS IIS brochure, Ice Patrol and CIS developed Iceberg Bulletin and Chart information sheets (**Figure 5**). Once the services agreed on the sheets, CIS converted them to French for their webpage.

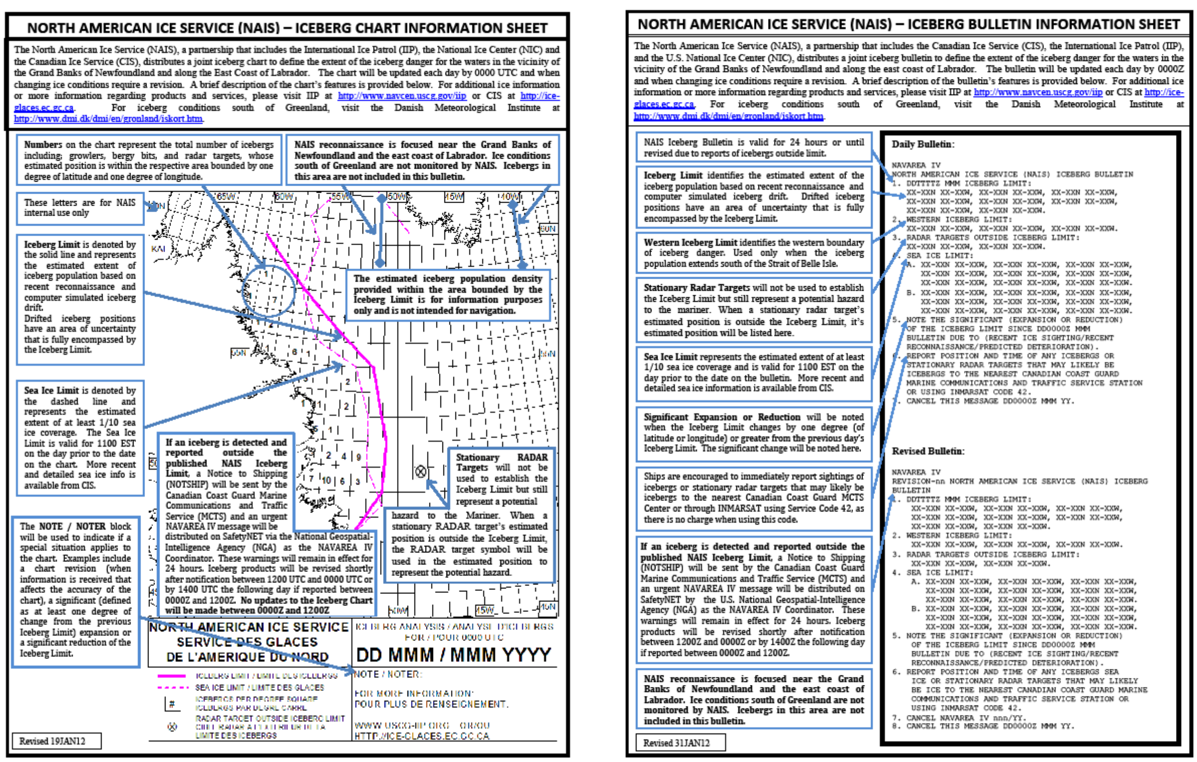


Figure 5: Examples of communicating changes to mariners.

Leading up to the changes that became effective 01 February 2012, Ice Patrol advised mariners of the changes directly on daily products with guidance on how to obtain additional information. These efforts led to a fairly seamless transition to a complete NAIS iceberg product suite.

6. Quality Control

The above major changes took most of the time and effort of the off-season to research and implement so quality control of each services' products was not assessed in detail. Each service continued to quality control its own products. As the 2012 season progressed, it was clear that one advantage of the above changes was that both services reviewed products daily so quality control was inherent in the harmonization.

7. Addressed Legal Issues

Similar to the iceberg chart harmonization in 2011, a couple of legal issues arose as IIP researched and began implementing the changes discussed above. Commander, International Ice Patrol again reached out to the Office of International Law at U.S. Coast Guard Headquarters for a legal determination. In January 2012, a thorough legal review was complete and Ice Patrol proceeded with all of the changes discussed on 01 February.

Question 1:

Is sending a NAVAREA IV warning with a specific iceberg location outside of the iceberg limit consistent with SOLAS and U.S. Code? This question was primarily related to the lack of a 24-hour watch at Ice Patrol. Watchstanders were expected to be available for 12 hours of the watch day to create and distribute products as well as respond to iceberg reports. The other 12 hours of the watch day when the watchstander was out of the office was coordinated for MCTS St. John's to issue a NOTSHIP if an iceberg was reported outside the published limit. The watchstander would then revise products if necessary upon return to the office. The legal question was if the NOTSHIP converted to a NAVAREA IV warning with the iceberg location was equivalent to publishing a new iceberg limit.

The Office of International Law determined that use of NAVAREA IV warnings to notify ships of specific iceberg locations is consistent with SOLAS and U.S. Code. Neither SOLAS nor U.S. Code states exactly how vessels should be notified of ice conditions or dangerous areas, merely that the U.S. government should make such notifications. Notification via NAVAREA IV warnings, both for the iceberg limit and icebergs reported outside the published limit, were deemed acceptable.

Question 2:

Is using Canadian sourcing for NAVAREA IV warnings vice U.S. sourcing legally prohibited? This question was related to the first question in that it referred to the NOTSHIP being converted to a NAVAREA IV warning.

The Office of International Law determined that NAVAREA IV warnings from Canadian sources vice U.S. sources is not legally prohibited in the law nor does it raise the potential for liability. Also recommended was making the public aware of the change in practice, memorializing the practice, and monitoring the practice for reliability. Ice Patrol took action on all of the recommendations and the practice worked well during the 2012 season.

Once the areas of concern were satisfactorily addressed, Ice Patrol briefed the First Coast Guard District, Ice Patrol's Operational Commander, and the Program Manager at U.S. Coast Guard Headquarters on the changes.

Future Steps

Making the above major changes took organizational commitment to NAIS and dedicated effort by CIS and IIP personnel. 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. The 2011 Appendix indicated that "an average iceberg season will be a true test of the overall concept". The 2012 season proved to be an adequate test of the concept. Frequent communication between the services assisted in resolving issues that arose due to the major changes.

Remaining steps include quantifying the improved efficiency. The chart harmonization itself reduced chart production between the services by one-third while maintaining the same level of service to mariners. The additional changes made in 2012 should be quantified in terms of savings in resources such as funding and time spent generating NAIS iceberg products.

One intangible benefit of harmonization is that CIS and IIP operations are more similar than ever – product harmonization and continuity of operations are complementary processes that, when pursued in tandem, result in better alignment than if pursued separately. Next steps for Ice Patrol include formalizing the new relationship with NGA to disseminate iceberg information as NAVAREA IV warnings in the form of a memorandum of understanding. In addition, Ice Patrol is working with CIS and NWS to find a solution to CIS being able to transfer the chart for U.S. transmission.

Appendix C

NAIS Joint Reconnaissance Strategy

MST1 Ken A. Farah
MST2 Sara J. Weitkamp

This Appendix evaluates Canadian Ice Service (CIS) and International Ice Patrol (IIP) reconnaissance for the 2012 ice season in order to assess the effectiveness of the North American Ice Service (NAIS) joint reconnaissance strategy. The objective is to determine how actual reconnaissance aligned with the reconnaissance areas and goals depicted in **Figure 1**. Data provided includes hours flown by each service, coverage of the designated reconnaissance areas, and the gap in coverage, if any.

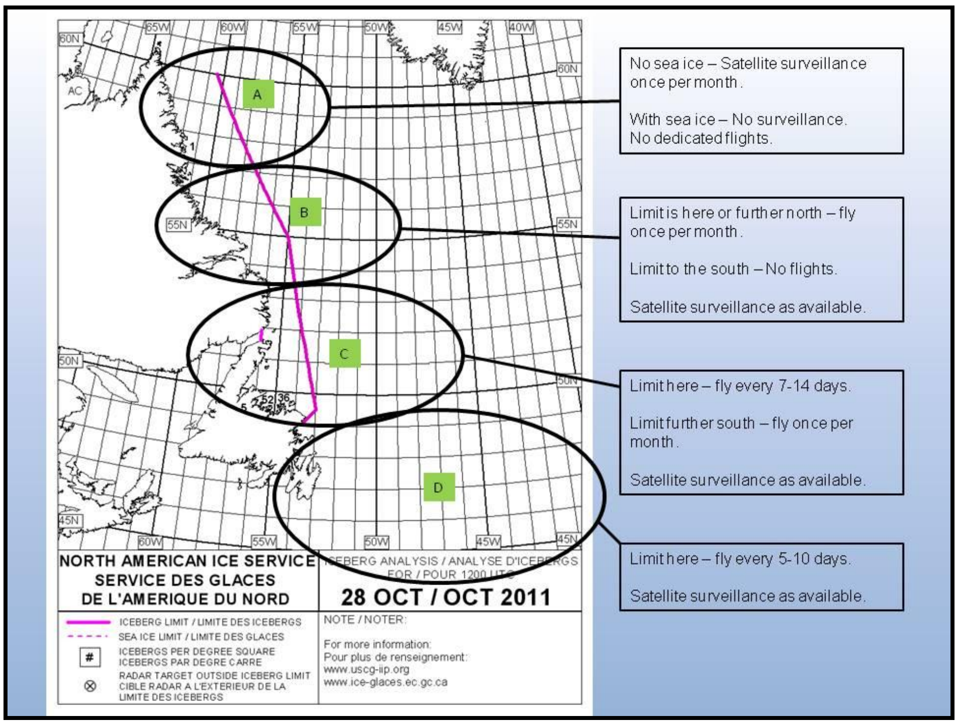


Figure 1: NAIS joint reconnaissance strategy.

In 2012, Ice Patrol flew 28 patrols for a total of 294.2 hours. CIS contracted 14 patrols flown by Provincial Aerospace Limited (PAL) for a total of 108.0 hours. Six iceberg patrols were conducted by Transport Canada for CIS for a total of 49.0 hours. The combined total for both agencies is 48 patrols for a total of 451.2 hours in support of NAIS. These figures are shown in **Figure 2**. The average number of IIP flight hours from 1983, when Ice Patrol began using the side-looking airborne radar, to present is also shown.

Note that Ice Patrol flight hours include transit hours. CIS and PAL do not calculate transit hours because the aircraft are based near the area of operations. In 2012, transit hours accounted for 118.1 hours (40%) for Ice Patrol. This means that only 176.1 flight hours (60%) were used for actual ice reconnaissance. Transit hours were included because they are budgeted as part of the mission.

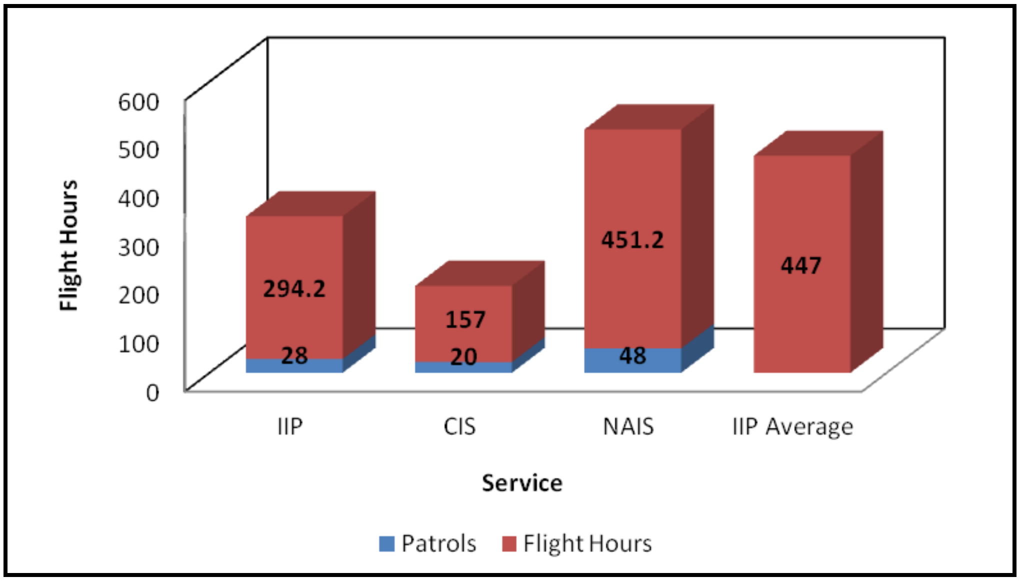


Figure 2: Patrols (blue) and flight hours (red) by service and IIP average (1983-2012).

In 2012, coverage of the Iceberg Limit, as established in general by the NAIS Collaborative Arrangement, was a joint effort between CIS and IIP. The gaps in coverage are depicted in **Figures 3 and 4**. The criteria for determining a “gap” starts with defining the area into which the Iceberg Limit extends (see Figure 1). Each area has a coverage requirement. **Figure 3** refers to the times that the Iceberg Limit was in Area C. **Figure 4** refers to the times that the Iceberg Limit was in Area D. The dates refer to the date a patrol was flown, with the color of the text referring to the area in which the patrol was primarily flown. The numbers above the bars indicate the number of days since a patrol was conducted in the corresponding area. Small numbers may indicate that a different part of the same area was flown. It is important to note, when evaluating the coverage, that significant analysis of conditions and discussion between IIP and CIS occurs in determining reconnaissance effort.

There were two gaps shown in **Figure 3**. The first, between 06 and 22 February (15-day gap), was a combination of poor weather and the HC-144A’s inability to conduct effective iceberg reconnaissance in icing conditions. The second, between 24 July and 20 August (26-day gap) was due to IIP no longer conducting reconnaissance and CIS having a limited budget of flight hours in August. CIS requested reconnaissance in the 12-18 Aug timeframe but that was further delayed by weather and other conflicts. There was one gap shown in **Figure 4** between 29 March and 15 April (15-day gap) due to poor weather that did not allow patrolling near the limit.

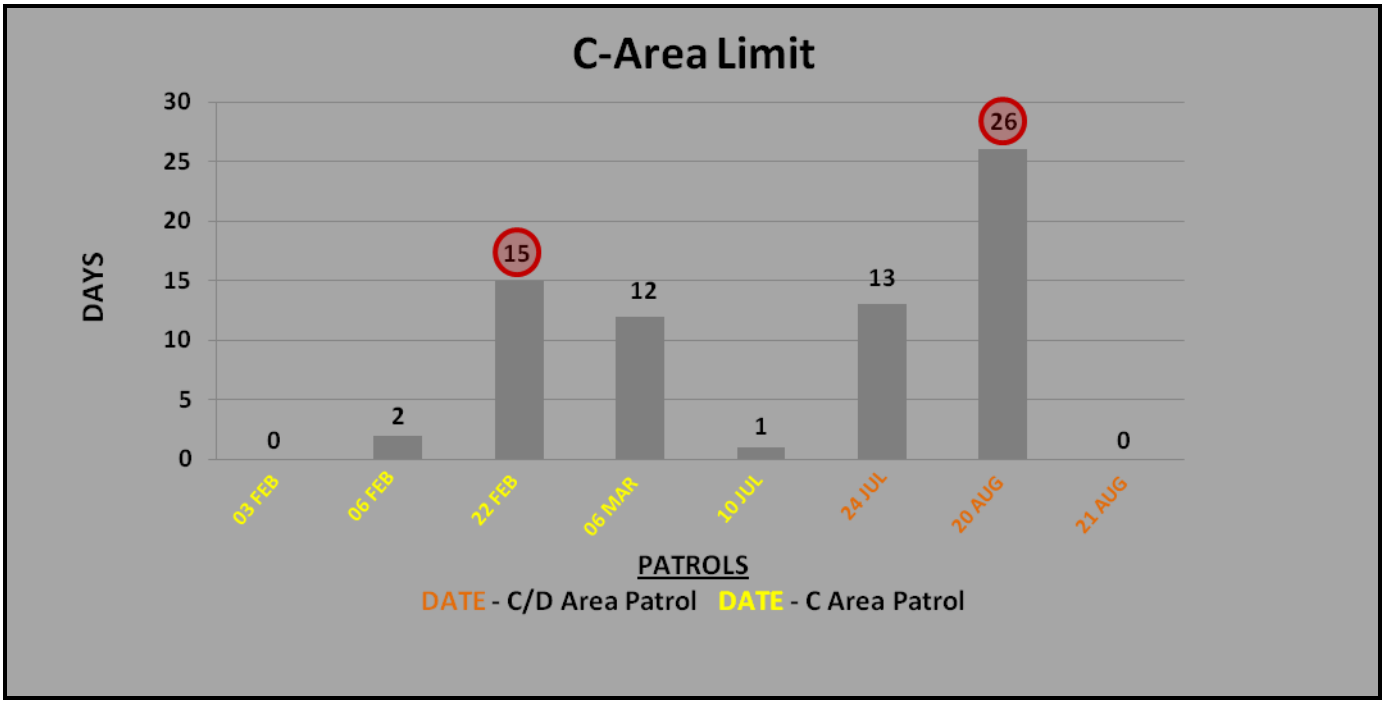


Figure 3: Patrols conducted when the Iceberg Limit was in Area C.

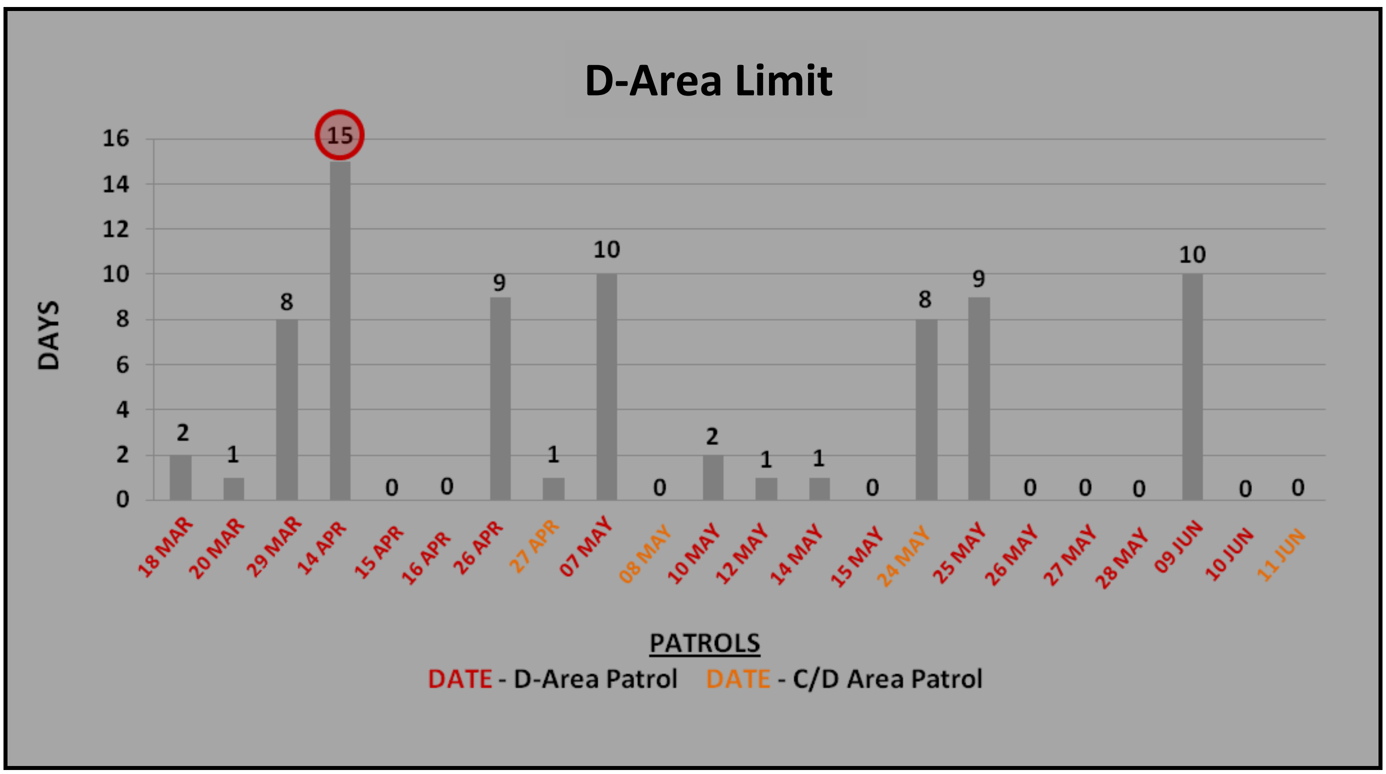


Figure 4: Patrols conducted when the Iceberg Limit was in Area D.

Appendix D

BAPS Replacement

Mr. Doug Jackson
Mobility & Ice Operations Division (CG-WWM-3), U. S. Coast Guard Headquarters

Background

The iceberg analysis and prediction system (BAPS) is the framework for executing the iceberg drift and deterioration model. The model was developed by Ice Patrol in the early 1990s and incorporated into the BAPS application developed by the Canadian Ice Service (CIS) to produce a common tool between the services. BAPS was first used operationally by Ice Patrol in 1997 (**Figure 1**). In 2009, Ice Patrol provided input to their Program Manager, CG-WWM-3, to draft a resource proposal that requested ~$1.5M to start a BAPS replacement project. The FY 2012 request was not approved.

Due to the increasing obsolescence of BAPS, in 2010, a detailed analysis by Ice Patrol's Information Technology (IT) Specialist concluded that the authority to operate the system would most likely be rescinded when Microsoft stopped issuing security updates for Windows XP in April 2014. The lack of security updates would make the system too vulnerable to operate reliably. The obsolescence was preventing Ice Patrol from utilizing a new iceberg model adopted by the North American Ice Service. It was also preventing Ice Patrol from utilizing improved ocean current data or displaying satellite data. A BAPS replacement needed to resolve the obsolescence issue and provide additional functionality.

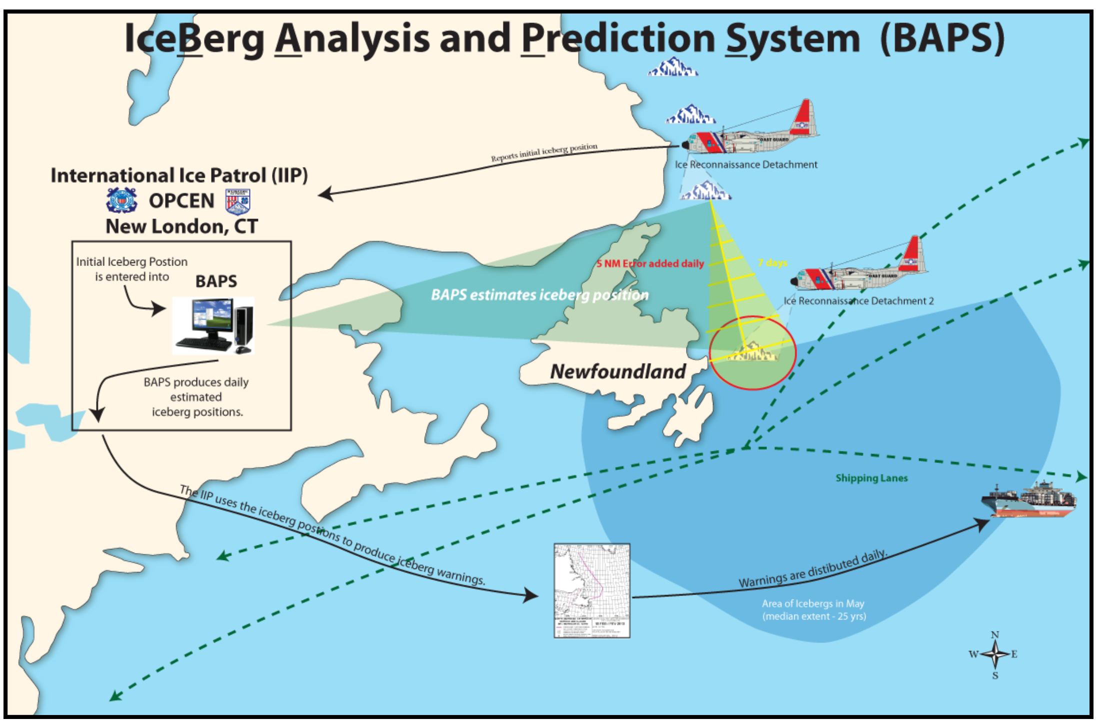


Figure1: Schematic of BAPS in Ice Patrol operations.

Alternatives Analysis

During 2010, Ice Patrol conveyed the mission-critical urgency of BAPS replacement to the Program Manager in correspondence and meetings. The Program Manager, with funding from the First Coast Guard District and the Deputy Commandant of Operations (DCO), contracted with the U.S. Coast Guard Research & Development Center to conduct an Alternatives Analysis (AA) and create a Functional Requirements Document (FRD). The AA considered four alternatives: status quo - allow BAPS to fail, upgrade the hardware and software as a stand-alone system at the Ice Patrol, upgrade the hardware and software but host the server at a Department of Homeland Security data center, and upgrade the hardware and software but integrate BAPS into the Coast Guard One View system. The analysis demonstrated that allowing BAPS to fail would double Ice Patrol's required aircraft support and increase Coast Guard costs exponentially. The analysis recommended:

- BAPS be upgraded initially in its current configuration with the lowest non-recurring and recurring life cycle costs and the lowest acquisition risk given the fiscal climate and potential budget impact

- A phased transition be developed to move the modernized BAPS to an enterprise-level application that is hosted on USCG infrastructure

Project Initiation

On completion of the AA in early FY 2012, the Program Manager established a team to manage the BAPS replacement project. In addition to the Program Manager, the team consisted of the Office for C2 & Operations Information Systems (CG-7612) and the Operations Systems Management Division (CG-633). Ice Patrol's IT Specialist was designated as the team's subject matter expert. The Project Team established a software development life cycle (SDLC) process and formal connections between the offices.

In 2011, the Assistant Commandant for C4&IT (CG-6) identified BAPS as a legacy C4&IT system in the Operations and Maintenance phase of the SDLC. All Coast Guard organizations involved in the planning, acquisition, production, deployment, support, operation, and disposition of C4&IT systems are required to follow the SDLC. Adherence to the SDLC supports compliance with the Office of Management and Budget Circular and DHS acquisition policies.

In 2012, as a result of the AA, CG-6 designated BAPS 2.0 as a system upgrade, entering the SDLC at the Planning and Requirements phase. The Project Team had requested FY 2012 backlog funding to start the project. In late 2012, ~$1M in funding from CG-761 and DCO was provided to contract with the U.S Coast Guard Operations Systems Center to begin modifications to the BAPS software. By September 2012, the contract was in place and work had begun on a feasibility study to determine the best approach.

Future Steps

Initially, BAPS will be modified to operate on a more current client workstation operating system, Windows 7 or greater. This will mitigate the anticipated system failure in 2014 and allow additional work to improve BAPS functionality. The initial modification is expected to be ready for testing in late FY 2013, initial operating capability in early FY 2014, and full operating capability by the start of the ice season in 2014. One of the functional requirements is to share the application with CIS and that timeline will be developed during the initial modification. In parallel with the recapitalization, the BAPS Project Team will complete the necessary documentation and tasks to satisfy the SDLC process and move BAPS into the Design phase.

Once continued operation is assured, the project will move to improvements in functionality. The focus will be to ensure that BAPS meets all the requirements listed in the FRD. Among the requirements, BAPS will automate all inputs and outputs, assist the watchstander in decision-making related to iceberg products, and automate production and distribution. The length of time and cost of these updates is currently unknown. As part of the current project, a way forward and an estimate of costs will be developed.

The final goal of the project, pending additional funding, is to move the modernized BAPS to an enterprise-level application hosted on the U.S. Coast Guard infrastructure. The intention is to eliminate the need for non-standard workstations, ensure connectivity between system environments (production, engineering, and continuity of operations), and provide BAPS with hardware and connectivity support through the C4&IT Service Center. During this phase of the project, the BAPS Project Team will work to move the system through the Design and Development SDLC phases. At the completion of these phases, BAPS 2.0 will be in the Operations and Maintenance phase. The project will have developed all SDLC artifacts and ensured that all segment architecture and a change management program have been implemented.

Appendix E

Titanic Centennial Commemoration

CDR Lisa K. Mack
MST2 Sara J. Weitkamp
MST3 Megan M. Sanks

Introduction

This appendix describes the events that Ice Patrol participated in during the 2012 season to commemorate the centennial of the sinking of RMS *Titanic* in April of 1912. Media and public interest for the centennial was expected to be significant and Ice Patrol relied on several other U.S. Coast Guard units and longtime partners to commemorate the centennial in a dignified and solemn manner.

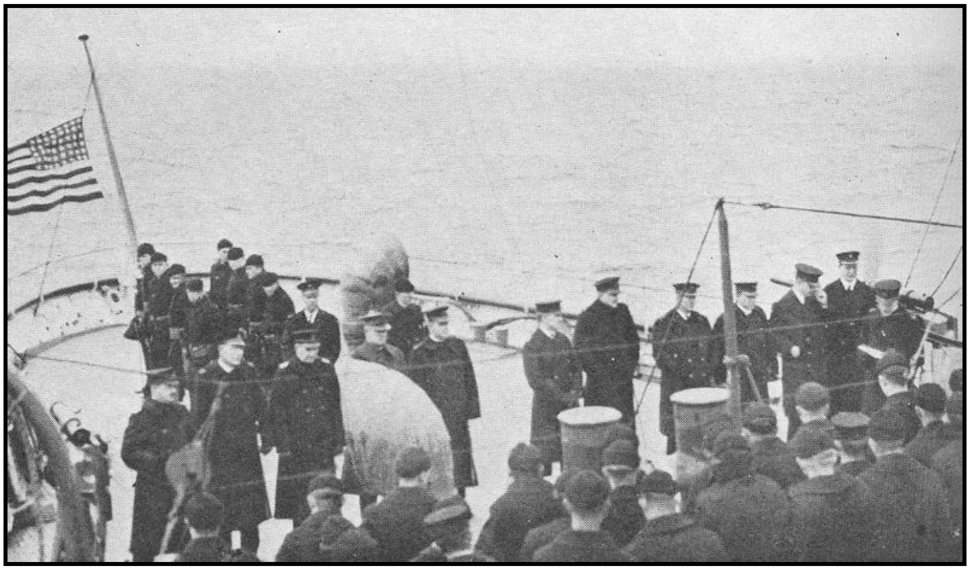
Photos included in this appendix are U.S. Coast Guard photos unless otherwise noted.

Background

In the late evening of 14 April 1912, RMS *Titanic*, steaming from Southampton, England, en route to New York City, struck an iceberg south of the Tail of the Grand Banks. Hours later, on 15 April 1912, Titanic sank with the loss of over 1500 lives. Over 700 survivors were rescued by the RMS *Carpathia.*

The tragedy galvanized the international community to establish an ice patrol for the transatlantic shipping lanes. By May of 1912, the U.S. Navy was conducting patrols of the Grand Banks to warn ships of iceberg danger. In 1913, with the U.S. Navy unable to provide ships, the U.S. Revenue Cutter Service took over the mission and to this day, with the exception of the two World Wars, the U.S. Coast Guard has conducted this important maritime safety mission. The first International Convention for the Safety of Life at Sea in1914 formalized the ice patrol service, and based on the experience of the previous two years, the U.S. was asked and agreed to overall management of the service.

From information contained in annual reports, the Ice Patrol has conducted a Titanic memorial ceremony to include a wreath laying or drop since at least 1923. The Titanic Historical Society has provided a wreath for this purpose since 1972 and the Titanic International Society has provided a wreath for several years. The centennial commemoration provided an opportunity to continue this tradition as well as highlight the unique mission and dedicated personnel of the Ice Patrol.



N. ATLANTIC - 1923 Titanic Memorial Service aboard U.S. Coast Guard Cutter *Modoc*.

Planning

In preparation for the events taking place primarily in April, Ice Patrol's Public Affairs Team conducted extensive planning in the months leading up to the centennial, including the following major tasks:

- Coordinated media relations training for all-hands and camera training for specific personnel by Ice Patrol's primary internal public affairs support, U.S. Coast Guard Public Affairs Detachment (PADET) New York. Ice Patrol also requested and received temporary duty support of a Public Affairs Specialist from U. S. Coast Guard Headquarters.
- Coordinated a visit to Ice Patrol by the founders of the Titanic Historical Society and supported a special rose petal project initiated by their partner, Titanic Museums. The Ice Patrol agreed to drop rose petals that visitors carried through their two museums over the Titanic resting site.
- Submitted a request for forces (RFF) for a commemorative wreath and rose petal drop. U.S. Coast Guard Cutter (USCGC) *Juniper* was assigned as the surface asset and Ice Patrol's regular deployment aircraft was assigned as the air asset. The RFF allowed Ice Patrol to pursue a joint commemorative flight with the Canadian Ice Service reconnaissance aircraft operated by Transport Canada. An Operation Order that detailed each asset's responsibilities was released by the U.S. Coast Guard First District.
- Prepared public affairs materials such as brochures, banners, and public affairs guidance and used a centennial commemoration logo design for commemorative merchandise available from the U.S. Coast Guard Academy Exchange.

Events

Ice Patrol participated in seven events and numerous media interviews during the two weeks surrounding the centennial of the sinking of the RMS *Titanic*. Coordination and participation was an all-hands effort as the 2012 season was developing into the first moderate iceberg season in three years after two light seasons. Details of the events are described in the following pages.

<u>Tuesday, 10 April 2012</u>
RMS *Titanic* Centennial Memorial Ceremony
USCGC *Juniper*, U.S. Coast Guard Base Boston, Boston, Massachusetts
-Remarks by:
  Rear Admiral Daniel Neptun, Commander, First Coast Guard District
  Mr. Edward Kamuda, President, Titanic Historical Society
  Mrs. Catherine Bernstein, Trustee, Titanic International Society
-Presentation of rose petals by Mr. Rick Laney, Titanic Museums
-Wreaths donated by Fisher's Florist, Ship Society of South Africa, Titanic Heroes, Titanic Historical Society, and Titanic International Society

BOSTON - Rear Admiral Neptun, Commander, First Coast Guard District, speaks at the memorial ceremony onboard USCGC *Juniper*.

<u>Wednesday, 11 April 2012</u>
"Titanic – 12,450 Feet Below" Exhibit Opening
Mystic Aquarium, Mystic, Connecticut
-Remarks by Dr. Robert Ballard, Oceanographer and Discoverer of Titanic

Media Interview/Photo Opportunity
USCG HC-130J aircraft, Groton-New London Airport, Groton, Connecticut
-Interviews by International Ice Patrol and Air Station Elizabeth City crewmembers

GROTON - International Ice Patrol crewmembers display commemorative wreaths.

<u>Friday, 13 April 2012</u>
RMS *Titanic* Centennial Memorial Ceremony
Anglican Church, Torbay, Newfoundland, Canada
-Remarks by:
Mayor Bob Kodner, Mayor of Torbay, Newfoundland
Mayor Dennis O'Keefe, Mayor of St. John's, Newfoundland
Superintendent Dan Frampton, Canadian Coast Guard
-Wreaths donated by the City of Halifax and Receiving Titanic

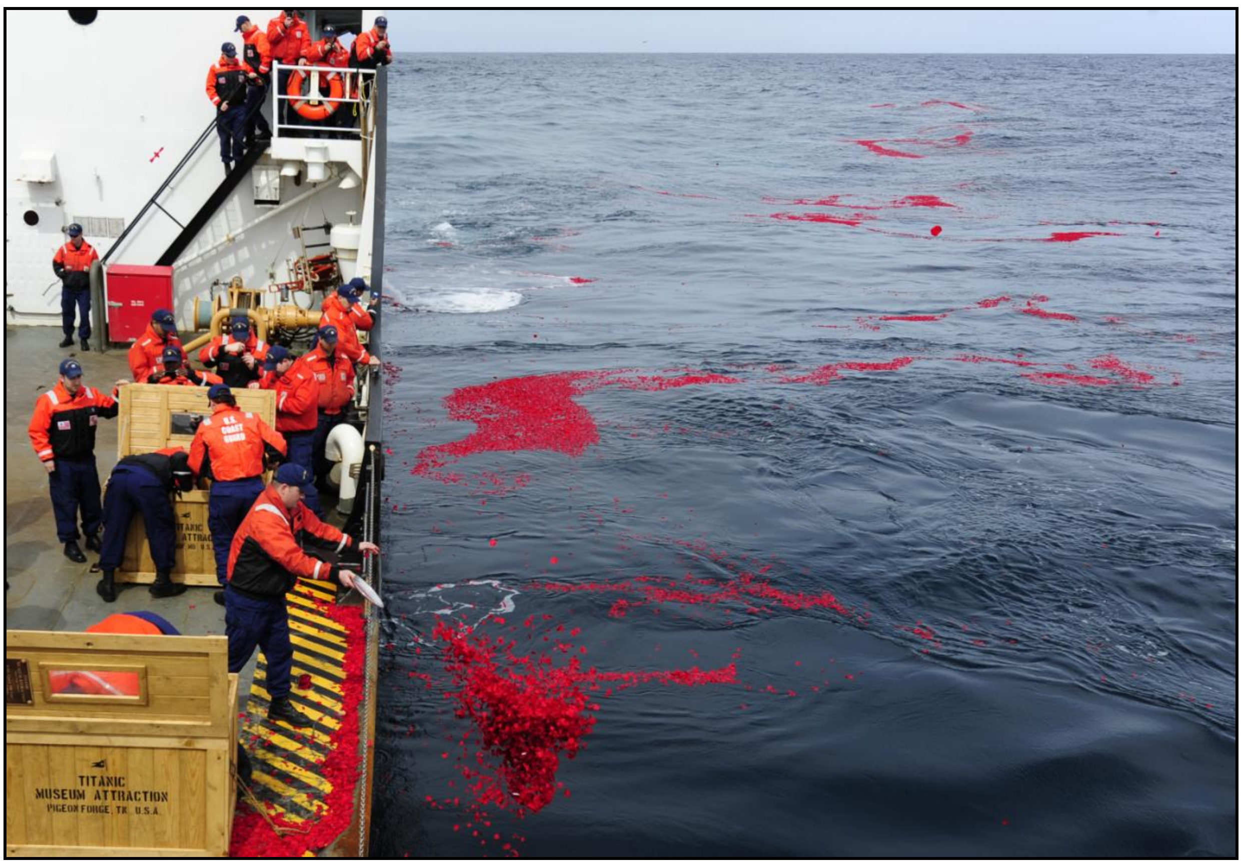
TORBAY - U.S. Coast Guard crewmembers attend the memorial ceremony in Newfoundland.

Saturday, 14 April 2012

Joint Commemorative Wreath and Rose Petal Drop
Titanic Resting Site, North Atlantic Ocean
-Flyover of Cape Race by Canadian Ice Service Dash-7 aircraft
-Joint wreath and rose petal drops conducted by Canadian Ice Service Dash-7 aircraft and
USCGC *Juniper*
-Additional wreath drops conducted by USCG HC-130J aircraft following divert for search and rescue case

N. ATLANTIC - Canadian Ice Service Dash-7 drops rose petals over the Titanic resting site.

N. ATLANTIC - USCGC *Juniper* disperses rose petals at sea. Photo courtesy of Canadian Ice Service.



N. ATLANTIC - USCGC *Juniper* crewmembers disperse rose petals over the Titanic resting site.

N. ATLANTIC - Air Station Elizabeth City crewmembers drop commemorative wreaths over the Titanic resting site.

<u>Sunday, 15 April 2012</u>
Titanic 100 Society Titanic Spiritual Ceremony
Fairview Lawn Cemetery, Halifax, Nova Scotia, Canada
-Remarks by the Honourable Peter McKay, Minister of National Defence
-U.S. Coast Guard remarks by CDR Lisa Mack, Commander, International Ice Patrol

HALIFAX - Flowers decorate graves of Titanic victims at Fairview Lawn Cemetery.
Vaughn, A. (2012). Fairview Lawn Cemetery [Photograph]. Retrieved from http://www.ctvnews.ca/victims-of-titanic-sinking-honoured-100-years-later-1.796513

Saturday, 22 April 2012
Titanic Historical Society Memorial Unveiling and Dedication Ceremony
Oak Grove Cemetery, Springfield, Massachusetts
-Remarks by the Honorable Richard Neal, United States House of Representatives, 2nd District of Massachusetts
-U.S. Coast Guard remarks by Dr. Donald Murphy, Chief Scientist, International Ice Patrol

SPRINGFIELD - Dr. Murphy, Chief Scientist, International Ice Patrol, speaks at the Titanic Historical Society's Titanic Memorial Unveiling and Dedication Ceremony.

Notable Coverage

Print – International:
Agence France-Presse (France)
Daily Sun (Bangladesh)
India Vision (India)
Jakarta Globe (Java)
Oman Tribune (Oman)
Ottawa Citizen (Canada)
PAB News (United Kingdom)
Süddeutsche Zeitung (Germany)
Tendencias 21 (Spain)
The Canadian Press (Canada)
The Chronicle Herald (Canada)
The Guardian (United Kingdom)

Print – National:
ABC Science
CNET News
Discovery News
Scientific American
The Atlantic
U.S. Capitol Historical Society

Print – Military:
Seapower
Navy Times
Proceedings Magazine (USCG)
Coast Guard Magazine

Television:
Bedlam Productions (United Kingdom)
Dan Rather Reports
Discovery Channel Canada
ITV Meridian (United Kingdom)

Radio:
Canadian Broadcasting Corporation
Federal News Radio
Irish National Radio

BOSTON - YN1 Gonzalez and MST2 Weitkamp talk to students during an exhibit.

ST. JOHN'S - MSTCS Luzader and MST2 Hendry take turns conducting an interview at the airport.

ST. JOHN'S – Crewmembers pose for filming at the airport.

GROTON - CDR Mack conducts an interview at the airport.

Acknowledgement

Thank you to our U.S. and Canadian partners for their outstanding support of International Ice Patrol's Titanic Centennial Commemoration.

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