Homeland Security

United States Coast Guard

Report of the International Ice Patrol in the North Atlantic

2009 Season
Bulletin No. 95
CG-188-64

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Season of 2009

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Forwarded herewith is Bulletin No. 95 of the International Ice Patrol (IIP), describing the Patrol's services and ice conditions during the 2009 season. With 1,204 icebergs present near the Grand Banks of Newfoundland from February to July, 2009 was the 11th most active iceberg season since the tragic loss of RMS Titanic in 1912.

In addition to carrying out our important mission, IIP managed numerous major changes in 2009. We physically relocated our office spaces from Groton, CT to New London, CT, began utilizing HC-130J aircraft for iceberg reconnaissance, improved the format of our Iceberg Analyses, and shifted our operational control (OPCON) from Coast Guard Atlantic Area in Portsmouth, VA to the First Coast Guard District in Boston, MA.

Many things did not change, however. Icebergs remained a threat to mariners in the North Atlantic Ocean, and IIP remained on the job. Our mission – to monitor the iceberg danger near the Grand Banks of Newfoundland and provide the limit of all known ice to the maritime community – remained. Our core values – Partnerships, Improvement and Commitment – remained. Additionally, we continued our traditions of pausing to remember all those who perished on April 15th, 1912 and during World War II; the former during an RMS Titanic Memorial Service on April 14th and the latter during a WWII Greenland Patrol Memorial Service on June 8th. As has become our custom, commemorative wreaths from these poignant services were later deployed into the North Atlantic Ocean during scheduled iceberg reconnaissance flights. Finally, our partnership with both the Canadian Ice Service (CIS) and U.S. National Ice Center (NIC) remained strong in 2009, as IIP was honored to host the 7th annual meeting of the North American Ice Service (NAIS), an innovative triumvirate between CIS, IIP and NIC.

On behalf of all of the dedicated women and men of the International Ice Patrol, I hope that you enjoy reading this report on the 2009 season.

S. D. Rogerson
Commander, U. S. Coast Guard
Commander, International Ice Patrol
Co- Director, North American Ice Service

International Ice Patrol
2009 Annual Report

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Cover Photograph: An iceberg visually detected in May 2009 during IRD 7. For the first time in over 20 years IIP conducted primarily visual iceberg reconnaissance.

Abbreviations and Acronyms

AIS	Automated Information System
AOR	Area of Responsibility
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
DDH	callsign for Hamburg Germany
DDK	callsign for Pinneberg Germany
ELTA	Brand name of Radar System equipped on HC-130J
FLAR	Forward-Looking Airborne Radar
GMES	Global Monitoring for Environment and Security
HC-130J	Missionized C-130 long-range reconnaissance aircraft
HF	High Frequency
HMCS	Her Majesty's Canadian Ship
IIP	International Ice Patrol
INMARSAT	INternational MARitime SATellite (also Inmarsat)
IRD	Ice Reconnaissance Detachment
KT	Knot
LAKI	Limit of All Known Ice
M	Meter
MB	Millibar
MCTS	Marine Communications and Traffic Service
M/V	Motor Vessel
NAFO	Northwest Atlantic Fisheries Organization
NAIS	North American Ice Service
NAO	North Atlantic Oscillation
NIC	National Ice Center
NIK	callsign for CAMSLANT
NM	Nautical Mile
NMF	callsign for USCG Communications Station Boston
NTIS	National Technical Information Service
NWS	National Weather Service
OPCEN	Operations Center
PAL	Provincial Aerospace Limited

Abbreviations and Acronyms (continued)

RADAR	RAdio Detection And Ranging (also radar)
RMS	Royal Mail Steamer
SME	Subject Matter Expert
SOLAS	Safety Of Life At Sea
SLAR	Side-Looking Airborne Radar
VON	callsign for MCTS St. John's
WOCE	World Ocean Circulation Experiment

Introduction

This is the 95th annual report of the International Ice Patrol (IIP). IIP was under the operational control of Commander, U.S. Coast Guard Atlantic Area until May 31, 2009 when it shifted to Commander, U.S. Coast Guard First District. The report contains information on IIP operations, environmental conditions, and iceberg conditions in the North Atlantic during 2009. 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 on and near the Grand Banks of Newfoundland and has broadcasted the Limit of All Known Ice (LAKI) to mariners. The activities and responsibilities of IIP are delineated in U.S. Code, Title 46, Section 738, and the International Convention for the Safety of Life at Sea (SOLAS), 1974 under 17 signatory nations.

The International Ice Patrol conducted aerial reconnaissance from St. John's, Newfoundland to search for icebergs in the southeastern, southern, and southwestern regions of the Grand Banks. In addition to IIP reconnaissance data, Ice Patrol received iceberg reports from other aircraft and mariners in the North Atlantic. At the Operations Center 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 the ice chart and text bulletin. In addition to these routine broadcasts, IIP responded to individual requests for iceberg information.

VADM Robert J. Papp, Jr. was Commander, U. S. Coast Guard Atlantic Area. When IIP transitioned to the First Coast Guard District in May, RADM Dale G. Gable was the First District Commander. In July 2009, RADM Joe L. Nimmich relieved RADM Gable. CDR Scott D. Rogerson 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.uscg-iip.org.

Summary of Operations

The International Ice Patrol (IIP) monitors iceberg danger near the Grand Banks of Newfoundland from 15 February to 01 July as mandated by SOLAS. This period is regarded as the Ice Season and is defined as such because the Grand Banks are normally free of icebergs from August through January. Although the Ice Season normally extends from February through July, IIP reporting services will commence whenever iceberg populations pose a threat to the primary shipping routes between Europe and North America and will continue until the threat has passed. Weekly products will commence the first Friday following 15 February and continue until ice conditions are severe enough to necessitate transmission of daily products, or until the season end. Distinct from the "Ice Season," the "Ice Year" is marked from October 1st of the previous year until September 30th of the current year.

In 2009, IIP actively monitored the iceberg danger to transatlantic shipping in its Area of Responsibility (AOR), defined as the region bounded by 40°N, 50°N, 39°W, and 57°W (**Figure 1**). IIP opened the season and began issuing weekly products on Friday, 20 February just days after moving its office space from Groton, CT to New London, CT. Ice conditions were light throughout February and early March. However, by mid- March, a significant iceberg distribution was tracked south of 50°N prompting the transition to daily products on 16 March. IIP's ice products were distributed daily at 1200Z until 28 July, the final day of the 2009 Ice Season.

During the 2009 Ice Year, IIP's Operations Center in New London, Connecticut received, analyzed, and processed 1,730 information reports concerning oceanographic, atmospheric, and/or ice conditions throughout IIP's AOR. These reports were generated by various land, sea, air, and space platforms including: merchant ships and Canadian Coast Guard vessels operating within or near the Grand Banks of Newfoundland, IIP reconnaissance flights, commercial aerial reconnaissance contracted by the Canadian Ice Service (CIS) and provided by Provincial Aerospace Limited (PAL), and satellite data processed by the USCG Intelligence Coordination Center (ICC).

Of the 1,730 information reports received by IIP, 437 reports relayed ice information identifying 17,354 individual objects to include icebergs, growlers, and/or stationary radar targets. Even though 17,354 individual objects were reported to IIP, only 8,254 objects were merged (added, deleted or re-sighted) by IIP to the iceberg drift and deterioration model known as BAPS. The disparity between the number of reported and merged objects illustrates two important points regarding IIP operations. Each ice information report is judged against several factors concerning accuracy and timeliness to ensure that only the most reliable information is used to generate IIP products. In addition, CIS, a strong partner of IIP in conducting the North Atlantic Ice Patrol, merged an additional 4,839 icebergs, bergy bits, growlers, and radar targets to BAPS. Under the current tenets of the partnership, CIS agrees to merge icebergs and radar targets detected north of 50°N and/or west of 55°W.

In total from both organizations (IIP and CIS), there were 13,093 objects merged to BAPS throughout the 2009 Ice Year, representing 6,216 distinct icebergs, bergy bits, growlers, and radar targets. Approximately 2,318 distinct objects were sighted, detected, or predicted to have drifted into IIP's AOR.

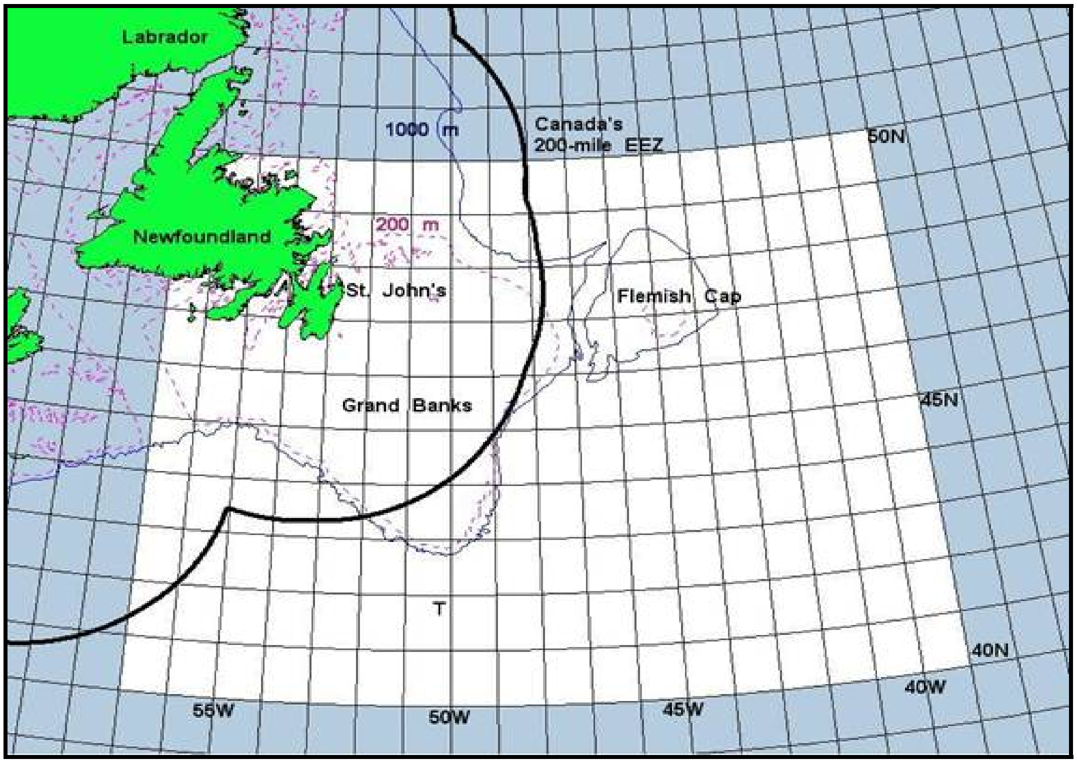

Figure 1. IIP's Operating Area. **T** indicates the location of *Titanic*'s sinking**.**

Information Reports

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

All ships that provided reports including weather, sea surface temperature, ice, and/or stationary radar target reports during the 2009 Ice Year are listed in **Appendix B**.

Although the majority of reports were received from merchant vessels, IIP received valuable information from several other sources as well. **Figure 2, Column 1** provides the breakdown of the sources for all information reports received during the 2009 Ice Year.

Ice Reports

In 2009, 440 (25%) of the 1,730 information reports received by IIP contained data on icebergs or stationary radar targets. Commercial reconnaissance was responsible for the greatest number with 195 (44%) ice reports. Merchant ships tallied the second highest number with 114 (26%) ice reports. IIP aerial reconnaissance flights provided 59 (14%) ice reports including 53 flight messages and 6 in-flight iceberg reports. The Canadian Government, including Canadian Coast Guard vessels, Canadian Forces aircraft, and the Canadian Ice Service combined to deliver 58 (13%) ice reports. Various other sources, including USCG ICC, scientific research vessels, and even one commercial trans-Atlantic flight combined to relay the remaining 14 (3%) ice reports. The breakdown by reporting source of all ice reports is illustrated in **Figure 2, Column 2.**

Merged Targets

All ice reports received at the IIP Operations Center are evaluated for accuracy and viability to determine if the reported information will be merged into IIP's iceberg drift and deterioration model. Several factors come into play during this evaluation, including atmospheric and oceanographic conditions, recent reconnaissance in the area, method of detection, and any other amplifying information relayed with the ice report. This standard is applied to all ice reports, even IIP's own reconnaissance, to ensure that accurate ice products are being broadcast to the maritime community.

Throughout the 2009 Ice Year, there were 13,093 updates to BAPS. CIS efforts produced 4,839 updates while IIP's resulted in 8,254. This number includes additions of new objects (icebergs, bergy bits, growlers and stationary radar targets), updates to existing objects in the model with information from new observations, and deletions of objects from the model based on recent reconnaissance or predicted deterioration.

Commercial reconnaissance conducted by Provincial Aerospace Limited (PAL) had the largest role, accounting for 74% of the updates to BAPS. Rounding out the largest remaining shares, IIP reconnaissance flights and the various platforms representing the Canadian Government accounted for 22% and 2% of the updates to the iceberg drift and deterioration model, respectively. The distribution of objects entered into BAPS by reporting source is displayed in the **Figure 2, Column 3.**

LAKI Iceberg Sightings

In order to meet SOLAS mandates, IIP develops a Limit of All Known Ice (LAKI) in order to inform the mariner of the southern, eastern, southeastern, and southwestern limit of the iceberg population. During the 2009 Ice Season, IIP began creating and distributing the LAKI to the mariner with the commencement of daily products on 16 March. On this date, IIP was tracking 89 icebergs south of 48°N, the latitude that marks the nominal northern extent of the trans-Atlantic shipping lanes. The LAKI is of critical importance because it defines the southern, eastern, southeastern, and southwestern boundary for ice-free ship navigation. As a result, the majority of IIP's reconnaissance missions focus on this boundary. In 2009, IIP flight messages accounted for 63% of all icebergs used to set the LAKI. A breakdown of information reports processed by IIP is shown in **Figure 2**.

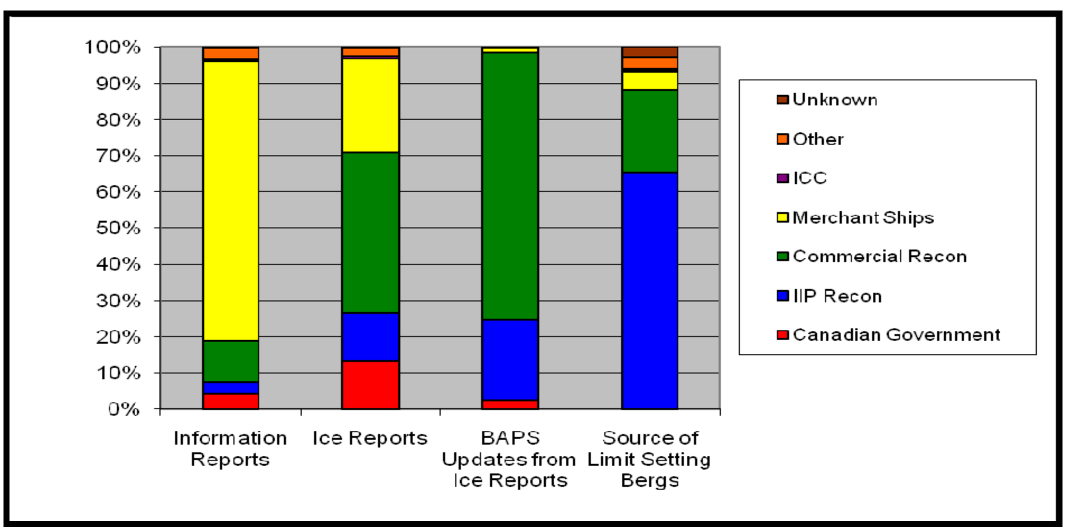

Figure 2. Distribution of information reports processed by IIP by reporting source during the 2009 Ice Year.

Products and Broadcasts

IIP issued a weekly ice chart and bulletin each Friday from 20 February to 13 March stating that IIP was monitoring iceberg conditions, but was not yet issuing daily products. The transition to daily products occurred on 16 March when significant iceberg populations south of 48°N threatened the trans-Atlantic shipping lanes. Daily products containing LAKI data valid for 1200Z as well as sea ice, iceberg distribution, and radar target information continued until the season was closed on 28 July.

The weekly ice chart also numerically displayed the current iceberg population density in each one degree of latitude by one degree of longitude square. This was a significant change from the ice charts of previous seasons and a break from two decades of IIP tradition. These changes addressed customer feedback and made IIP's ice chart similar to the charts produced by NAIS partner CIS. Charts from previous seasons used iceberg symbols rather than numbers and displayed an Area of Many Bergs.

In 2009, IIP transmitted 135 scheduled ice bulletins and 10 revised bulletins via SafetyNET. All scheduled bulletins reached SafetyNET on time, on or prior to 1200Z. The on-time delivery percentage for Ice Charts was 96.79%. Ice Charts are scheduled to be broadcast three times daily at 0438Z, 1600Z, and 1810Z.

Note: Information concerning product format and distribution methods can be found in IIP's annual Announcement of Services, on IIP's website, www.uscg-iip.org, or in NGA Publication 117.

JAAWIN Hit Counter Analysis

During the 2009 Ice Season, IIP conducted a three-month analysis to determine the type and number of viewers of the daily ice bulletin on the JAAWIN (Joint Air Force and Army Weather Information Network) web site. JAAWIN is sponsored by the U.S. Department of Defense and provides various operational weather and oceanographic products to users at all security levels, including the standard internet user. The results were encouraging. Ninety percent of the users identified by the analysis were military, and the remaining 10% were government, education, standard web users, and foreign. The analysis also counted the total number of hits received on the ice bulletin page. The site received four hits in March, 26 hits in April and 26 hits in May, for a total of 56 hits. Although exact users can not be identified or surveyed, the number of hits on the JAAWIN web site during the evaluation period validates its use as a means of disseminating IIP ice information.

Safety Broadcasts

Any report of an iceberg or stationary radar target near or beyond the published LAKI challenges the accuracy of IIP products and is a potential threat to safe navigation. When such a report is received, IIP transmits an unscheduled safety broadcast to mariners to report the location and type of object (iceberg or radar target) sighted or detected. During the 2009 Ice Season, IIP sent eight unscheduled safety broadcasts for six reports of icebergs and two reports of sea ice outside the published LAKI.

The information published in IIP's ice chart and bulletin is intended to be valid for a 24-hour period, defined as 1200Z of the current day through 1200Z the following day. Ice reports requiring a safety broadcast also have the potential to impact IIP's published products. If the object reported is in a position that requires a modification of the ice products and if time allows the modifications to be made prior to the scheduled broadcast, IIP's currently published products will be revised and retransmitted.

Seven of the eight reports requiring a safety broadcast during the 2009 Ice Season required a revision of the LAKI. In one other instance, a typographic error was discovered in the LAKI published in the daily ice bulletin. As a result of these revisions, the LAKI accuracy for the 2009 Ice Season fell to 95%. (**Figure 3**).

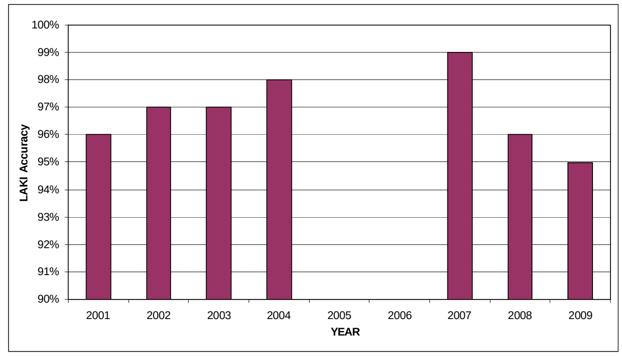

Figure 3. Recent historical distribution of LAKI accuracy as measured by the number of revisions to the LAKI based on ice reported outside the limit. (Note: Due to extremely light ice conditions no LAKI was produced in 2005 and 2006)

Historical Perspective

To determine the severity of the ice season, IIP uses two traditional measurements. The first is season length, measured in the number of days daily products are issued. The second 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 2009 Ice Season lasted 135 days with 1,204 icebergs (not including bergy bits or growlers) sighted, detected, and/or modeled to have drifted south of 48°N. The season length for 2009 places it near the 50th percentile when compared to the last 26 years (Figure 4, Red Columns). This timeframe encompasses IIP's modern reconnaissance era when aerial reconnaissance using radar-equipped aircraft became standard. Although only in the 50th percentile based on season length, the 2009 Ice Season climbed into the top ten as the eighth most severe when judged against iceberg populations south of 48°N during the same timeframe (**Figure 4, Blue Columns).**

The total number of icebergs detected during the 2009 Ice Season was nearly 50% higher than the modern seasonal average (1983-2008) of 829 icebergs. However, the 1,204 icebergs detected or drifted south of 48°N in 2009 was over 2.5 times the overall seasonal average of 476 icebergs measured against iceberg records dating back to 1900.

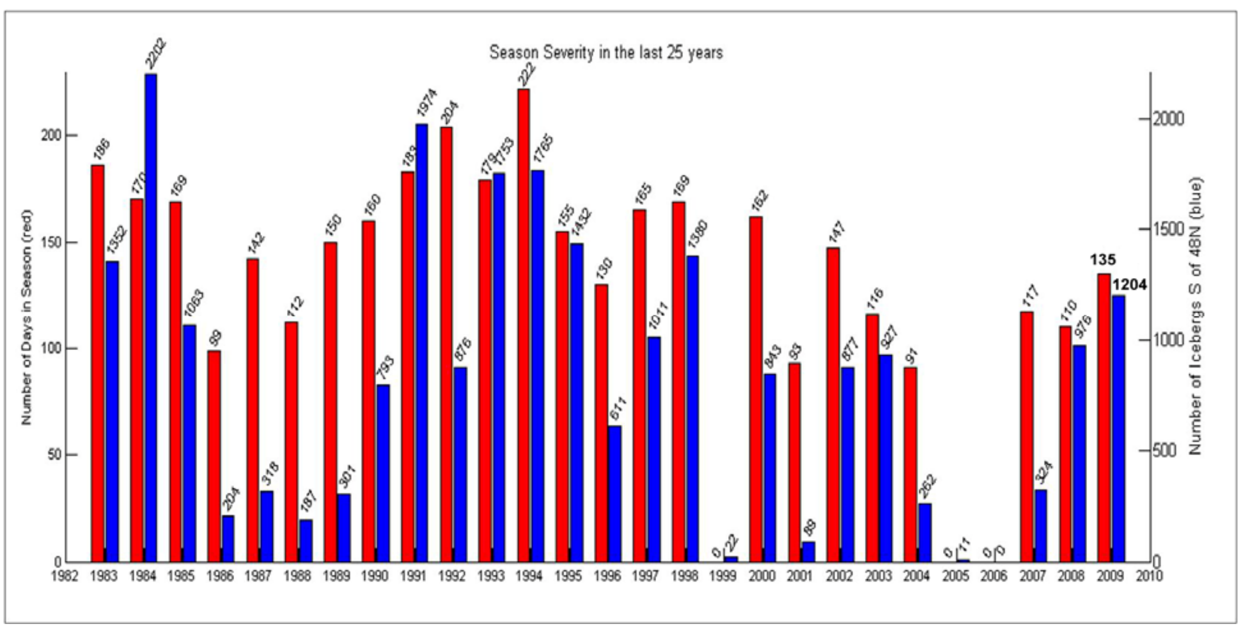

Figure 4. 1983-2009 Season Severity Chart – Ice Season length is measured by the number of days IIP issued daily products. (Note: Daily products were not transmitted in 1999, 2005, and 2006 due to very light ice conditions) The number of icebergs south of 48N does not include bergy bits or growlers.

Canadian Support

As they do every year, the Canadian Government generously supported IIP during 2009. CIS shared valuable reconnaissance data, including iceberg and information reports from Canadian Coast Guard and Canadian Forces assets, critical environmental data from the Canadian Meteorological Center, and most importantly, their own sea ice and iceberg expertise. The synchronized iceberg-modeling database, now in its fourth year of operation, continued to ensure that all ice information received by IIP or CIS was quickly merged and accurately reflected on both organizations' ice products.

IIP also appreciated the critical support from PAL who continued to share valuable ice observation data throughout the 2009 Ice Season. Their reconnaissance flights routinely covered the interior portions of the Grand Banks of Newfoundland surrounding and in support of commercial oil operations. Their reconnaissance efforts in this area not only provided critical information to IIP's Operations Center, but also allowed IIP's reconnaissance to focus on other important regions within the IIP AOR.

IIP thanks C-CORE for continuing to provide iceberg data to IIP during the 2009 Ice Season and for their ongoing efforts to improve the ice detection algorithms designed for satellite iceberg reconnaissance. IIP looks forward to working with C-CORE in 2010 to assess the new capabilities of RADARSAT-2.

Environment Canada Environnement Canada

Iceberg Reconnaissance and Oceanographic Operations

Ice Reconnaissance Detachment

The Ice Reconnaissance Detachment (IRD) is a sub-unit under Commander, International Ice Patrol which is partnered with Coast Guard Air Station Elizabeth City (ECAS).

During the 2009 Ice Season, 14 IRDs deployed to observe and report icebergs, sea ice, and oceanographic conditions on and near the Grand Banks of Newfoundland. All observations were transmitted to the IIP Operations Center in New London, CT where they were entered into the iceBerg Analysis and Prediction System, processed, and distributed to mariners operating in IIP's Area of Responsibility as described in the **Summary of Operations** chapter.

The Pre-Season IRD departed on 04 February to conduct official meetings with IIP partners in Elizabeth City, North Carolina and St. John's, Newfoundland and to determine the early season iceberg distribution. During the Pre-Season IRD, a moderate iceberg distribution was detected. As a result, all subsequent IRDs were conducted as scheduled with the exception of IRDs 13 and 14 which were cancelled due to a light iceberg distribution at the end of the season. The Post-Season IRD was conducted from 04-06 August, concluding 2009 IIP deployments to Canada.

Throughout the 2009 Ice Season, IRDs operated out of IIP's forward operating base in St. John's, NL for a total of 108 days. 2009 had a total of 82 flights, including 49 iceberg reconnaissance flights (including one ELTA test flight), 17 dedicated transit flights, nine combination transit/ Northwest Atlantic Fisheries Organization (NAFO) flights, four combination transit/iceberg reconnaissance flights, and three logistics flights. A summary of 2009 IRD flight operations is provided in **Table 1.**

IRD	Deployed Days	Iceberg Patrols	Transit Flights	Logistics Flights	Flight Hours
PRE	10	2	*4	2	41.4
1	6	3	*2	0	31.7
2	9	4	2	0	39.7
3	8	2	*2	0	25.9
4	9	3	*2	0	32.8
5	9	5	*2	0	50
6	8	4	*2	0	43.6
7	9	6	*2	0	54.8
8	8	5	2	0	45.2
9	6	3	*2	1	43.6
10	9	5	2	0	43.5
11	8	5	2	0	45
12	6	2	2	0	24.5
13	Cancelled				
14	Cancelled				
POST	3	0	2	0	10
TOTAL	**108**	**49**	**30**	**3**	**531.7**

Table 1. 2009 IRD summary (* denotes a transit flight of which a portion of the flight included an IIP or NAFO patrol; Iceberg patrols for IRD 8 included one test flight. Flight hours include patrol, logistics, and transit hours).

Aerial Iceberg Reconnaissance

Due to the consistently inclement environmental conditions in IIP's AOR, detecting and classifying targets is a perpetual challenge for IIP IRDs. It is for this reason that the use of radar has become critical to IIP operations. In times of reduced visibility, IIP relies heavily on the detection and classification capability of radar as the primary means of conducting IIP iceberg reconnaissance. In no-visibility conditions, the radar's imaging capability must be relied upon as the primary mean of classifying targets. A detailed description of IIP's reconnaissance strategy is provided on IIP's web site at http://www.uscg-iip.org in the FAQ section.

Coast Guard aircraft provided the primary means of detecting icebergs in the vicinity of the Grand Banks in 2009. All 2009 aerial iceberg reconnaissance operations were conducted using HC-130J (missionized) and C-130J (non-missionized) long-range reconnaissance aircraft provided by ECAS. The HC-130J aircraft were equipped with the ELTA-2022 360° X-Band Radar and APN-241 Weather Radar, and the C-130J aircraft were equipped with only the APN-241 Weather Radar.

2009 marked a significant transition in Ice Patrol reconnaissance aircraft and sensor capabilities. IIP successfully implemented the HC-130J and C-130J aircraft with associated sensors into IRD iceberg reconnaissance operations and discontinued the use of the SLAR/FLAR equipped HC-130H aircraft. IIP continued to use an Automated Information System (AIS) receiver as an integrated component of the HC-130J mission system to assist in target discrimination.

Ice Patrol reconnaissance successfully implemented the new aircraft and sensors despite many complications, including the retrofitting of the C-130J aircraft with the new mission systems and various technical problems associated with the new system. These complications contributed to the limited availability of fully functioning HC-130Js throughout the 2009 Ice Season. Because of this, IIP conducted a large percentage of visual only patrols during the 2009 season compared to the previous four years when no visual only patrols were required (**Table 2**). When interpreting the data in **Table 2**, note that 2005 and 2006 were extremely light ice years compared to 2007-2009.

Year	Radar and Visual Patrol Total	Radar Only Patrol Total	Visual Only Patrol Total
2005	15	2	0
2006	17	0	0
2007	38	2	0
2008	35	2	0
2009	17	0	36

Table 2. IIP Radar and Visual Patrol Comparison.

When available, the 360° coverage provided by the ELTA Radar allowed IIP to use 20 NM track spacing operating the radar in the 30 NM range to achieve >200% radar coverage (**Figure 5**) on each patrol, regardless of visibility.

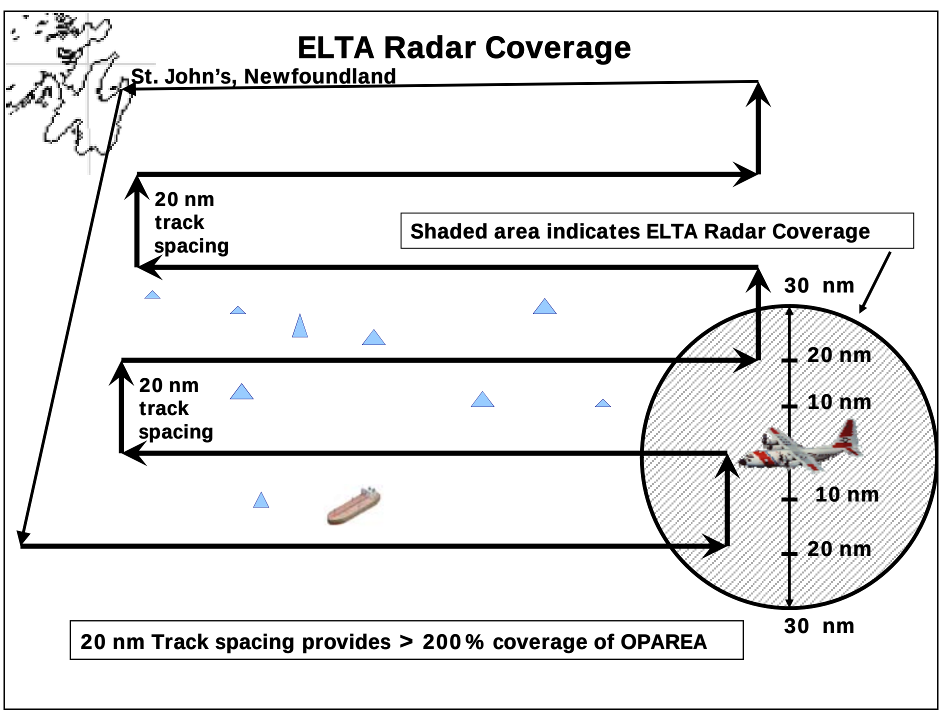

Figure 5. IIP Radar Reconnaissance Plan in 2009.

IIP utilized 20 NM track spacing upon recommendation of the Coast Guard Office of Aviation Forces (CG-711) following the testing of the ELTA radar in September 2008. When visual only patrols were conducted, 10 NM track spacing was utilized in accordance with IIP Standard Operating Procedures to ensure that no targets were missed when operating without a functioning ELTA-2022 radar.

The 20 NM track spacing used with the ELTA-2022 radar provided only 66% of the coverage that was provided by the HC-130H with SLAR/FLAR combination. This radar combination effectively conducted patrols with 30 NM track spacing. **Table 3** shows a three-year comparison of annual totals of track miles and area coverage. This data shows a drastic increase in total track miles flown and a corresponding drastic decrease in total area covered associated with patrols conducted with reduced track spacing.

As a result of the reduced patrol altitude required for ELTA operations (~1000-5500 feet compared to SLAR/FLAR operations at ~5500-8000 feet) combined with the increased number of visual only patrols, the number of patrol miles with visibility encountered in IIP's AOR during 2009 was much greater than in years past (**Table 4**).

2009 IRD Target Summary

In 2009, IRDs detected a total of 1,070 icebergs. Visual surveillance detected 72% of the icebergs. The remaining icebergs were identified using radar only (14%) and using both radar and visual surveillance (14%). **Figure 6** shows the breakdown of the detection sources for icebergs.

The Grand Banks are a productive fishing ground frequented by fishing vessels, ranging from 20 to over 70 meters in length. Determining whether an ambiguous radar contact is an iceberg or a stationary vessel is particularly difficult with small targets. These contacts often present similar radar returns and cannot easily be differentiated. Therefore, when a radar image does not present distinguishing features, IIP classifies the contact as a radar target (R/T) in hopes of being able to identify it on a subsequent pass or another patrol.

Figure 7 presents the number and types of targets that IRDs detected during the 2009 Ice Year.

Year	Total Track Miles Flown (nautical miles)	Total Area Coverage (square miles)
2007	52,977	3,178,626
2008	53,690	3,221,370
2009	80,677	1,883,778

Table 3. Three Year Track Mile / Area Coverage Comparison.

Year	Total Track Miles With Visibility (nautical miles)	Total Track Miles Without Visibility (nautical miles)
2005	7,059	12,398
2006	7,679	10,452
2007	10,066	42,911
2008	19,490	34,200
2009	56,071	24,606

Table 4. Five Year Track Mile Visibility Comparison.

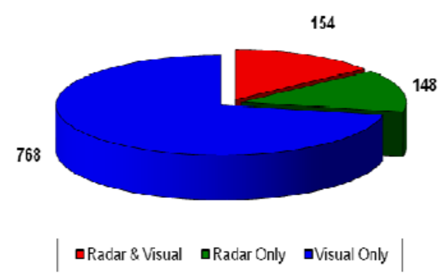

Figure 6. Breakdown of icebergs by detection source.

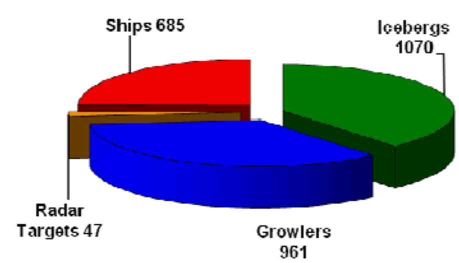

Figure 7. Breakdown of targets detected by IRDs in 2009.

The Grand Banks region continues to be rapidly developed for its oil reserves with new exploration conducted daily and many prospects of future exploration in the region. In November 1997, Hibernia, a gravity-based oil-production platform, was set in position approximately 150 NM offshore on the northeastern portion of the Grand Banks. In addition to Hibernia, other drilling platforms—including GSF Grand Banks, Terra Nova, Sea Rose, and Henry Goodrich—are routinely on the Grand Banks. Consequently, this escalated drilling has increased air and surface traffic in IIP's AOR, further complicating target identification. However, this difficulty is offset by the information reports this traffic provides. Reports from ships, aircraft, and drilling platforms greatly aid IIP in the creation of a Limit of All Known Ice (LAKI) that is as accurate and reliable as possible.

Northwest Atlantic Fisheries Organization Support

IIP began providing support to the Northwest Atlantic Fisheries Organization (NAFO) through D1 during the 2009 Ice Season. This new partnership was formed in conjunction with IIP's transition of operational control from Coast Guard Atlantic Area to the First Coast Guard District on 31 May 2009. IIP IRDs collect position information of sighted fishing vessels during routine reconnaissance flights and provide this information to D1 via the IIP OPCEN the following day. **Table 5** provides a summary of the support provided to NAFO in 2009 including total patrol hours for flights where NAFO information was collected.

Month	Fishing Vessels Detected	Patrol Hours
May	90	82.6
June	33	66.3
July	41	54.6
Total	164	203.5

Table 5. Fishing vessels sighted during May-July 2009.

Radar Testing and Evaluation

During the 2009 Ice Season, IIP conducted additional testing of the HC-130J long-range reconnaissance aircraft equipped with the ELTA-2022. Testing was conducted in concert with normal operations throughout the season and during one dedicated test flight conducted during IRD 8. Future testing is still necessary to further refine the ELTA-2022's capability to detect and identify small icebergs in IIP's AOR at different altitudes under normal operating conditions. Additional information regarding this year's test and a brief summary of the CG-711 test report from September 2008 are provided as **Appendix C** to this report.

2009 Flight Hours

During the 2009 Ice Season, IIP conducted 49 iceberg reconnaissance sorties, three logistics flights, one test sortie, and 30 transit flights from ECAS to and from St. John's. Of the 30 transit flights, three included iceberg patrols, and eight included D1 NAFO patrols. **Figure 8** shows IIP's flight hour breakdown for 2009.

Figure 8. 2009 Flight Hours.

Figure 9 shows a comparison of the breakdown of the flight hours used for the last six ice seasons. Although the overall flight hours for the 2009 Ice Season were only slightly more than those used in 2008, a much greater percentage of hours were utilized for reconnaissance patrols. In 2009, 347 flight hours were used for actual ice reconnaissance flights compared to 244 flight hours in 2008. The 10 NM track spacing required for visual only patrols combined with the significant iceberg population south of 48°N explains this increase in patrol hours. In 2008, significant time was devoted to testing of both the ELTA-2022 radar and the SELEX Seaspray radar. In 2009, only one dedicated test flight was conducted. Finally, the transition from the HC-130H to the HC-130J proved to be a significant improvement in the reliability of IIP's reconnaissance platform. The decreased need for logistics flights in response to aircraft maintenance issues is a result of this increased reliability. **Figure 10** compares flight hours to the number of icebergs south of 48°N since 2000.

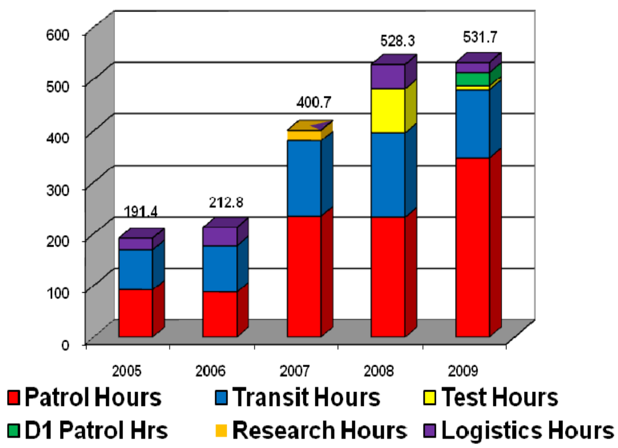

Figure 9. Summary of flight hours (2004-2009).

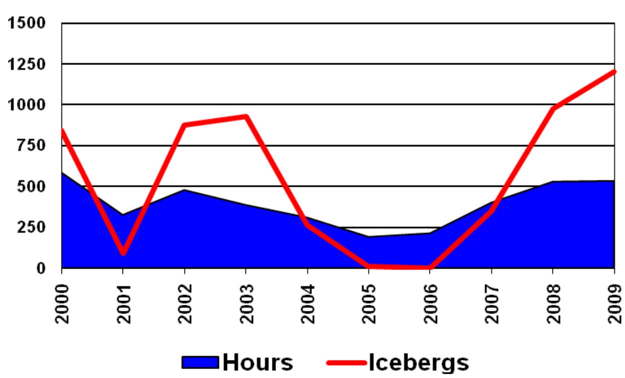

Figure 10. Flight hours versus icebergs south of 48°N (2000-2009).

Commercial Reconnaissance Study

In 2009, IIP completed a commercial reconnaissance study analyzing the availability and feasibility of using commercial aircraft to supplement future IIP operations and reduce IIP's dependence on USCG aircraft. A detailed report was provided to IIP by Potomac Management Group (PMG), the USCG Research and Development Center (RDC) government contractor hired to conduct the study. A summary of the findings are provided in **Appendix D** of this report. It has not yet been determined how soon dedicated commercial reconnaissance aircraft may be incorporated into IIP operations.

Satellite Iceberg Reconnaissance

All 2009 satellite iceberg reconnaissance operations were conducted in cooperation with the USCG Intelligence Coordination Center (ICC), located in Suitland, MD. This is a change from previous years where IIP is now working directly with the ICC for satellite support rather than sending requests to National Ice Center (NIC) personnel who in turn made a request to ICC personnel. ICC is now placing orders, analyzing received images, and working on the development of processes to conduct satellite reconnaissance for IIP. Coast Guard personnel stationed at the NIC, who previously served as a liaison between IIP and the ICC in years past, are now focused on providing increased ice analysis support to the NIC for other Coast Guard ice operations.

In 2009, IIP, NIC, and ICC continued the development and implementation of Standard Operating Procedures (SOP) for conducting satellite iceberg reconnaissance and ambiguous target identification. These SOP identify the new procedures for coordinating directly with ICC. The transfer of the USCG petty officer billet located at the NIC from USCG headquarters to IIP mentioned in the 2008 IIP Annual Report did not happen as desired due to the redefined focus for that position at the NIC.

IIP continued cooperation with C-CORE in the analysis and verification of iceberg detections using RADARSAT II satellite imagery. This was done through the use of coincident IIP reconnaissance flights with ordered satellite swaths in IIP's AOR during the 2009 Ice Season. C-CORE is affiliated with Memorial University in St. John's, NL and has been working in cooperation with IIP since 2003.

IIP will continue to evaluate satellite information provided by C-CORE during the 2010 Ice Season. IIP may also pursue partnerships with other satellite providers to further develop reliable satellite reconnaissance capabilities.

A breakdown of 2009 satellite iceberg reconnaissance is provided in **Table 6**. Only ICC iceberg reports were merged into BAPS. RADARSAT II iceberg data provided by C-CORE is currently being evaluated for accuracy and has not yet been approved for operational use and incorporation into BAPS.

	ICC	C-CORE
Number of acquisition requests	13	26
Number of iceberg messages provided	1	30
Number of messages merged into BAPS	1	0

Table 6. 2009 Satellite Iceberg Reconnaissance.

Commemorative Wreath Deployments

In conjunction with reconnaissance operations, IIP air-deployed several wreaths in 2009 to commemorate both the tragic sinking of the RMS Titanic as well as those lost in the execution of the Greenland Patrol during WWII. Three wreaths commemorating the 97th anniversary of the sinking of the RMS Titanic in 1912 were deployed on IRD5, and one wreath honoring the Greenland Patrol was deployed on IRD9.

Environmental Conditions

Environmental conditions in IIP's AOR permitted adequate visibility (≥10 NM) for visual-only reconnaissance 69.5% of the time during the 2009 Ice Season. For the remaining roughly 30%, IIP relied heavily on the ELTA-2022 radar to detect and classify targets in low-visibility conditions, such as low cloud decks and fog.

Oceanographic Operations

In 2009, IIP air-deployed three World Ocean Circulation Experiment (WOCE) drifting buoys from USCG C-130J and HC-130J aircraft and coordinated the deployment of four WOCE drifting buoys from Canadian Coast Guard (CCG) vessels. These buoys were deployed on the Grand Banks of Newfoundland and in the inshore and offshore branches of the Labrador Current. The WOCE drifting buoys, drogued at a depth of 15 or 50 meters, provided near real time ocean-current information that was used to modify the historical-current database within BAPS. **Figure 11** shows 2005-2009 air and ship WOCE drifting buoy deployments.

All seven WOCE drifting buoys functioned properly and transmitted oceanographic data for sufficient durations,

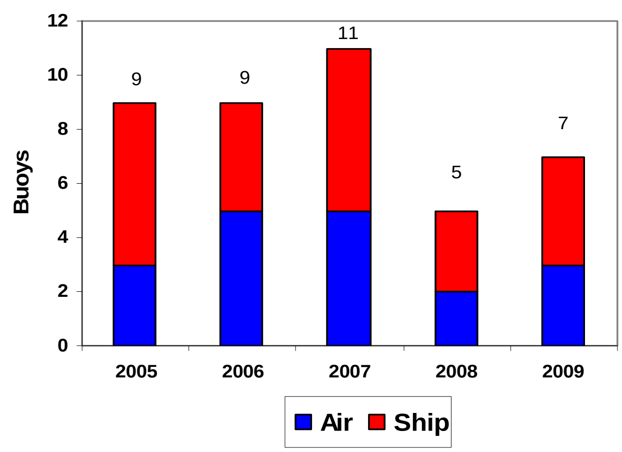

Figure 11. WOCE Buoy deployments (2005-2009).

ranging from two to nine months. Air-deployed WOCE drifting buoys are purchased by IIP and prepared and deployed through cooperative efforts by IIP and ECAS personnel. Buoy deployments are conducted in conjunction with IRD iceberg reconnaissance operations when flying patrols near desired drop locations.

Ship-deployed WOCE drifting buoys are purchased and prepared by IIP personnel and deployed by vessels of opportunity, usually CCG vessels operating out of St. John's, NL. As part of a volunteer operation, these vesselsof opportunity deploy WOCE drifter buoys at locations requested by IIP. The ship deployments save IIP significant amounts of time and money while strengthening international partnerships.

Figure 12 depicts composite drift tracks for the WOCE drifting buoys deployed in 2009. Detailed WOCE drifter information is provided in IIP's 2009 WOCE Buoy Drift Track Atlas, available upon request from IIP.

In August 2009, IIP assisted Coast Guard District Seventeen (D17), Air Station Kodiak, the National Oceanic and Atmospheric Administration (NOAA), and representatives from the international science community with the first deployment of a WOCE drifting buoy in the Arctic Ocean north of Barrow, Alaska. With assistance from partners at Coast Guard Air Station Elizabeth City, IIP provided the deployment package, including parachute and rigging, and IIP subject matter expert to oversee and assist with the deployment. This successful deployment represents the beginning of further cooperation between IIP and the international science community to prepare for and safely deploy additional buoys in the region.

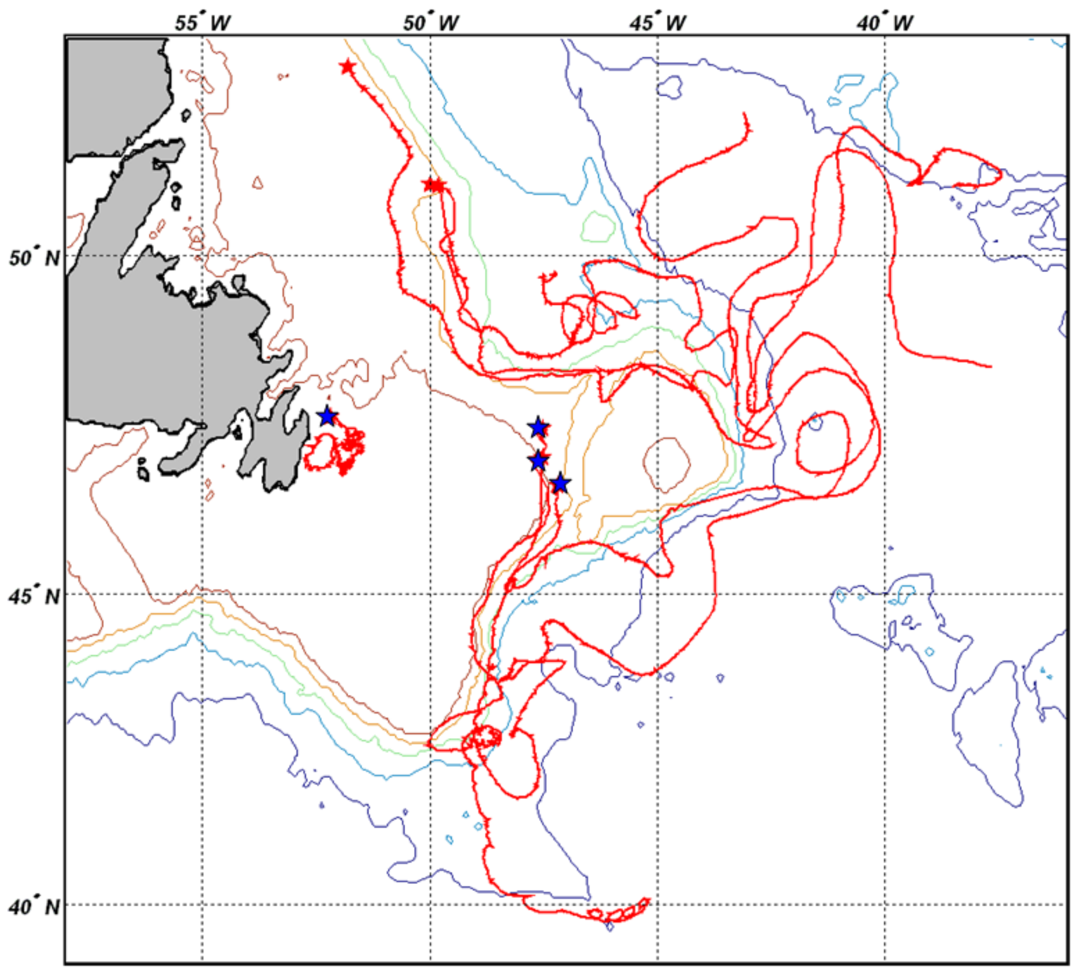

Figure 12. Composite buoy tracks. Red stars represent drop locations of air-deployed buoys. Blue stars represent ship-deployed buoys.

Ice and Environmental Conditions

Introduction

The 2009 Ice Season marked one of the busiest years in International Ice Patrol (IIP) history. Between February and July, 2009, 1204 icebergs drifted into the transatlantic shipping lanes making 2009 the 11th most severe ice year in IIP's iceberg-count records, which extend back to 1900. Unusually extensive and persistent sea ice near the Grand Banks in 2009 protected the icebergs from deterioration, increased the hazard to navigation for North Atlantic mariners, and made detecting icebergs more difficult for IIP reconnaissance flights.

This section describes the progression of the ice year and the accompanying environmental conditions. The following month-by-month narrative begins as sea ice began forming along the Labrador coast in December 2008 and concludes on 28 July 2009 when Ice Patrol sent its final daily ice chart and bulletin to mariners. The narrative draws from several sources, including the *Seasonal Summary for Eastern Canada, Winter 2008-2009* (Canadian Ice Service, 2009a); sea-ice analyses provided by the Canadian Ice Service (CIS) and the U. S. National Ice Center (NIC); sea surface temperature anomaly plots provided

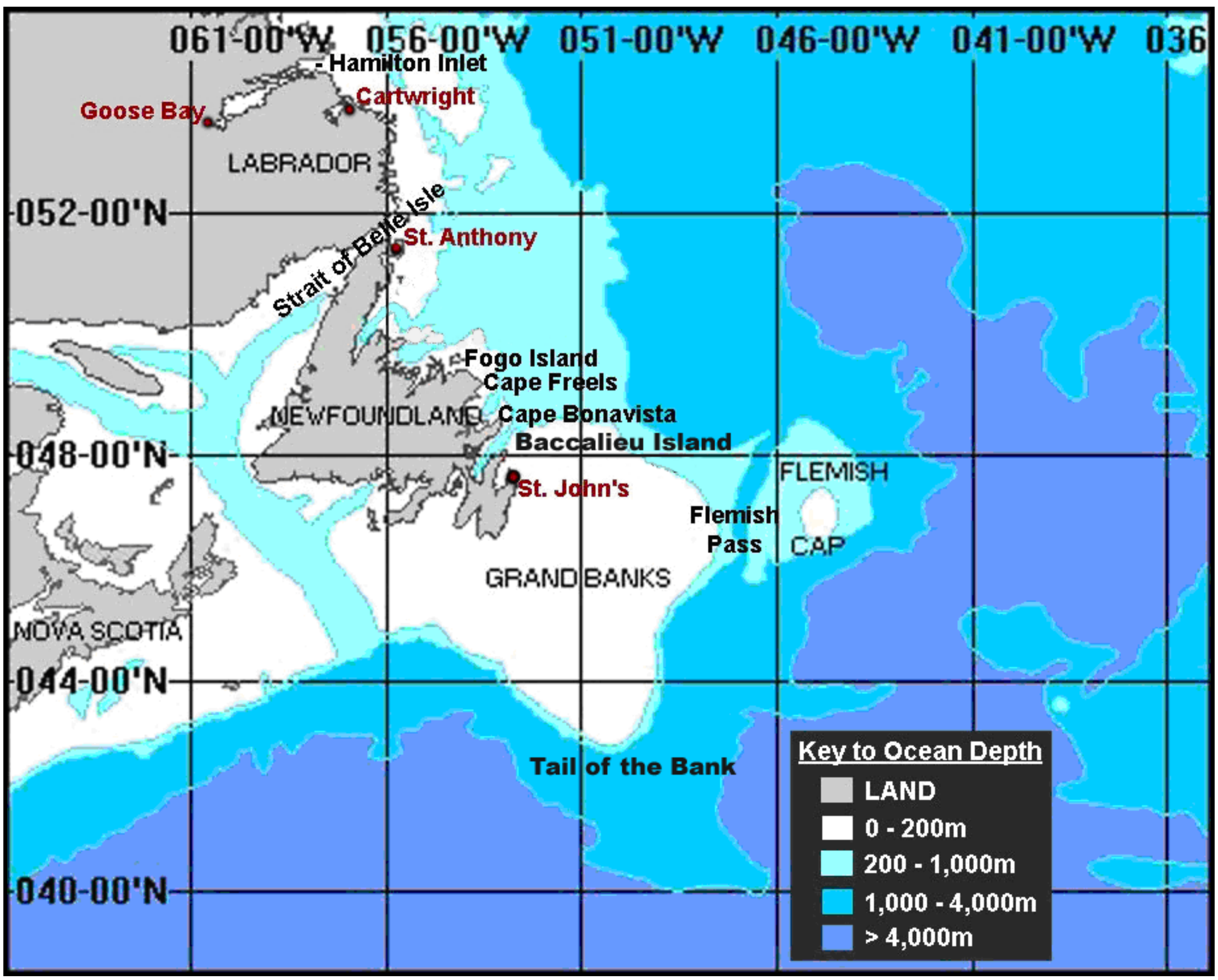

Figure 13. Grand Banks of Newfoundland.

by the National Oceanic and Atmospheric Administration's National Weather Service (NOAA/NWS, 2009a); and, finally, summaries of the iceberg data collected by Ice Patrol and CIS. The plots on pages 40 to 53 document the Limits of All Known Ice (LAKI) twice a month (the 15th and last day of each month) for the period during which Ice Patrol provided daily warnings to mariners in 2009. In addition, the LAKI for the first (16 March) and last (28 July) daily iceberg warnings are presented.

The progress of the 2009 Ice Year (October 2008 through September 2009) is compared to sea-ice and iceberg observations from the historical record. The sea-ice historical data are derived from the *Sea Ice Climatic Atlas, East Coast of Canada, 1971-2000* (CIS, 2001), which provides a 30-year median of ice concentration at seven-day intervals for the period from 26 November through 16 July. Historical iceberg information is derived from Viekman and Baumer (1995), who present LAKI climatology from mid-March to 30 July based on 21 years of Ice Patrol observations from 1975 through 1995. They provide the extreme, 25th percentile, median, 75th percentile, and minimum LAKIs for the period. The 25th and 75th percentiles indicate that, respectively, 25% and 75% of the LAKI were more extensive than those historical positions. Finally, the average number of icebergs estimated to have drifted south of 48°N for each month was calculated using 109 years (1900 through 2008) of Ice Patrol records (IIP, 2009).

Pre-season Predictions

The pre-season sea-ice forecast for east Newfoundland waters (CIS, 2008), which was issued on 4 December 2008, predicted a slightly delayed advance and faster-than-normal retreat of sea ice in 2009, with the southern ice edge:

- arriving at St. Anthony **(Figure 13)** by the end of the first week of 2009,
- reaching 48° N, its southernmost 2009 extent, in early March, and
- beginning a faster-than-normal retreat during the last week of March.

From 10-23 October 2008, CIS conducted a census of the iceberg population off Baffin Island's southern coast. It was based on approximately 30 images each from RadarSat-1 and Envisat (Desjardins, 2008). The resulting iceberg count was 217, the second lowest CIS fall iceberg count in the nine years of the survey's history. Based on the satellite-observed population of offshore icebergs and the estimated travel time toward the shipping lanes, Desjardins (2008) predicted an early March opening date for the 2009 iceberg season (defined as the date that IIP starts providing daily warnings to mariners).

December 2008

In early December, sea ice began forming in the bays along Labrador's coast. By mid-month, about a week later than normal, the southern edge of the main pack moved south of Cape Chidley, Labrador's northernmost point. Colder-than-normal air temperatures in Labrador throughout December promoted vigorous sea-ice development along the Labrador coast. The mean monthly air temperatures at Cartwright, Goose Bay and Nain, Labrador were 1.4°C to 2.9°C below normal (Environment Canada, 2009a and 2009b). Near normal sea surface temperature conditions persisted along the Labrador coast throughout the month (NOAA/NWS, 2009a). Throughout December, the southern ice edge continued its southward movement, and by month's end, it arrived at the northern reaches of the Strait of Belle Isle.

January 2009

The first half of January was much warmer than normal in Newfoundland and southern Labrador, which slowed southward sea ice expansion somewhat. By mid-January, the southern ice edge reached the latitude of St. Anthony, about a week later than the preseason forecast. During the second half of January, there was a dramatic reversal of the air temperatures in northern Newfoundland and southern Labrador, with both St. Anthony and Goose Bay experiencing much lower-than-normal air temperatures. Sea ice continued to push southward in east Newfoundland waters. Shortly after mid-month, ice conditions in the vicinity of the Strait of Belle Isle prompted the Canadian Coast Guard (CCG) to recommend that the strait not be used by transatlantic shipping after 23 January. Despite weather conditions that favored sea-ice expansion, by month's end, ice concentration was well below normal (**Figure 14**).

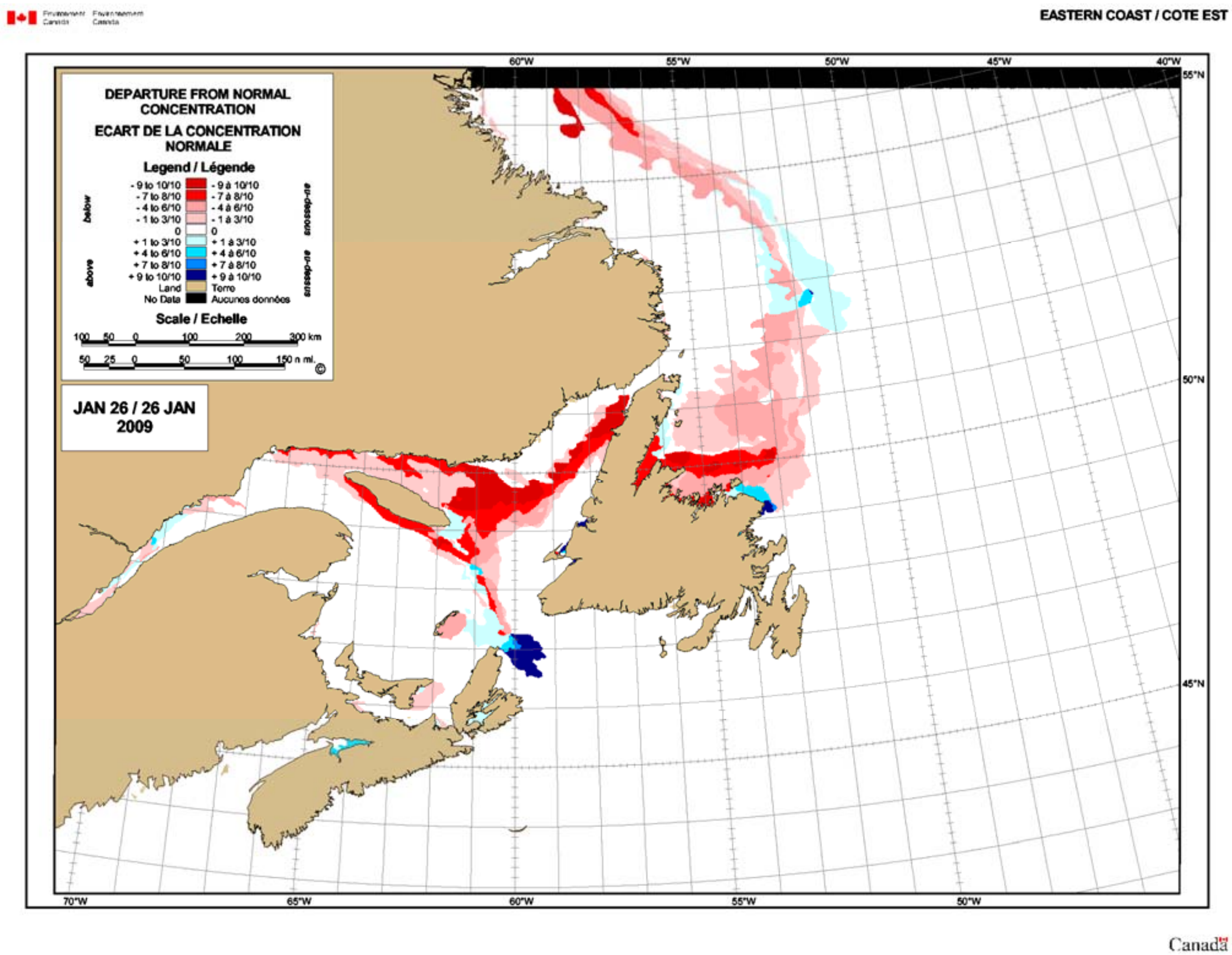

Figure 14. Departure of sea ice from normal on 26 Jan 2009. Map Courtesy of the Canadian Ice Service.

January was an extraordinarily stormy month in the North Atlantic Ocean, with 12 storms with winds that reached hurricane force (Bancroft, 2009). Most of the storms originating near the U. S. and Canadian east coasts in January 2009 moved generally from southwest to northeast, which carried the storms into the central Atlantic south of Greenland. The exception was an early January (2-5 January) storm that moved north of Newfoundland and lingered off the central Labrador coast for three days bringing storm-force onshore winds that compressed the ice along the Labrador coast. The impact of this storm appears to have been short lived, as by month's end, the offshore extent of the sea ice along the Labrador coast returned to normal. On 28 January, an iceberg reconnaissance flight conducted by Provincial Aerospace Ltd. (PAL) under CIS sponsorship, found 34 icebergs within the sea ice off the central Labrador coast. The areas east of the sea ice edge were not searched.

In January 2009, no icebergs passed south of 48°N. The 1900-2008 mean for the month is three.

February 2009

Throughout February warmer-than-normal conditions dominated Labrador and Newfoundland. The average temperature anomaly for the month ranged from +2.9°C in St. John's to +4.3°C in Cartwright.

Stormy and warmer-than-normal air temperatures slowed the progress of the southern ice edge in early February. By 12 February the southern ice edge was at the latitude of Cape Bonavista, about 30 NM north of its normal position, while the eastern limit was about 30 NM farther east of Cape Bonavista than normal.

During the second half of the month, the southern ice edge wavered between Cape Bonavista and Baccalieu Island, about 50 NM north of its normal position. Meanwhile, the eastern ice edge was significantly compressed by strong onshore winds during the passage of two strong storms, one on 15 February and the other on 19 February.

IIP's preseason ice reconnaissance detachment (IRD) deployed to Newfoundland on 6 –12 February. Two preseason IRD flights and several by PAL located a large population of icebergs and radar targets south of 52°N (**Figure 15**), most within the sea ice. It was becoming clear that 2009 would be an active iceberg season and that IIP would soon begin providing daily warnings to mariners. As a result, IIP deployed its first regular-season IRD on 20 February.

During the month, no icebergs passed south of 48°N. The 1900-2008 mean for February is 14.

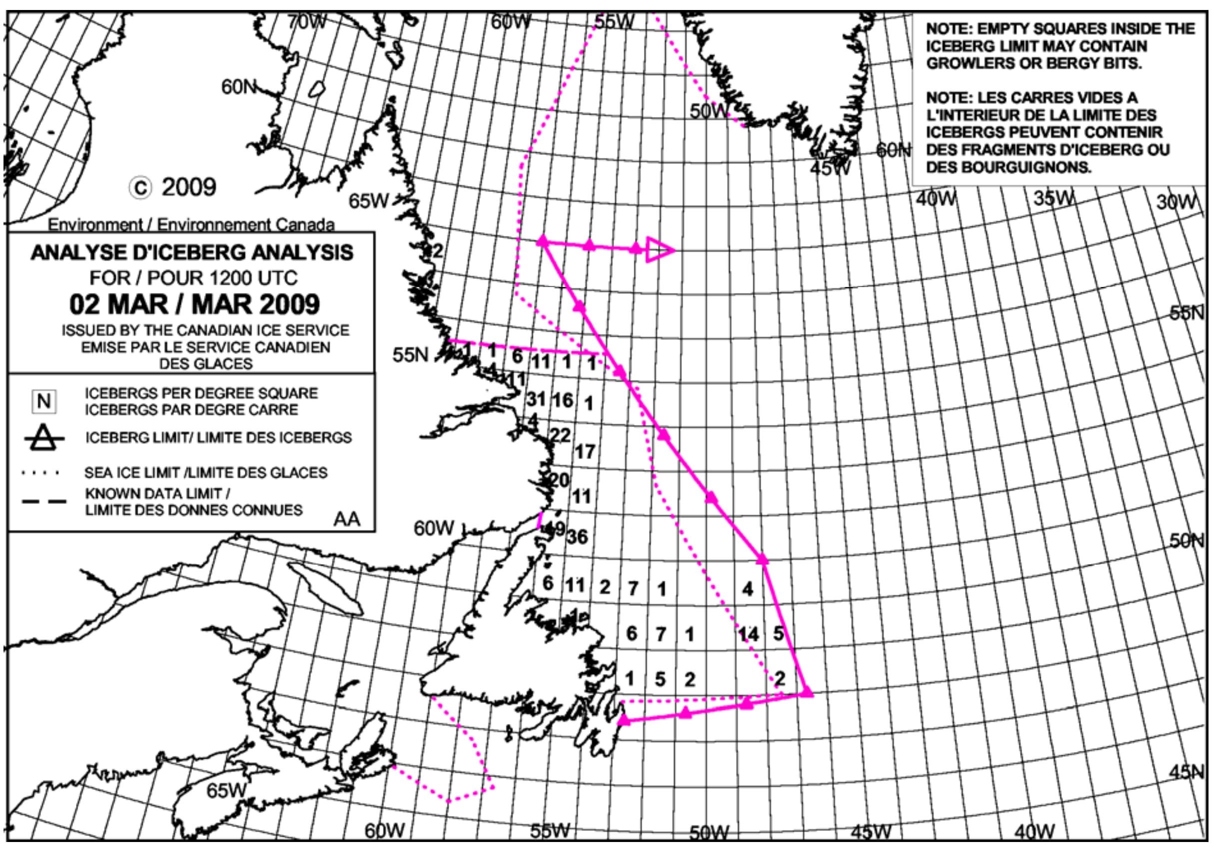

Figure 15. Iceberg distribution on 2 March 2009. The numbers indicate the number of icebergs and radar targets within a 1° of latitude by 1° of longitude bin. Chart Courtesy of the Canadian Ice Service.

March 2009

Labrador was colder than normal during March, with Goose Bay and Nain reporting monthly mean air temperatures 1.9°C and 2.4°C below normal, respectively. Newfoundland observed near-normal temperatures during the month.

For the first 10 days of March, the southern ice edge remained north of 48°N, which is about 60 NM north of its normal position. The eastern ice edge was about 170 NM east of Cape Bonavista, near its normal position. Over the following two weeks, the ice edge moved over 200 NM to the southeast **(Figure 16)** reaching its maximum southward position for the year, 45°-10'N, on 24 March.

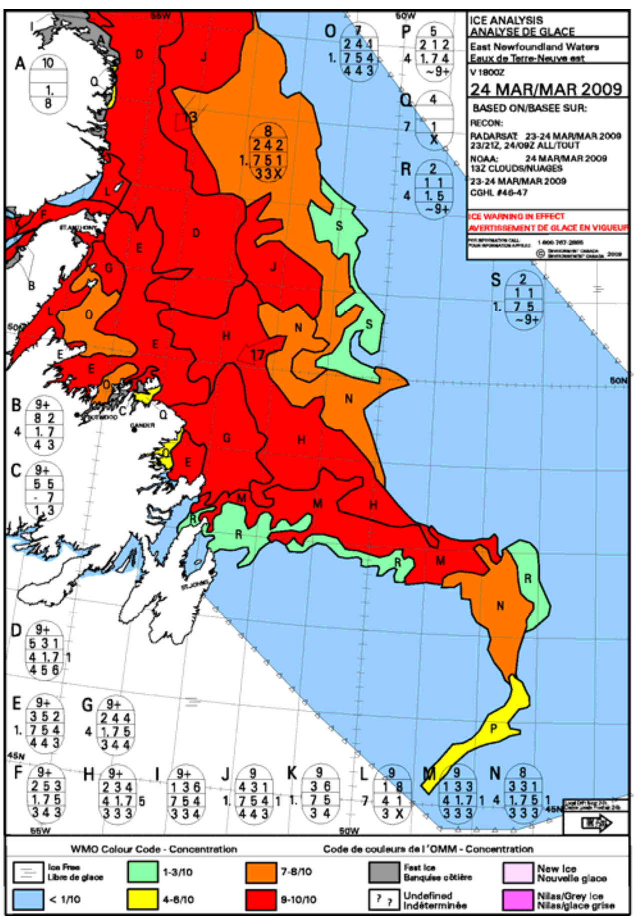

Figure 16. Sea ice concentration on 24 Mar 2009. Chart courtesy of the Canadian Ice Service.

The early March meteorological conditions favored the southeastward movement (red arrow on **Figure 17**) of the ice edge over the period 9 – 19 March. The ice was also being driven southward by the offshore branch of the Labrador Current. The heavy ice conditions forced the suspension of operations on the GSF GRAND BANKS, a semi-submersible drill rig, which was conducting exploratory drilling a short distance from the advancing ice. The platform was towed to safety.

The southern sea ice edge remained near its southernmost position for the year until month's end, after which it began to retreat.

Early in the month of March, a series of reconnaissance flights by IIP and PAL (under CIS and oil-company sponsorship) documented a large population of icebergs immediately north of 48°N. Shortly thereafter, PAL began conducting nearly daily reconnaissance in the

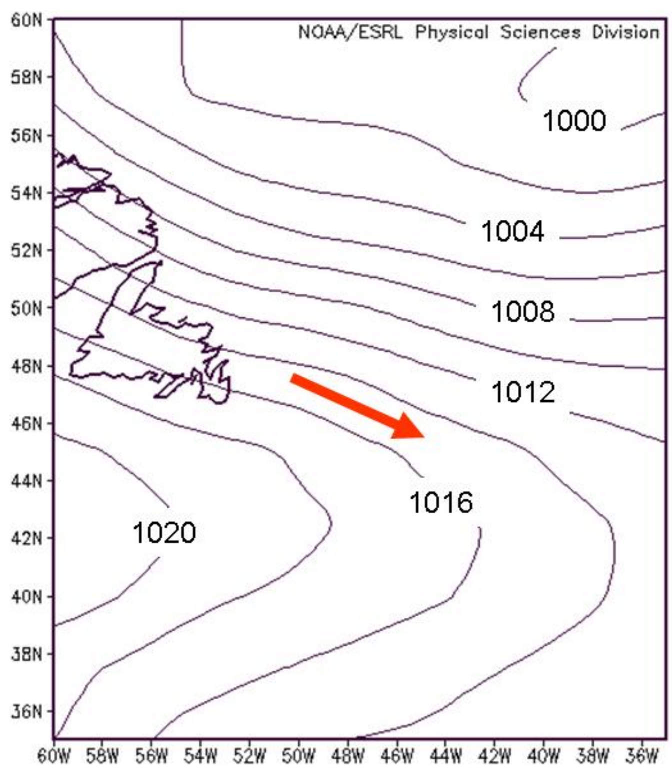

Figure 17. Mean sea-level pressure for 9 March to 19 March 2009. Plot courtesy of NOAA Earth System Research Laboratory, Physical Sciences Division.

vicinity of the oil platforms on the northeastern Grand Banks. By mid-month, many icebergs had advanced south of 48°N and had become a significant threat to the safety of transatlantic mariners. Consequently, IIP began providing daily iceberg warnings on 16 March, about a week later than the pre-season forecast.

On 31 March, the southern LAKI was at the median, and the eastern LAKI was at the 25th percentile. During the month, 286 icebergs passed south of 48°N, nearly five times the mean of 59.

April 2009

Air temperatures in northern Newfoundland and southern Labrador were near normal for the month, while St. John's was 2.2°C warmer than normal.

During the first week of April, the southern ice edge retreated rapidly northward to the latitude of St. John's, where it remained until mid-month. On 16 April, it was about 60 – 90 NM south of its usual position. During the second half of April, there was a brief re-advance of the southern ice edge, during which it again extended into Flemish Pass. All the while there was a broad shore lead from St. John's to Fogo Island. At month's end there was still significant sea ice south of Cape Freels, the southern edge extending south of 48°N, 300 NM southeast of its normal location.

Throughout April, the IIP Operations Center received numerous reports of icebergs in the shipping lanes. Nearly daily PAL reconnaissance flights, conducted in support of oil-field operations, documented the large iceberg population west of Flemish Pass between 46°N and 49°N. IIP reconnaissance flights focused on the eastern and southern LAKI. In addition, Canadian Coast Guard icebreakers and merchant ships observed many icebergs near the Grand Banks.

In early April, a warm core eddy formed from a meander of the North Atlantic Current and moved into the southern end of Flemish Pass, where it remained until early May. Its clockwise circulation had a significant impact on the flow of the offshore branch of the Labrador Current, and thus the distribution of icebergs for more than a month. **Figure 18**, a sea surface temperature image from 19 April, shows cold (<3°C) Labrador Current waters moving eastward immediately north of the eddy. This eastward flow was confirmed by the drift (**Figure 19**) of an IIP drifting buoy, with the drogue centered at 50 m. The drifter was deployed in Flemish Pass on 15 April by Canadian Coast Guard Ship (CCGS) Cygnus.

From IIP iceberg reconnaissance flights and several ship reports, it was evident that the flow north of the eddy was drawing icebergs out of the southward-moving Labrador Current and moving them eastward along 46°N, just to the south of Flemish Cap. At mid-month, the southern and eastern LAKI were at 42°N and 41°W, respectively, which puts both near the 25th percentile. During the second half of April, the southern LAKI retreated to 44°-15'N, which is less than the median. It is likely that the retreat of the southern LAKI is the result of icebergs being removed from the offshore branch of the Labrador Current before they reached the Tail of the Bank. The eastern LAKI expanded significantly eastward during the second half of April. By 30 April, it was east of 40°W, which is near the extreme position for the date. Again, this is a likely result of the ocean circulation pattern during April.

An estimated 266 icebergs passed south of 48°N in April. This number, although far above the 1900-2008 mean of 124, is well short of the record for the month. In 1984, the season with the most icebergs on record, IIP estimated that 953 icebergs passed south of 48°N in April.

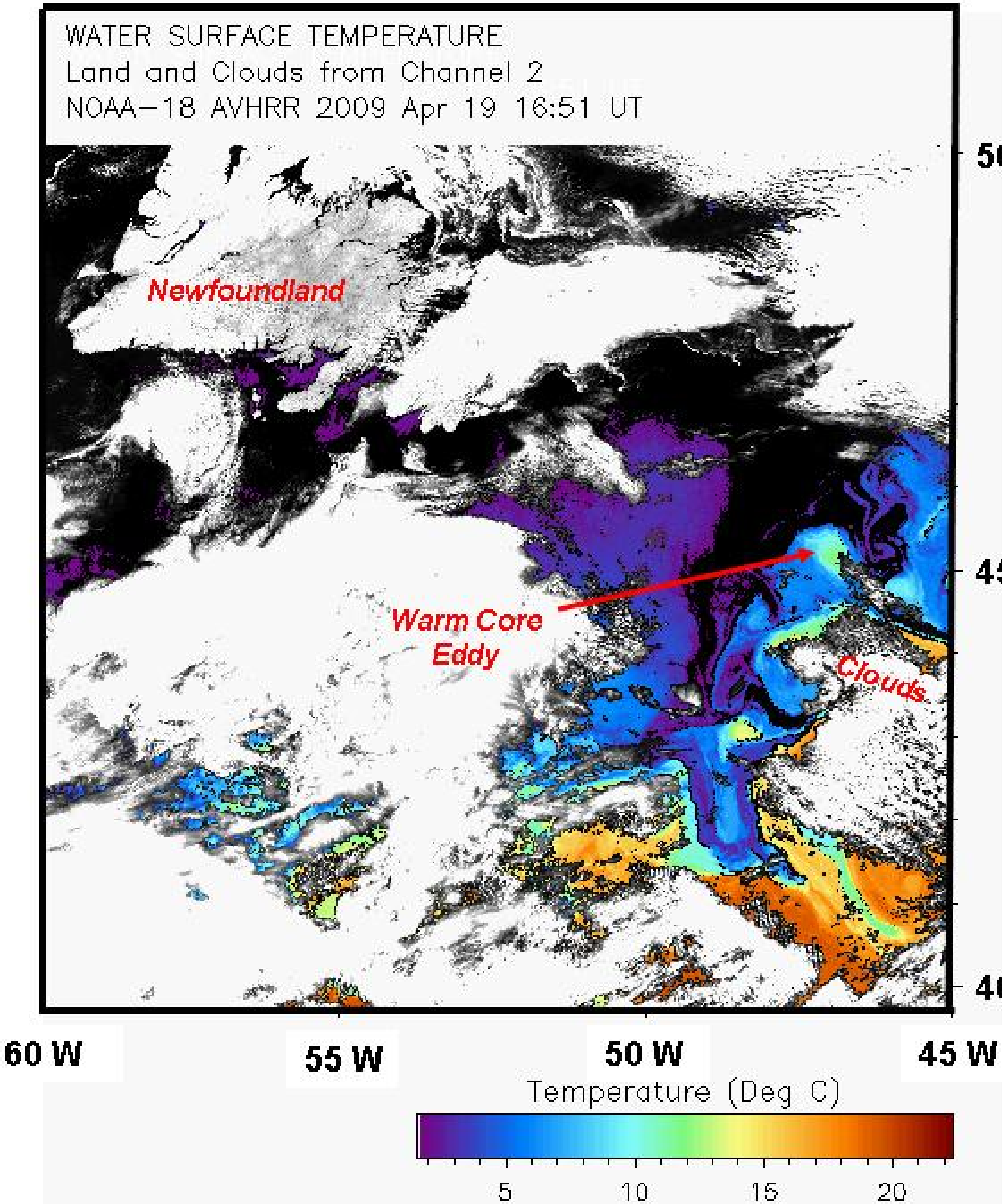

Figure 18. Advanced Very High Resolution Radiometer image of the Grand Banks on 19 April 2009 showing a warm core eddy at approximately 45°N, 47°W. Image provided by the Ocean Remote Sensing Group, Johns Hopkins University Applied Physics Laboratory.

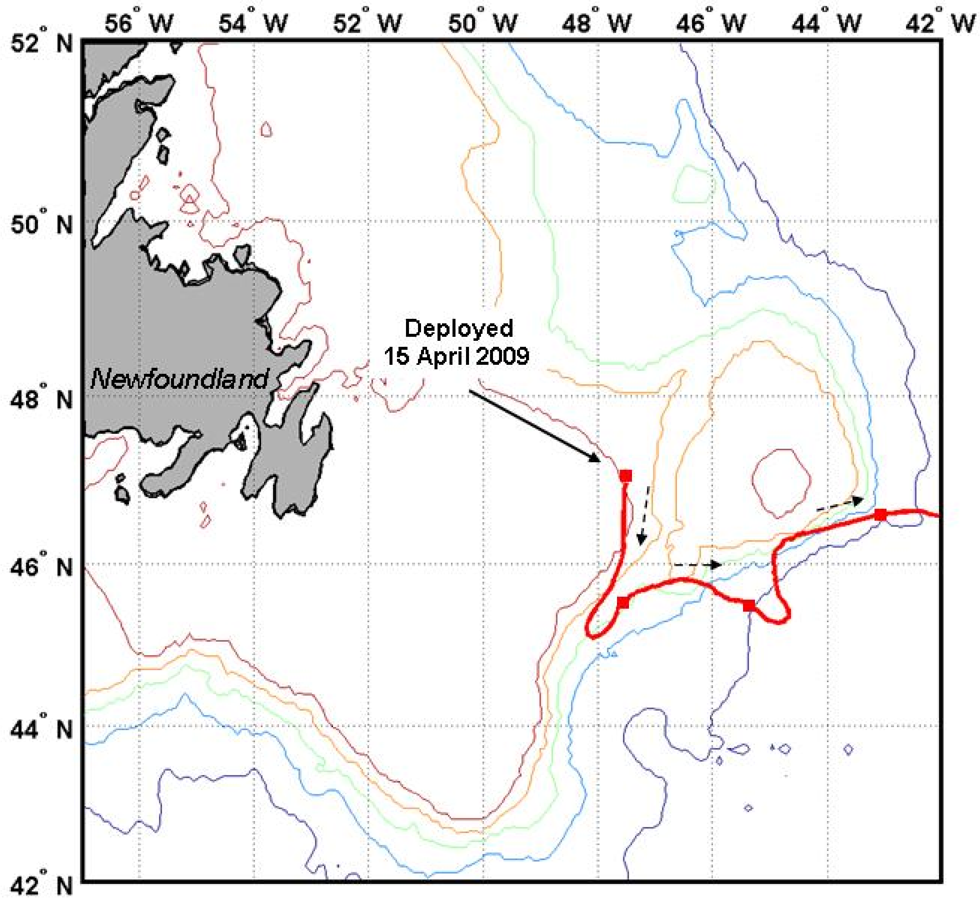

Figure 19. Trajectory of IIP drifting buoy 90635 (drogue centered at 50 m) deployed in Flemish Pass on 15 April 2009 by CCGS Cygnus. Squares mark the drifter positions at 10-day intervals.

May 2009

Southern Labrador experienced near-normal air temperatures in May, while eastern Newfoundland was warmer than normal. St. Anthony and St. John's recorded 1.3°C and 2.4°C, respectively, above-normal temperatures for the month.

In May, the warming ocean began taking a toll on sea ice concentration in east Newfoundland waters, although the southern and eastern extent remained far greater than normal. The southern ice edge lingered near 48°N throughout the first half of the month, while the eastern ice edge remained in the northern reaches of Flemish Pass. At mid-month, the retreat was more than three weeks behind normal. During the second half of May, ice destruction accelerated. By month's end, the southern ice edge had retreated to 50°N, although the ice concentration south of 52°N was generally less than 3/10. The greatly reduced ice concentrations in the Strait of Belle Isle allowed the CCG to recommend the use of the Strait for transatlantic crossings on 27 May.

A series of CIS-sponsored PAL flights on 11 and 12 May found over 500 icebergs between 49°N and 56°N, most within the sea ice. It was clear from the survey flights that the coming disappearance of sea ice would leave behind a large iceberg population that would remain a threat to safe navigation for some time to come.

In mid-month, the southern LAKI was near 42°N, which is about the 25th percentile, and the eastern LAKI was east of 40°W, which is close to the extreme for the date. During the second half of May, the southern and eastern LAKI retreated about 90 NM as the warming sea temperature increased the rate of iceberg destruction. This left the southern LAKI north of its median position and the eastern LAKI near the median at month's end. At the end of May, IIP was tracking over 300 icebergs, growlers, and radar targets south of 48°N.

In May, 450 icebergs passed south of 48°N, far greater than the 1900-2008 mean of 147.

June 2009

In June, warmer-than-normal conditions prevailed in Newfoundland and southern Labrador. The monthly mean air temperature in Cartwright was 1.9°C above normal, while St. John's was 1.2°C above.

Early in the month, the southern ice edge continued a slow northward retreat that was two to three weeks behind the normal pace. By mid-month, the southern edge was 30 NM north of the eastern entrance to Strait of Belle Isle. The pace of the retreat increased in the second half of June. By month's end, about one week later than normal, the southern ice edge moved north of Hamilton Inlet.

There was a large and widely distributed iceberg population in the shipping lanes in early June. By mid-month, IIP was tracking 262 icebergs, growlers, and radar targets south of 48°N. The southern LAKI was at the 25^{th} percentile while the eastern LAKI was at 39°-15'W, near the extreme for the date. There was also a large iceberg population between 48°N and 52°N, the area that had recently become free of sea ice. With the sea ice gone from east Newfoundland waters and the seasonal warming of ocean waters taking hold, the second half of June saw a dramatic reduction in the number of icebergs. On 30 June, IIP was tracking 86 icebergs, growlers, and radar targets south of 48°N. Despite the small number of icebergs, the southern and eastern LAKI were at the median and extreme positions, respectively. The eastern LAKI on 30 June was being defined by a single iceberg that was estimated to have melted the following day, bringing the eastern LAKI westward five degrees of longitude, about 200 NM.

In June, Ice Patrol estimated that 180 icebergs passed south of 48°N, over twice the 1900-2008 mean of 85.

July 2009

Rapidly warming ocean temperatures (**Figure 20**) hastened sea ice destruction along the Labrador coast in early July. By mid-month, about a week ahead of normal, the last significant concentration of sea ice left the Labrador coast, exposing the large upstream iceberg population along the coast to increased deterioration.

Meanwhile, farther south, much warmer-than-normal sea temperatures in east Newfoundland waters fueled a steady decline in the number of icebergs. In mid-July, IIP was tracking 10 icebergs, growlers and radar targets south of 48°N. The southern LAKI was at 45°-15'N and the eastern LAKI 45°W, both near the median for the date.

Ice Patrol's last 2009 Ice Reconnaissance Detachment returned from Newfoundland on 27 July after verifying that the iceberg population had been reduced to a small number of icebergs that would soon melt. Ice Patrol broadcast its last daily iceberg warning to mariners on 28 July.

Twenty-one icebergs passed south of 48°N in July, the 1900-2008 mean for the month is 30.

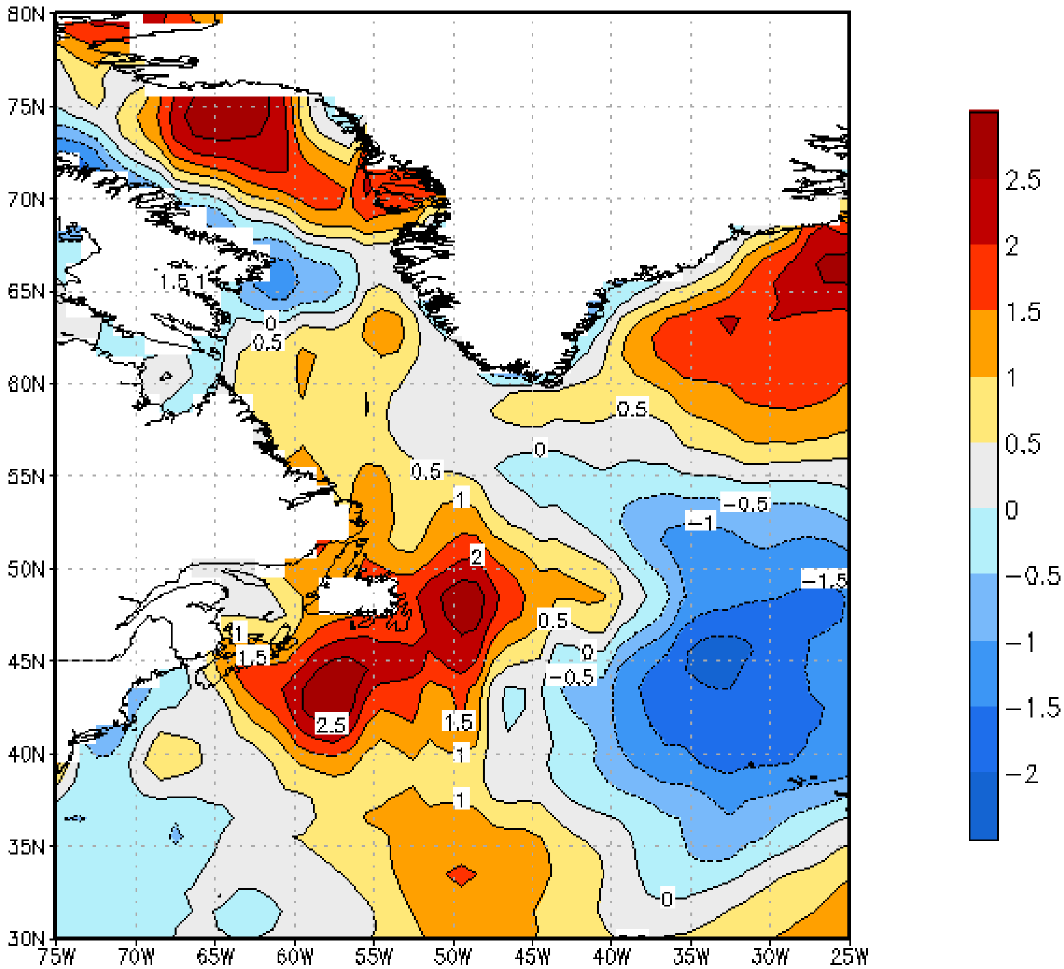

Figure 20. Mean sea surface temperature anomaly for July 2009 in degrees C. Plot courtesy of NOAA/NWS (2009a).

Discussion

Classifying the severity of the 2009 iceberg season using the traditional measures of the number of icebergs estimated to have passed south of 48°N and season length in days gives mixed results. According solely to the iceberg count, 2009 falls well into the extreme category (> 600 icebergs), but the 135-day season length (defined as the number of days IIP provided daily iceberg warnings to mariners) places it toward the middle of the average severity class (105-180 days).

The most balanced measure of the severity of an iceberg season is the season severity index (SSI) proposed by Futch and Murphy (2003). It takes into account three major severity indicators: number of icebergs estimated to have passed south of 48°N, length of season, and average area enclosed by LAKI. All three indicators, which are weighted equally, are normalized to the mean over the period 1983 - 2009. Finally, the normalized contributions of each are summed. From the perspective of the mariner, the SSI is more useful than simply using the number of icebergs that entered the shipping lanes during the season. In addition to the iceberg count, it takes into account, how long the iceberg danger was present and the areal extent of the iceberg danger.

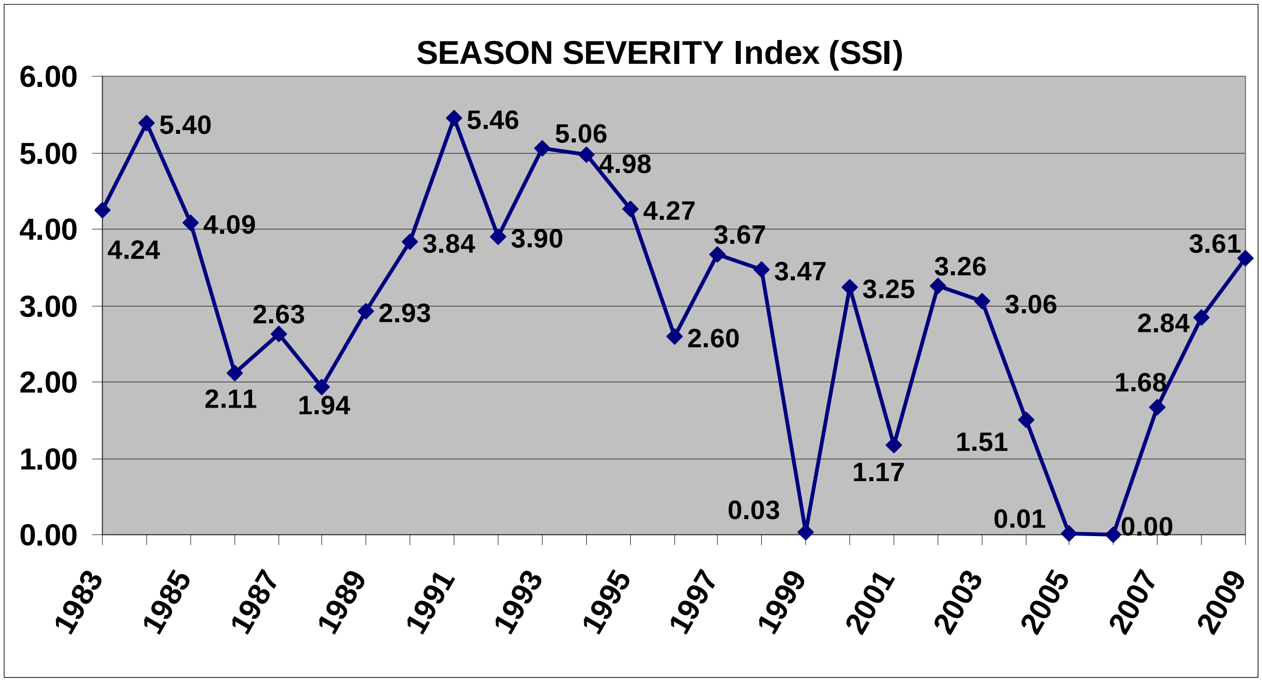

Figure 21. Iceberg season severity index (SSI) for the modern IIP reconnaissance era (1983-2009) based on Futch and Murphy (2003).

The period 1983 – 2009 was selected for this analysis primarily because it is a homogeneous period for IIP's airborne reconnaissance. Over the period, IIP relied on airborne radar reconnaissance, which allows patrols to be conducted over a wider range of weather conditions than the previous airborne visual patrols or the ship-board reconnaissance that preceded it.

Although there are too few data in the 27-year record for a detailed statistical analysis, the SSI values in **Figure 21** seem to fall into three simple bins: 0 - 2 (7 years), 2 – 4 (13 years), and 4 – 6 (7 years). The severe iceberg seasons in the mid-1980s and mid-1990s are clearly shown, as are recent light iceberg seasons. The 3.61 SSI for the 2009 season suggests that, overall, the season was on the upper end of the moderate scale rather than extreme.

Understanding the conditions that lead a large number of icebergs entering the shipping lanes presents its own set of complexities. The winter 2009 (December 2008 through March 2009) North Atlantic Oscillation (NAO) Index was -0.40 (Hurrell, 2009). This value is calculated using the difference in normalized sea-level atmospheric pressure between Lisbon, Portugal and Stykkisholmur/Reykjavik, Iceland.

The NAO, the dominant pattern of winter atmospheric variability in the North Atlantic, fluctuates between positive and negative phases. The positive phase is associated with meteorological conditions that favor the movement of icebergs into the shipping lanes. These include strong and persistent northwest winds along the Labrador coast, which bring colder-than-normal air temperatures and greater-than-normal sea-ice extent off Labrador and Newfoundland. In addition, the persistent northwest winds promote southward iceberg movement. Warmer-than-normal conditions and less extensive sea ice off the Labrador coast are associated with the negative NAO phase. The -0.40 NAO Index in 2009 suggests neutral conditions that neither favor the movement of icebergs to the Grand Banks nor inhibit them.

The mean sea level pressure for the 1 December 2008 – 31 March 2009 period

(**Figure 22**) appears to favor the movement of icebergs southward along the Labrador coast early in the iceberg season. On the other hand, the sea ice conditions early in the year (**Figure 23**) did not suggest an unusual number of icebergs would reach the shipping lanes in 2009. Indeed, as forecast by CIS, the sea ice advance was delayed somewhat. By early March, when the sea ice usually reaches its maximum extent on the Grand Banks, there was less sea ice than normal. The meteorological conditions in the following two weeks changed this picture dramatically. Persistent northwest winds advected a large amount of sea ice onto the Grand Banks. By the end of March, the sea ice edge reached 45°N, and the ice coverage was well above normal.

When the sea ice finally began to retreat at the end of March, the pace was much slower than forecast. This undoubtedly contributed to the preservation of icebergs making their way toward the shipping lanes. **Figure 24** shows the estimated number of icebergs entering into the shipping lanes for each month of the 2009 Ice Year. This distribution is consistent with average conditions, with the largest number of icebergs passing into the shipping lanes in May. The 2009 May total was 450, which is three times the average. Even more remarkable is the rapid decline in the number of icebergs in June and July, which is a likely reflection of the warmer than normal ocean temperatures.

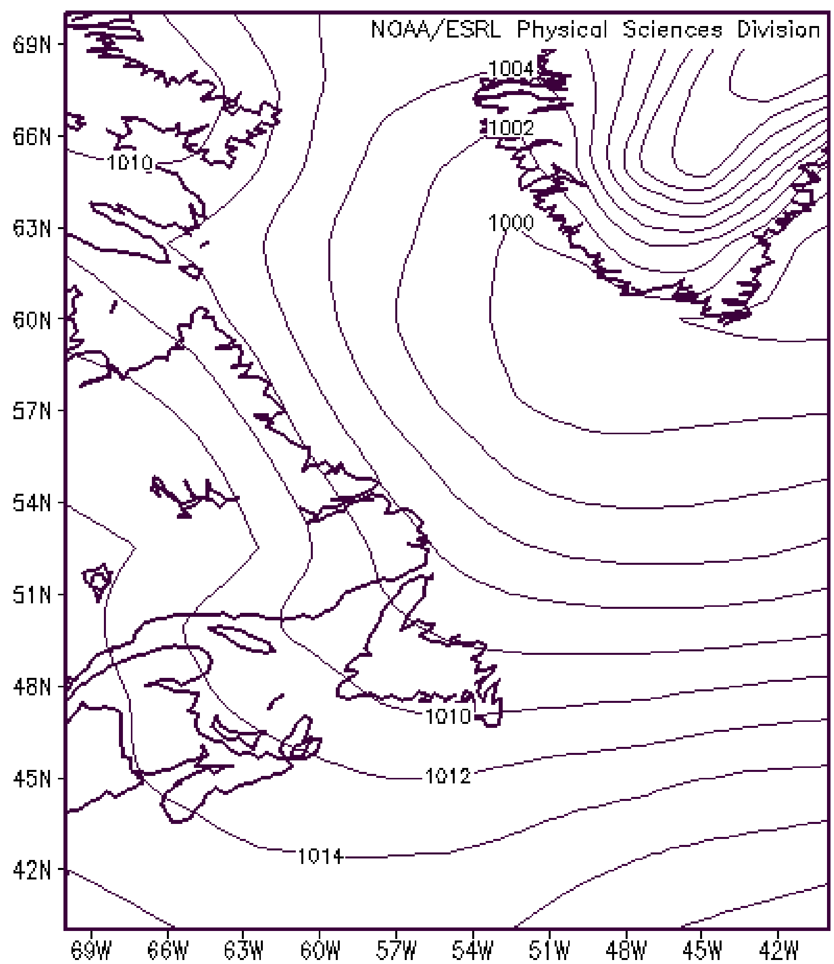

Figure 22. Mean sea-level pressure for 1 December 2008 to 31 March 2009. Plot courtesy of NOAA Earth System Research Laboratory, Physical Sciences Division.

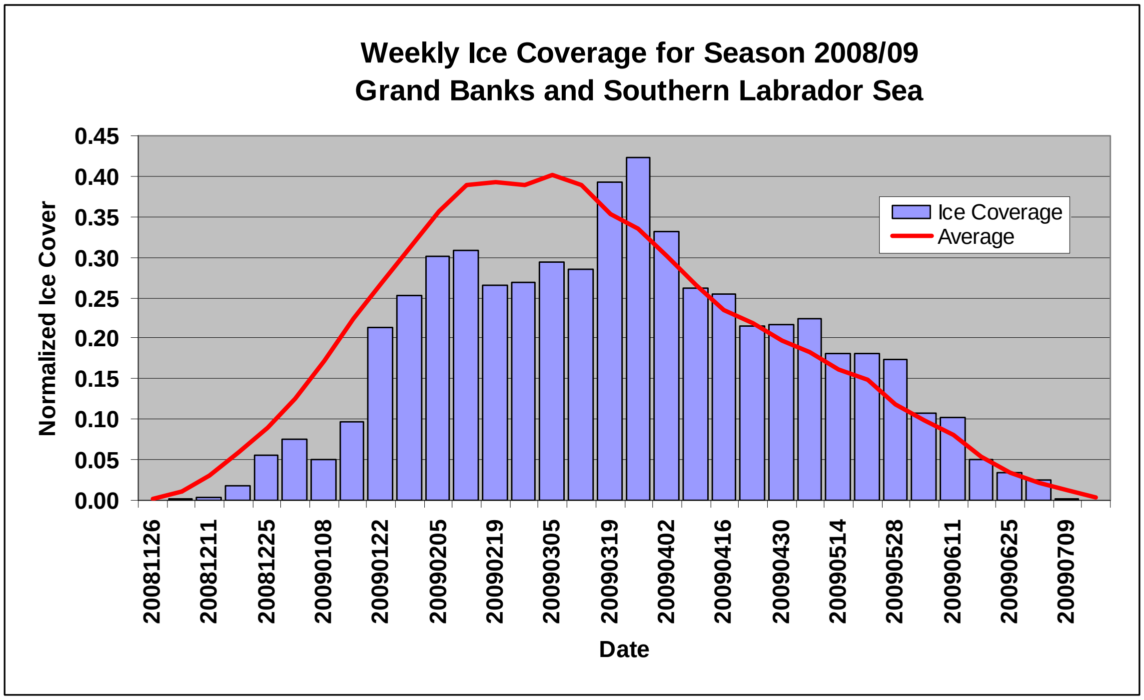

Figure 23. Weekly ice coverage on the Grand Banks and along the Southern Labrador coast for the 2008 - 2009 ice season. The ice coverage is normalized to the total area of the Grand Banks and Southern Labrador coast regions. (CIS, 2009b).

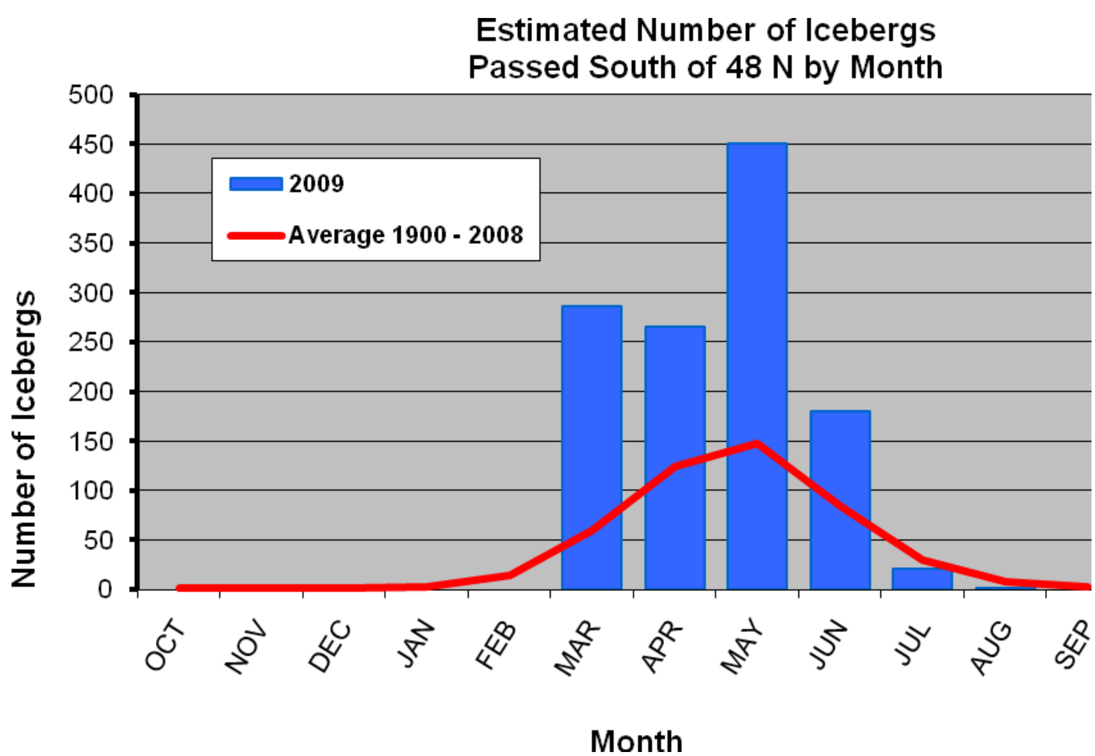

Figure 24. Estimated number of icebergs that passed south of 48°N each month during 2009 Ice Year.

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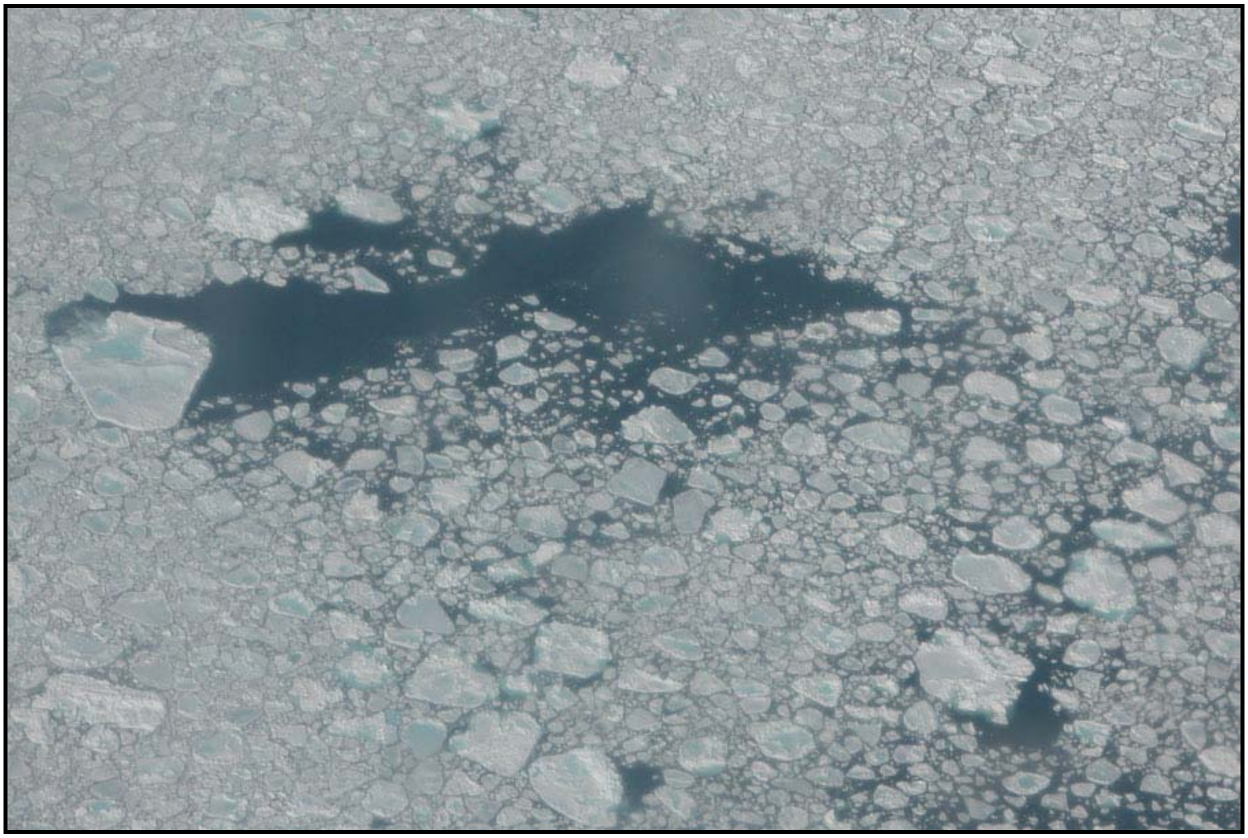
Monthly Sea-Ice Charts



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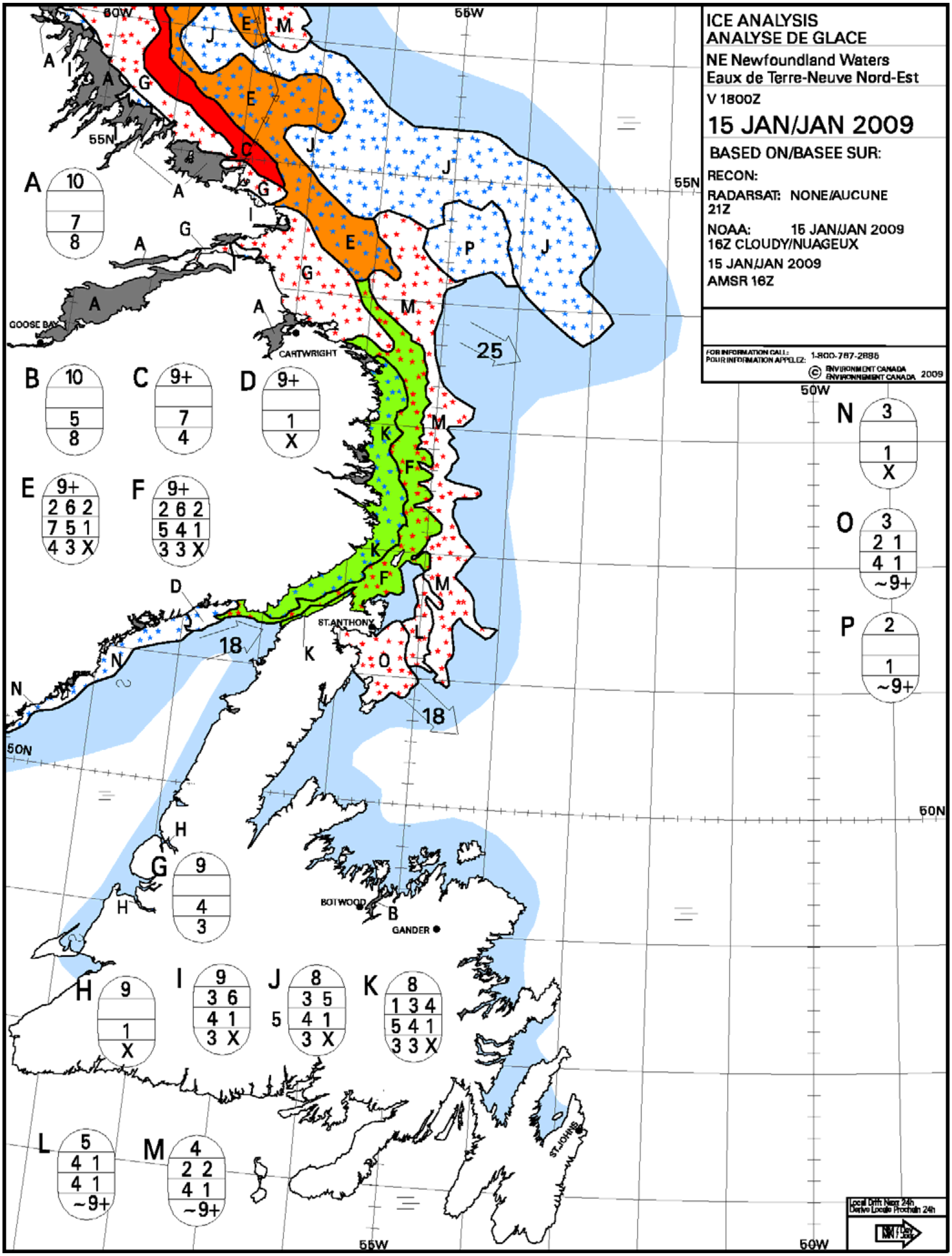
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RECON:
RADARSAT: NONE/AUCUNE
21Z
NOAA: 15 JAN/JAN 2009
16Z CLOUDY/NUAGEUX
15 JAN/JAN 2009
AMSR 16Z
FOR INFORMATION CALL: POUR INFORMATION APPELEZ: 1-800-767-2885
© ENVIRONMENT CANADA ENVIRONNEMENT CANADA 2009
GOOSE BAY
CARTWRIGHT
ST.ANTHONY
BOTWOOD
GANDER
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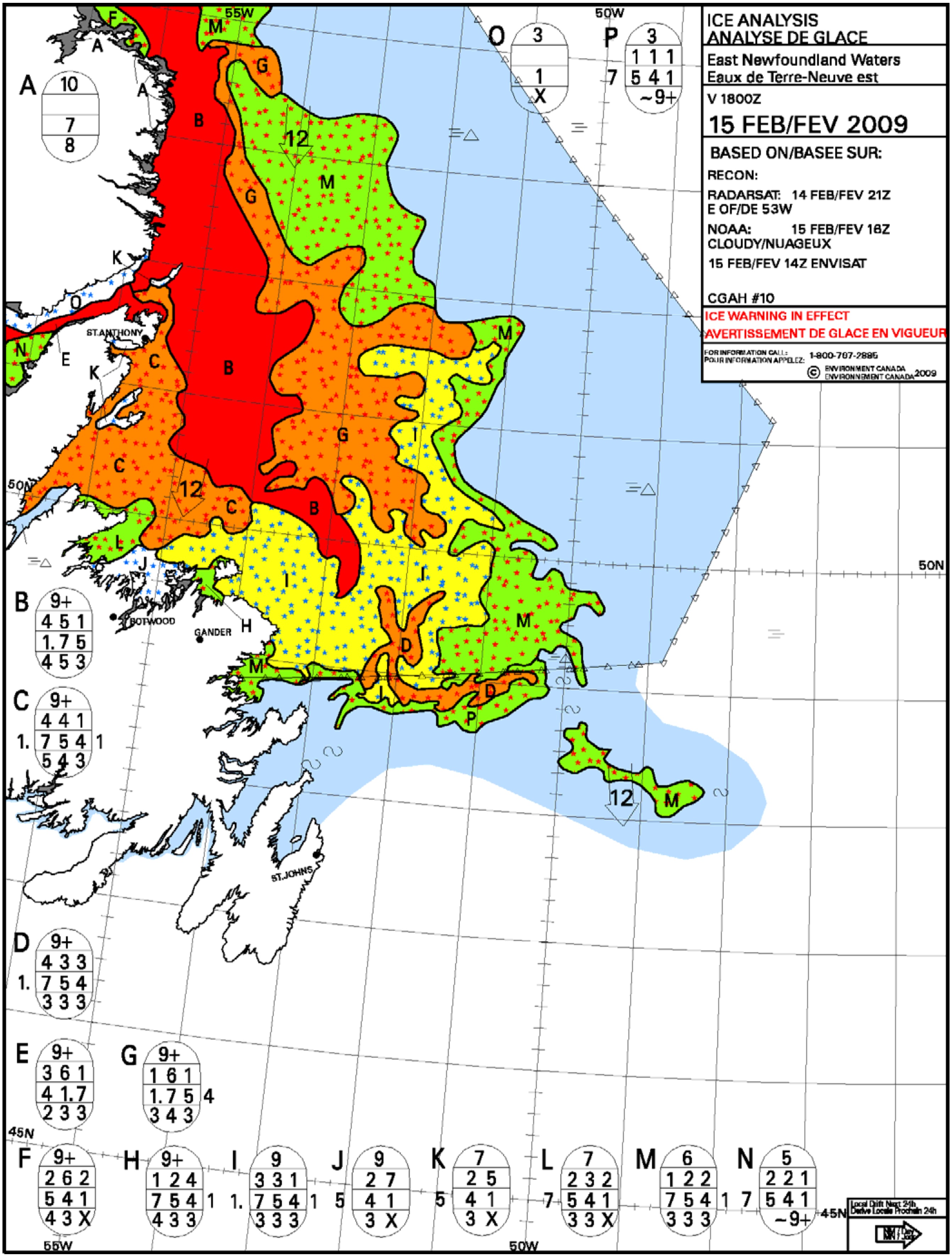
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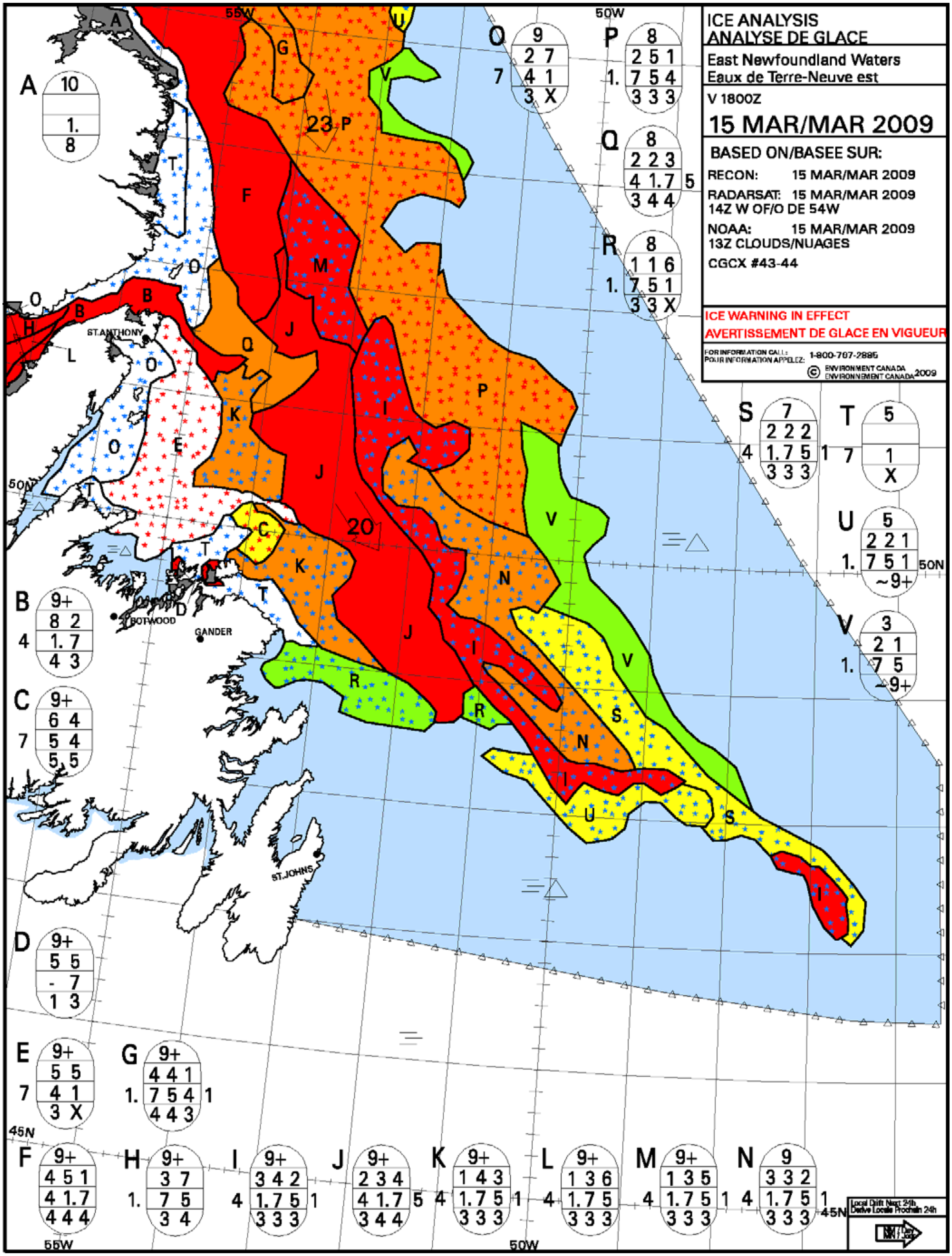
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CGCX #43-44
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ENVIRONNEMENT CANADA 2009
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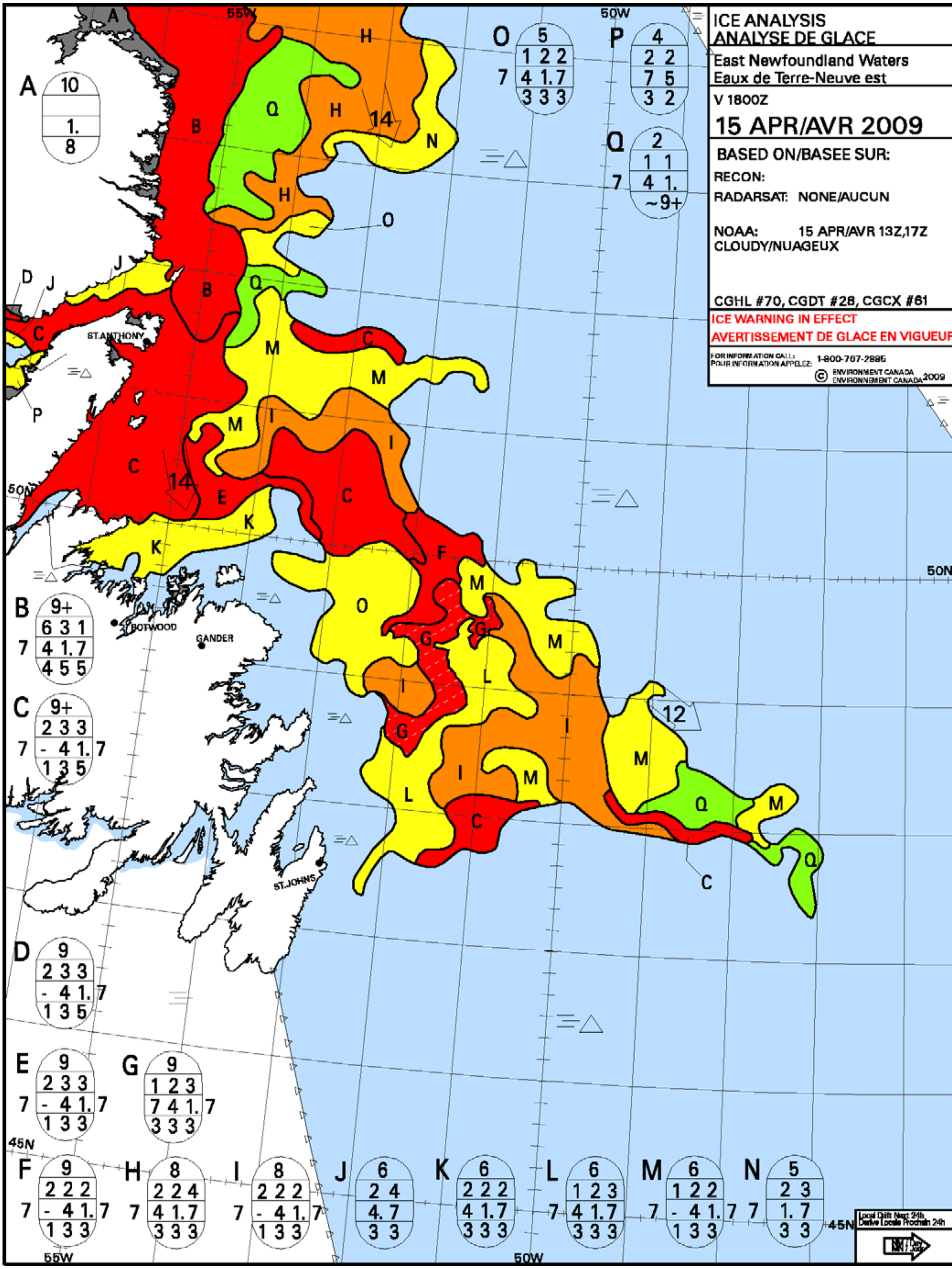

ICE ANALYSIS
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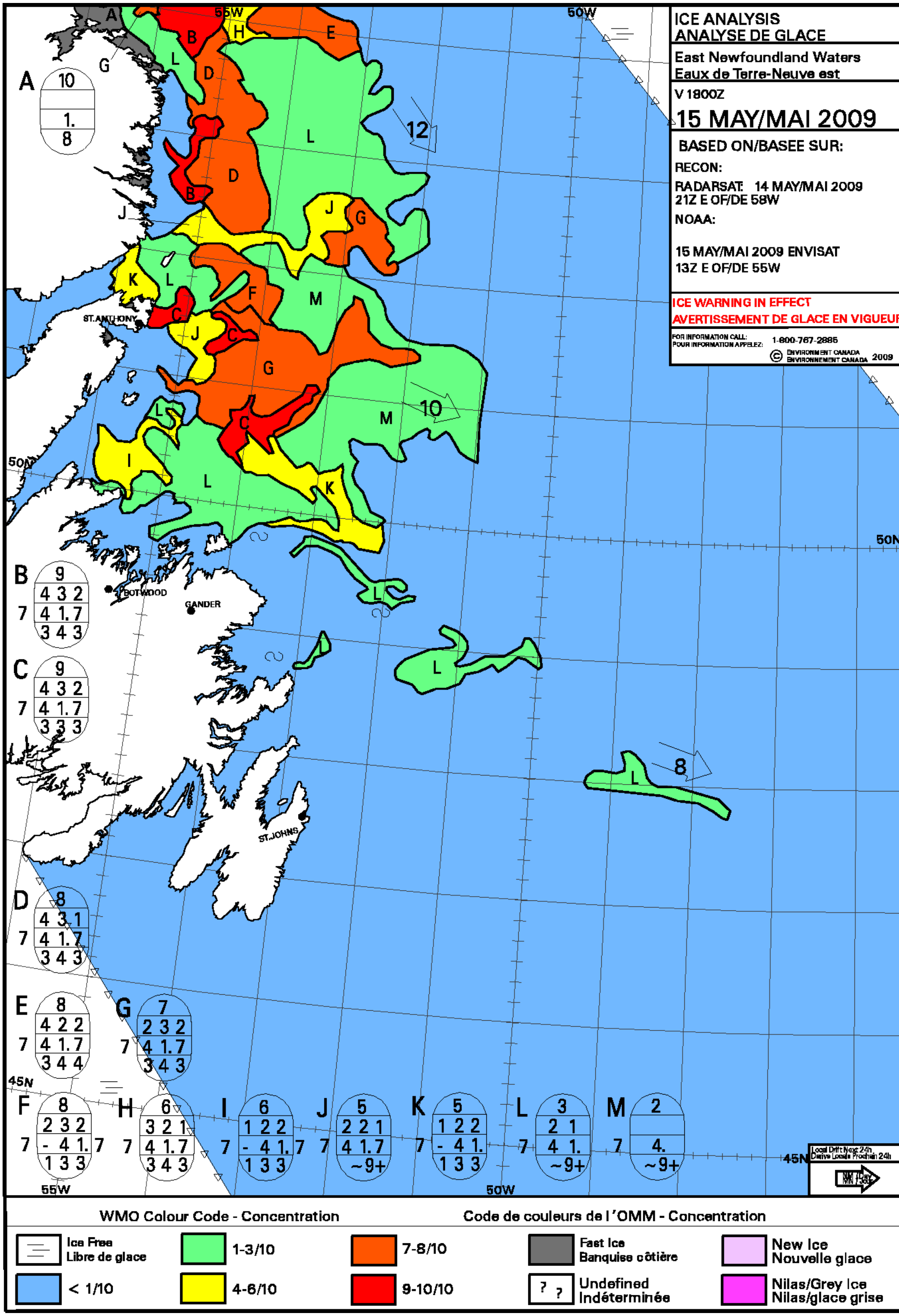
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WMO Colour Code - Concentration
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Libre de glace
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Fast Ice
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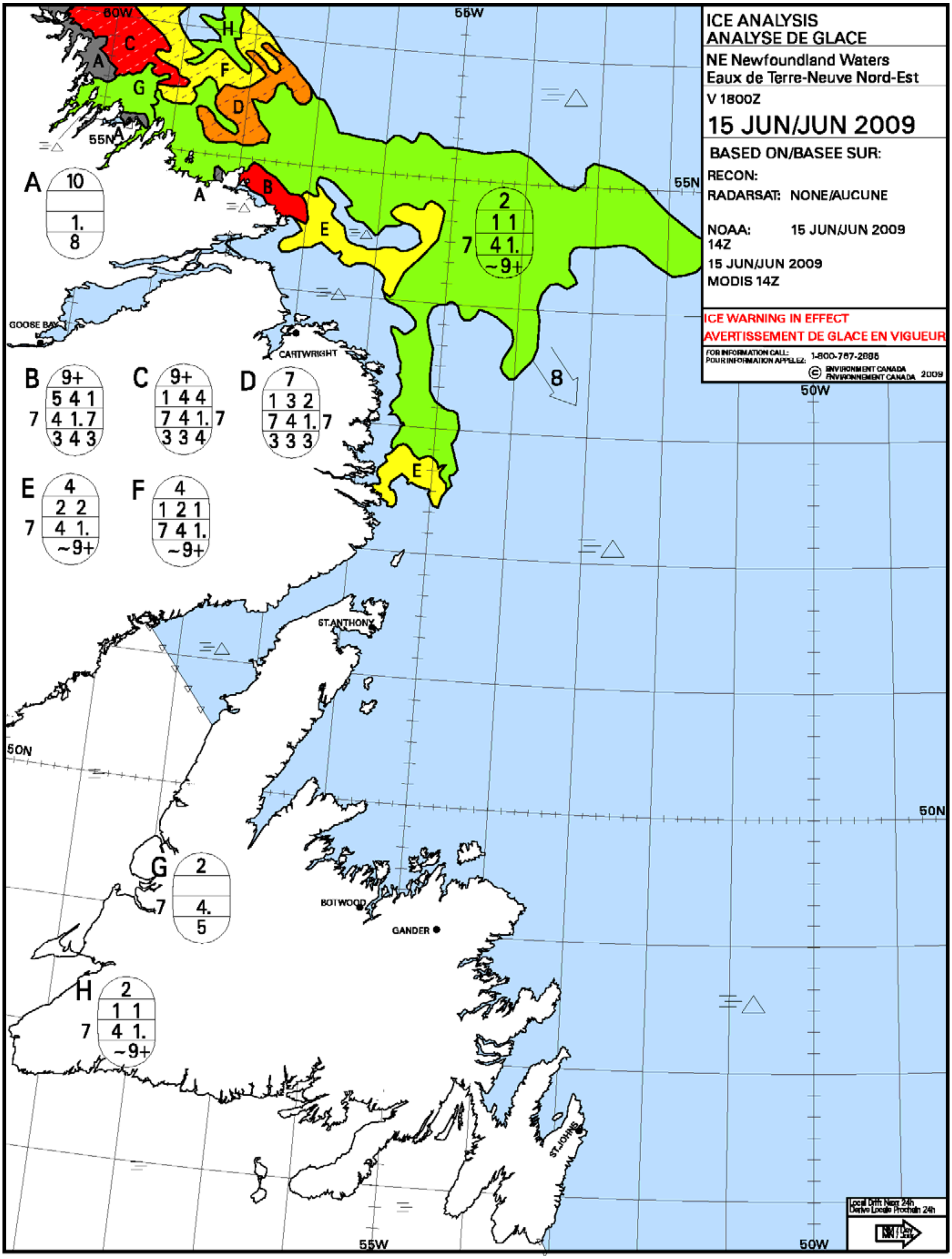
Undefined
Indéterminée
New Ice
Nouvelle glace
Nilas/Grey Ice
Nilas/glace grise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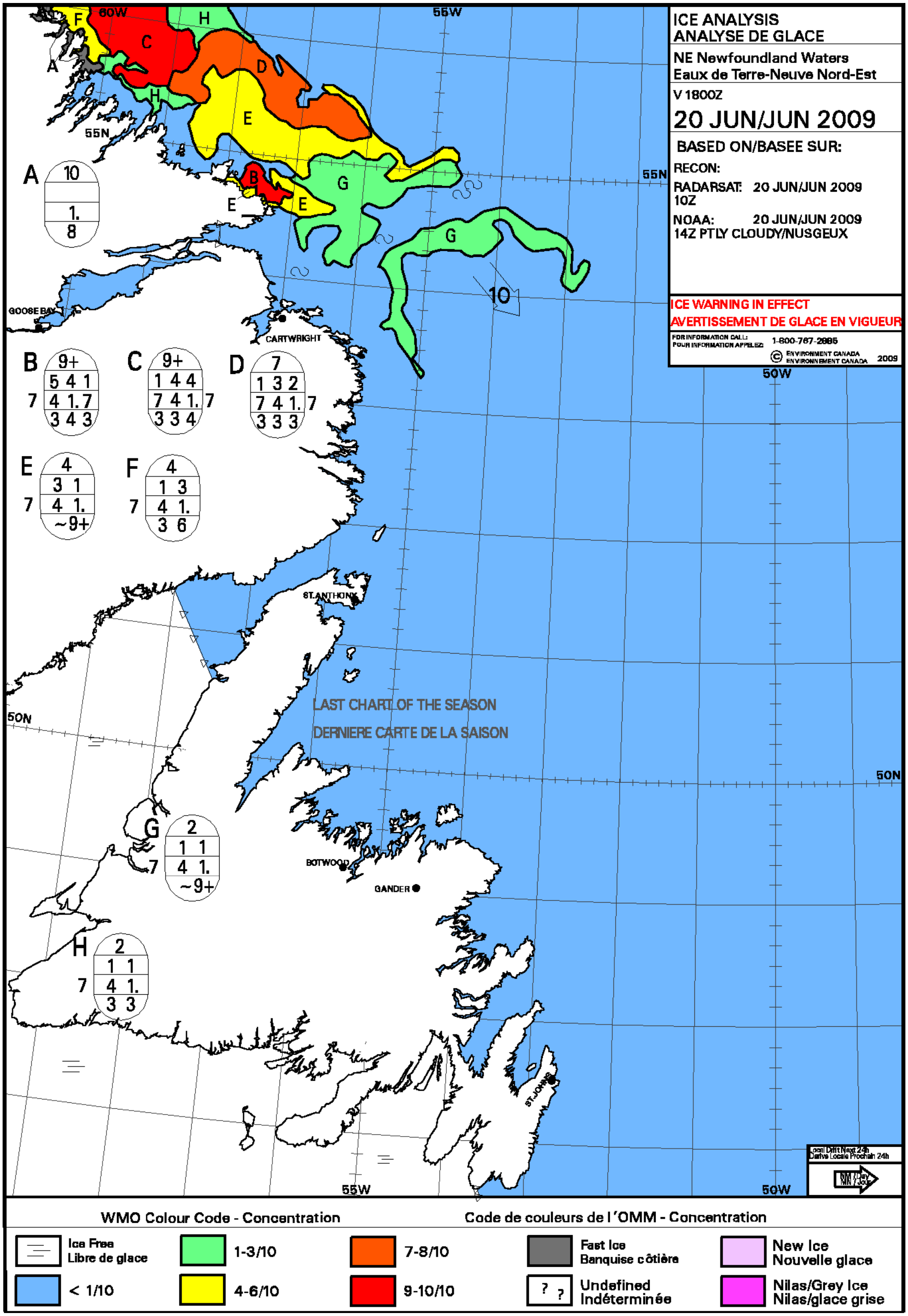
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© ENVIRONMENT CANADA ENVIRONNEMENT CANADA 2009
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BOTWOOD
GANDER
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WMO Colour Code - Concentration
Code de couleurs de l'OMM - Concentration
Ice Free
Libre de glace
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7-8/10
9-10/10
Fast Ice
Banquise côtière
Undefined
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New Ice
Nouvelle glace
Nilas/Grey Ice
Nilas/glace grise

Biweekly Iceberg Charts

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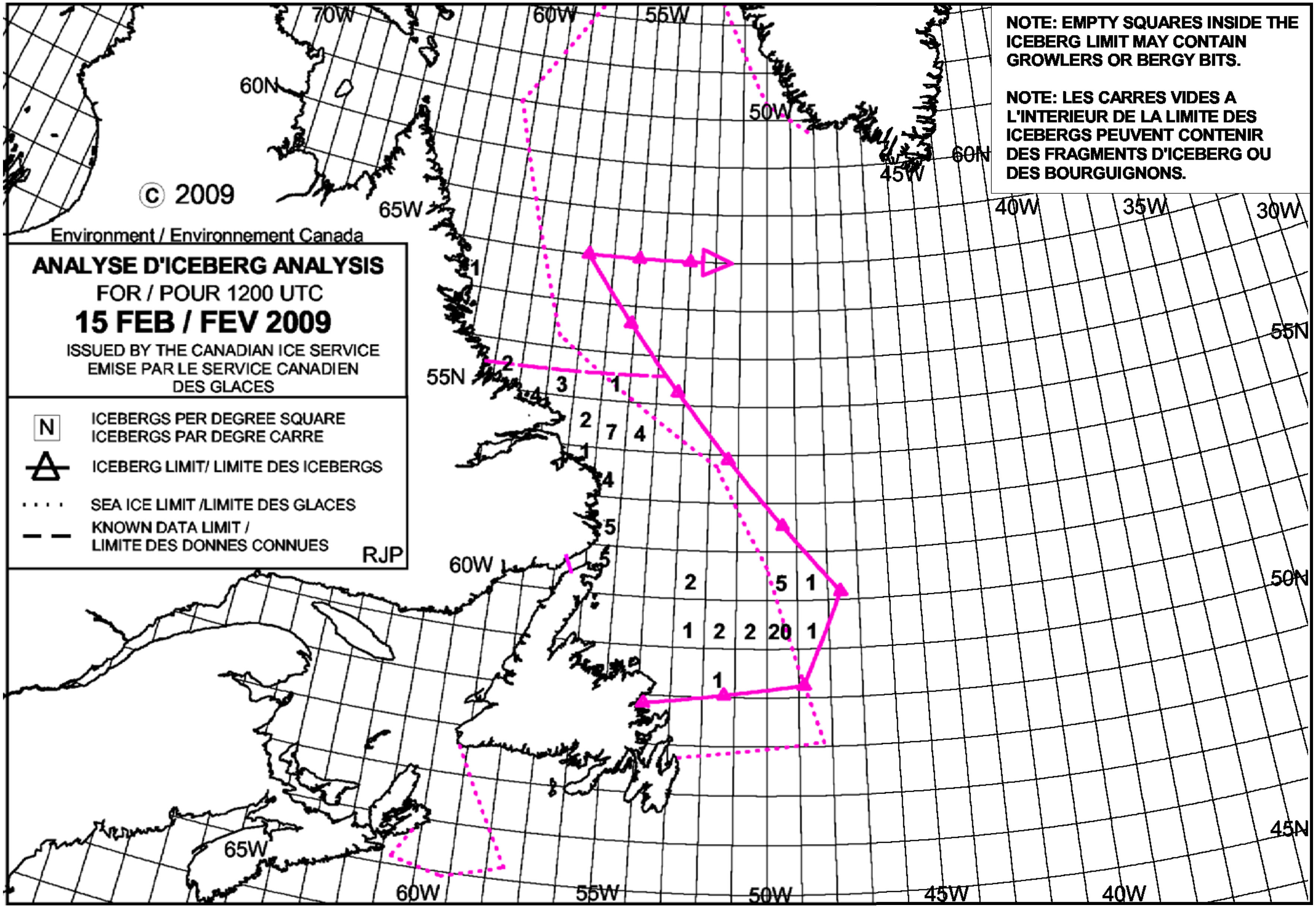
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ANALYSE D'ICEBERG ANALYSIS
FOR / POUR 1200 UTC
15 FEB / FEV 2009
ISSUED BY THE CANADIAN ICE SERVICE
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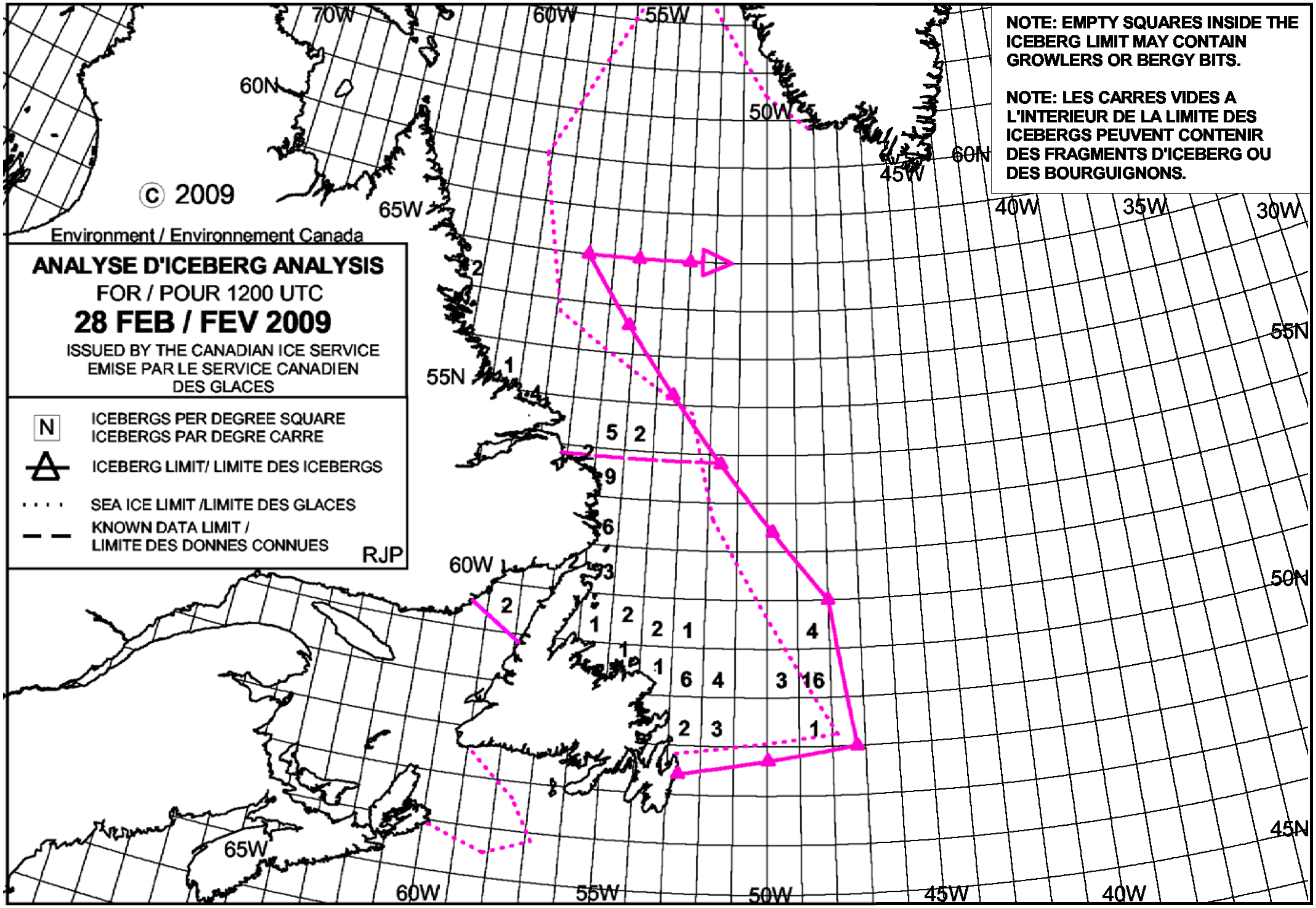

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© 2009
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NOTE: EMPTY SQUARES INSIDE THE ICEBERG LIMIT MAY CONTAIN GROWLERS OR BERGY BITS.
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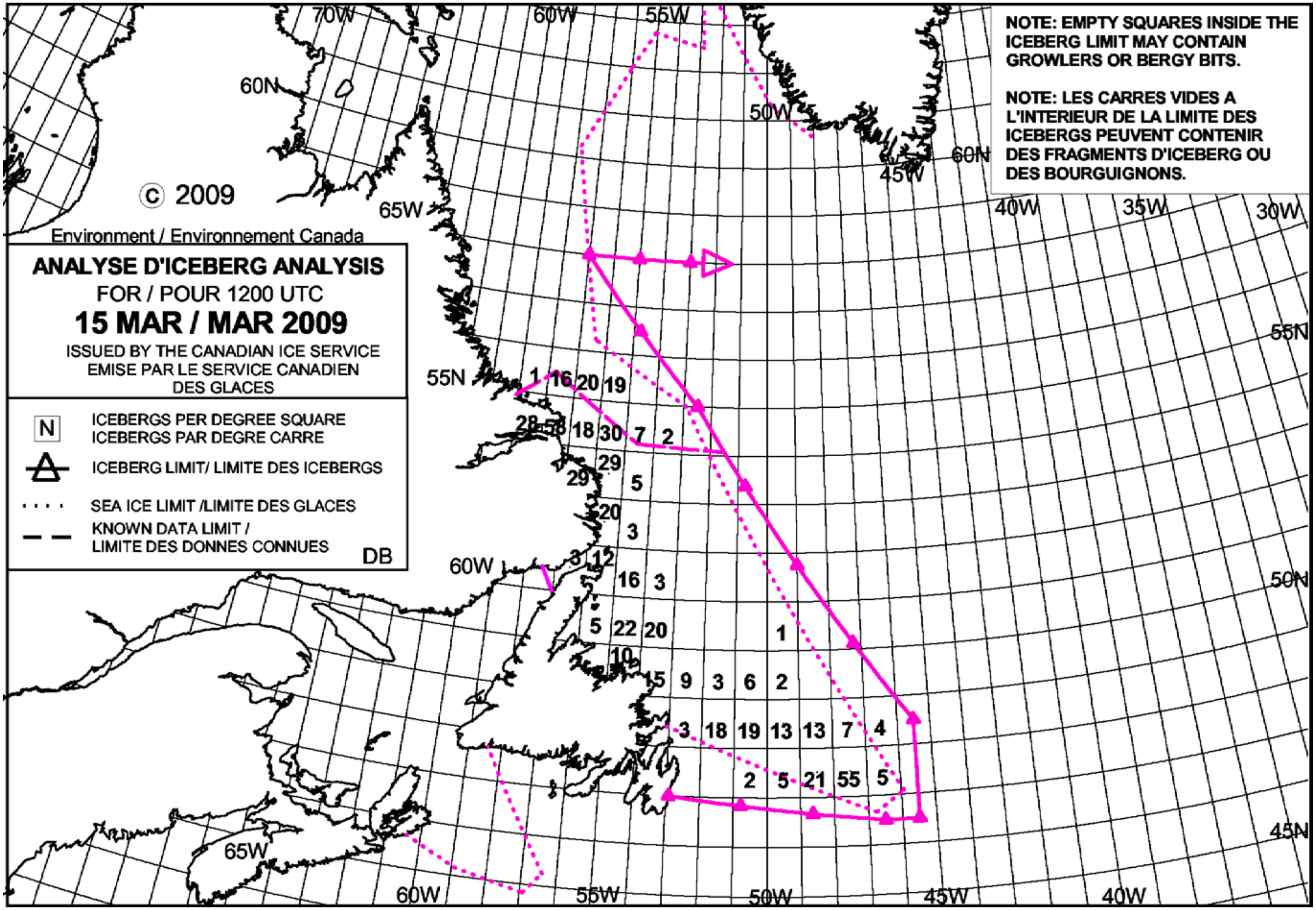
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ANALYSE D'ICEBERG ANALYSIS
FOR / POUR 1200 UTC
15 MAR / MAR 2009
ISSUED BY THE CANADIAN ICE SERVICE
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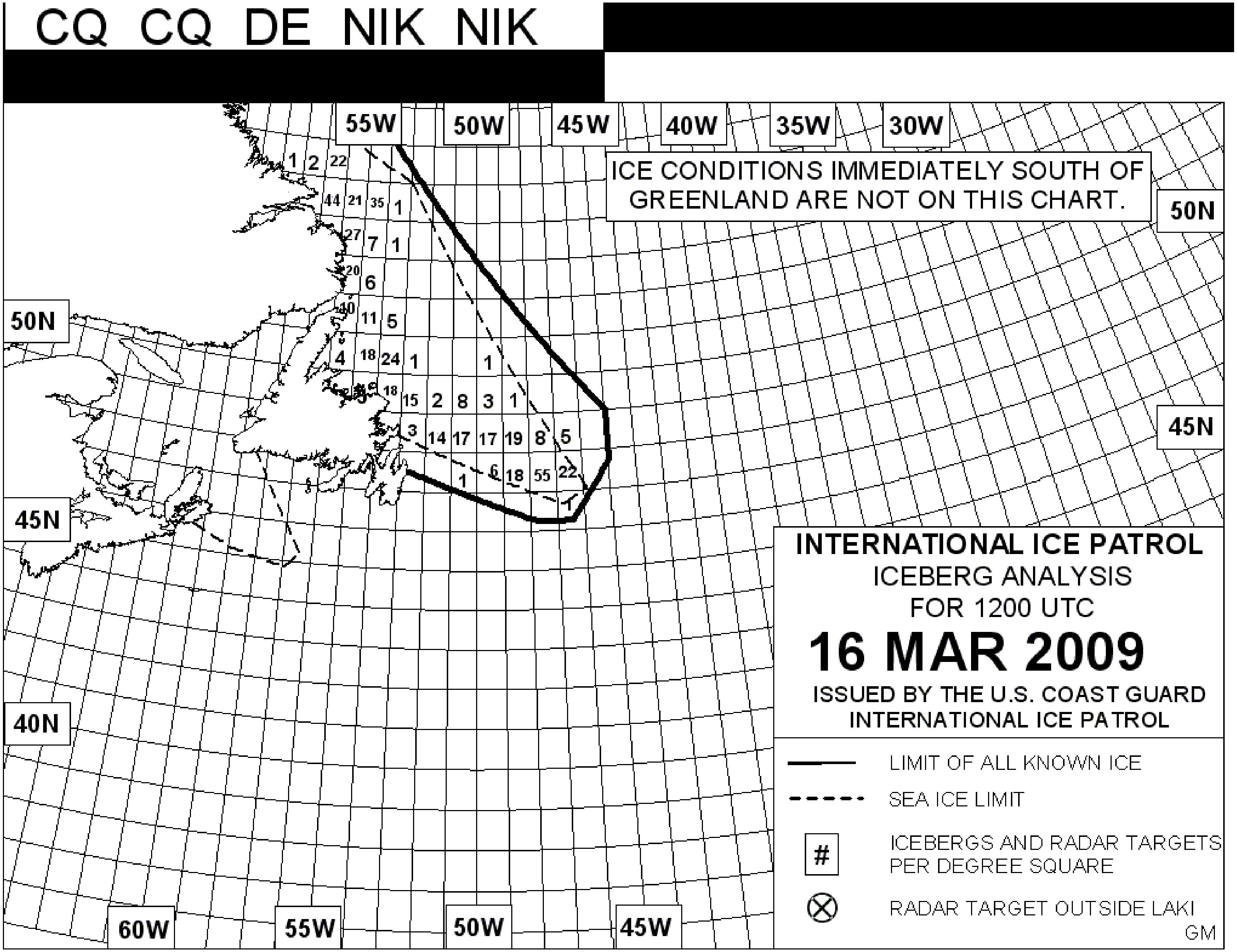
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INTERNATIONAL ICE PATROL
ICEBERG ANALYSIS
FOR 1200 UTC
16 MAR 2009
ISSUED BY THE U.S. COAST GUARD
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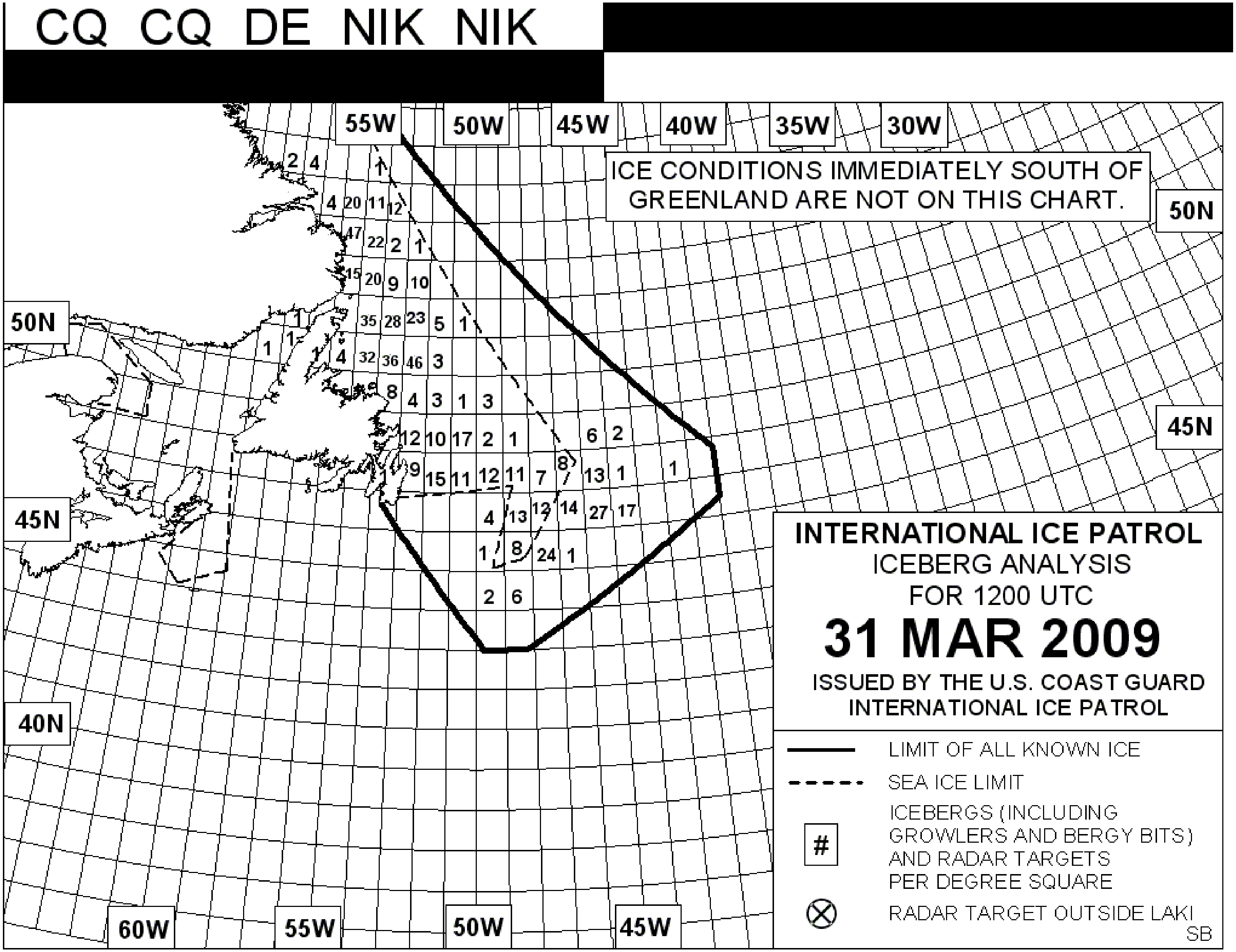
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INTERNATIONAL ICE PATROL
ICEBERG ANALYSIS
FOR 1200 UTC
31 MAR 2009
ISSUED BY THE U.S. COAST GUARD
INTERNATIONAL ICE PATROL
LIMIT OF ALL KNOWN ICE
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ICEBERGS (INCLUDING GROWLERS AND BERGY BITS) AND RADAR TARGETS PER DEGREE SQUARE
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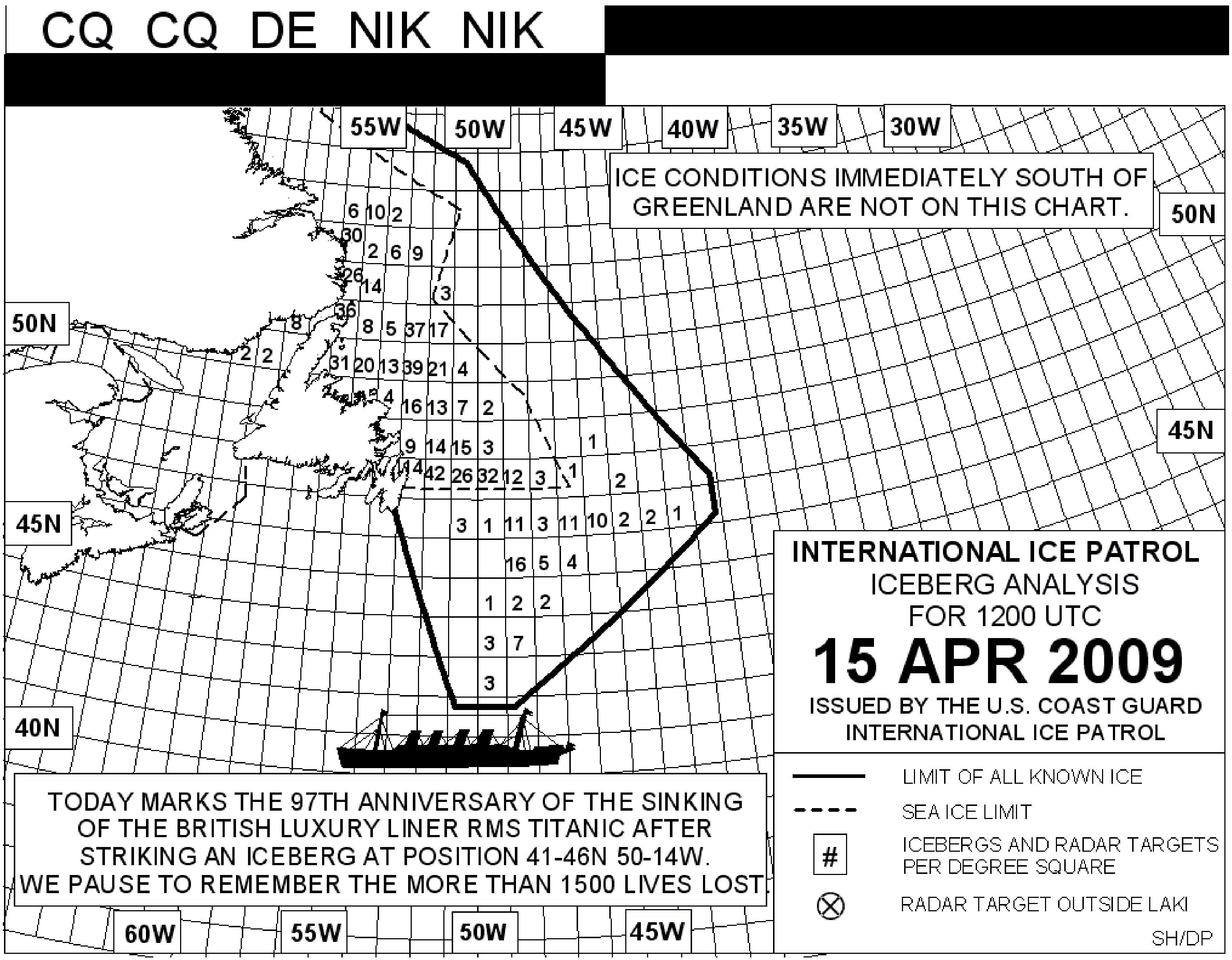
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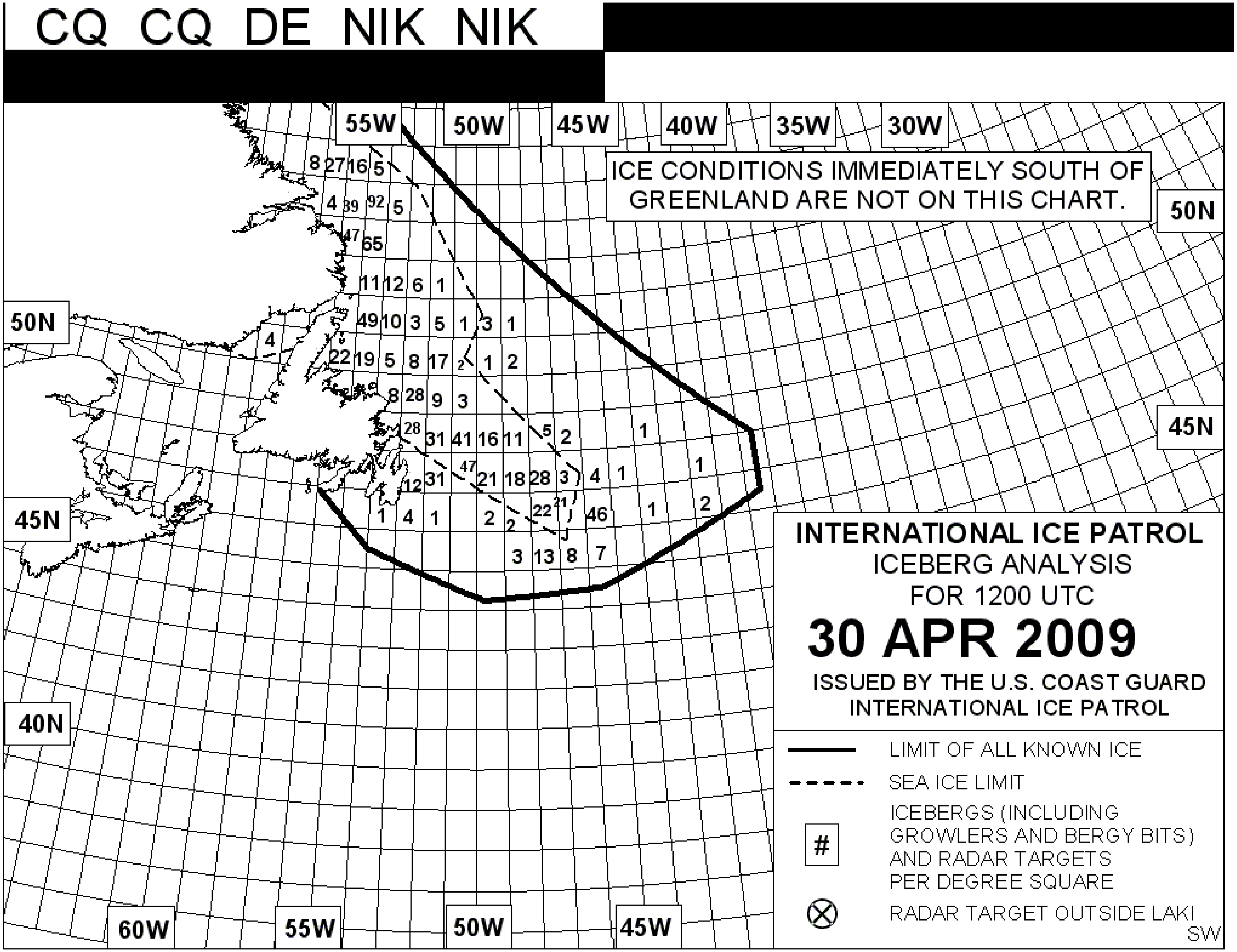
INTERNATIONAL ICE PATROL
ICEBERG ANALYSIS
FOR 1200 UTC
15 APR 2009
ISSUED BY THE U.S. COAST GUARD
INTERNATIONAL ICE PATROL
LIMIT OF ALL KNOWN ICE
SEA ICE LIMIT
ICEBERGS AND RADAR TARGETS PER DEGREE SQUARE
RADAR TARGET OUTSIDE LAKI
SH/DP
TODAY MARKS THE 97TH ANNIVERSARY OF THE SINKING OF THE BRITISH LUXURY LINER RMS TITANIC AFTER STRIKING AN ICEBERG AT POSITION 41-46N 50-14W.
WE PAUSE TO REMEMBER THE MORE THAN 1500 LIVES LOST.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INTERNATIONAL ICE PATROL
ICEBERG ANALYSIS
FOR 1200 UTC
30 APR 2009
ISSUED BY THE U.S. COAST GUARD
INTERNATIONAL ICE PATROL
LIMIT OF ALL KNOWN ICE
SEA ICE LIMIT
ICEBERGS (INCLUDING GROWLERS AND BERGY BITS) AND RADAR TARGETS PER DEGREE SQUARE
RADAR TARGET OUTSIDE LAKI
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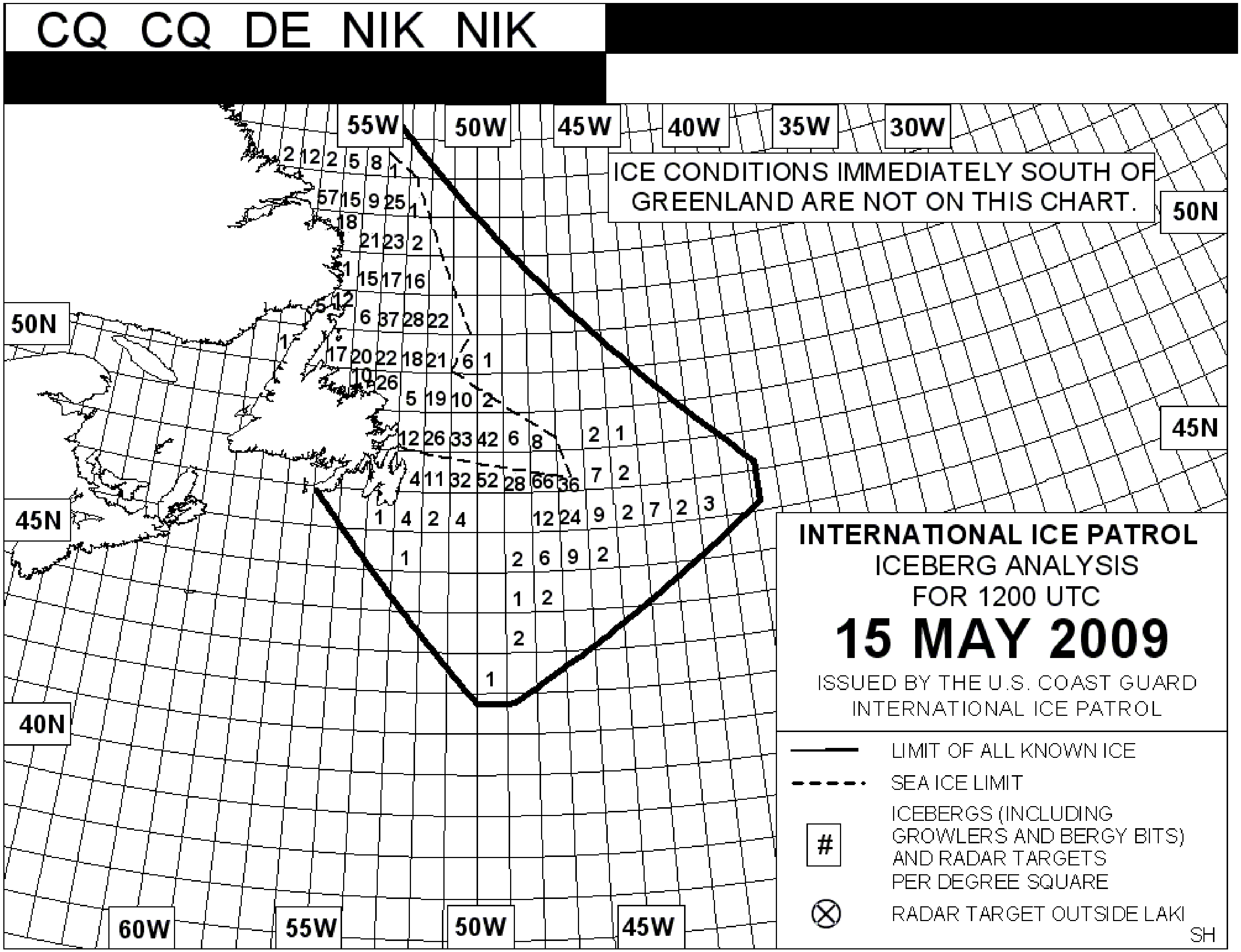
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ICE CONDITIONS IMMEDIATELY SOUTH OF GREENLAND ARE NOT ON THIS CHART.
INTERNATIONAL ICE PATROL
ICEBERG ANALYSIS
FOR 1200 UTC
15 MAY 2009
ISSUED BY THE U.S. COAST GUARD
INTERNATIONAL ICE PATROL
LIMIT OF ALL KNOWN ICE
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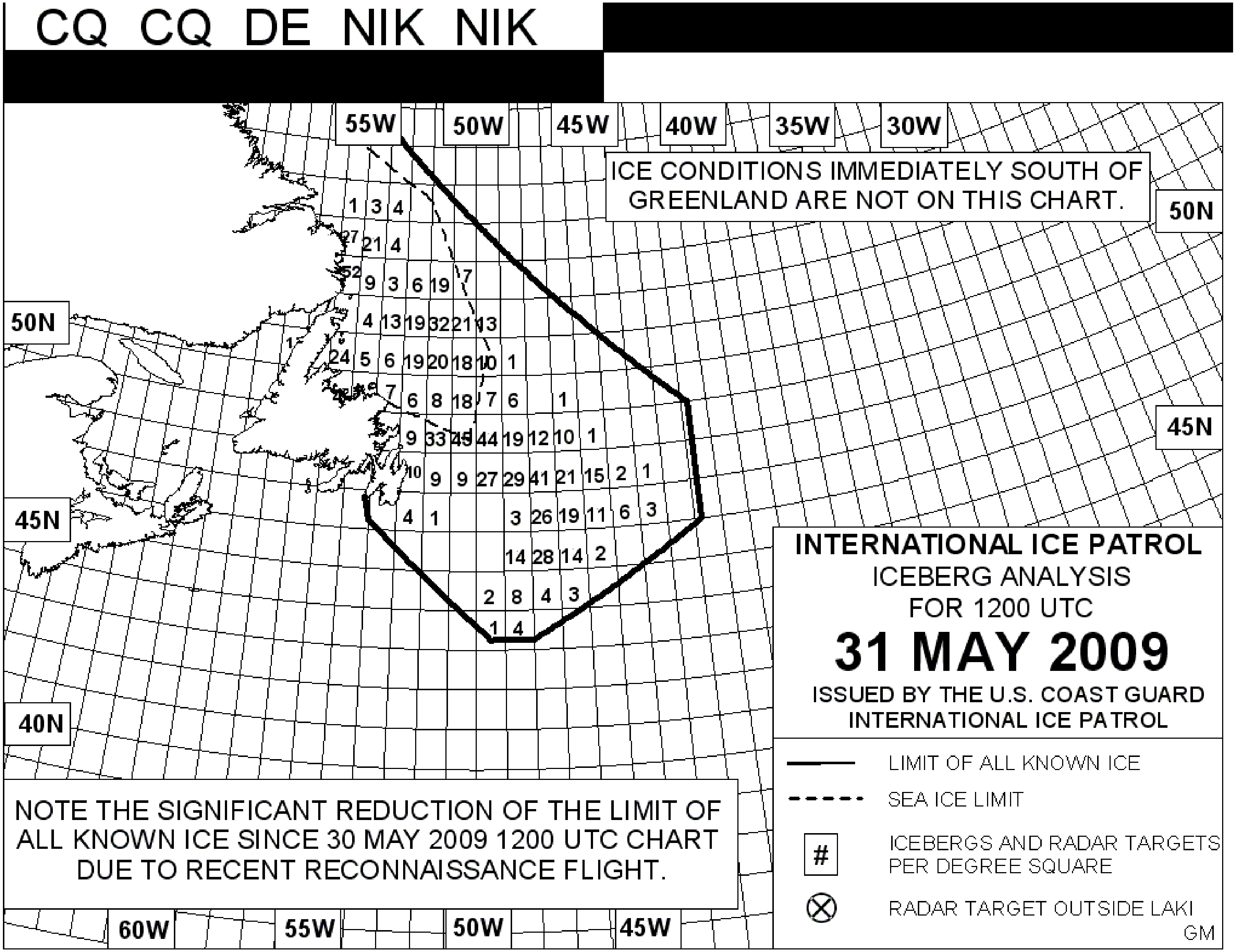
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INTERNATIONAL ICE PATROL
ICEBERG ANALYSIS
FOR 1200 UTC
31 MAY 2009
ISSUED BY THE U.S. COAST GUARD
INTERNATIONAL ICE PATROL
LIMIT OF ALL KNOWN ICE
SEA ICE LIMIT
ICEBERGS AND RADAR TARGETS PER DEGREE SQUARE
RADAR TARGET OUTSIDE LAKI
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NOTE THE SIGNIFICANT REDUCTION OF THE LIMIT OF ALL KNOWN ICE SINCE 30 MAY 2009 1200 UTC CHART DUE TO RECENT RECONNAISSANCE FLIGHT.
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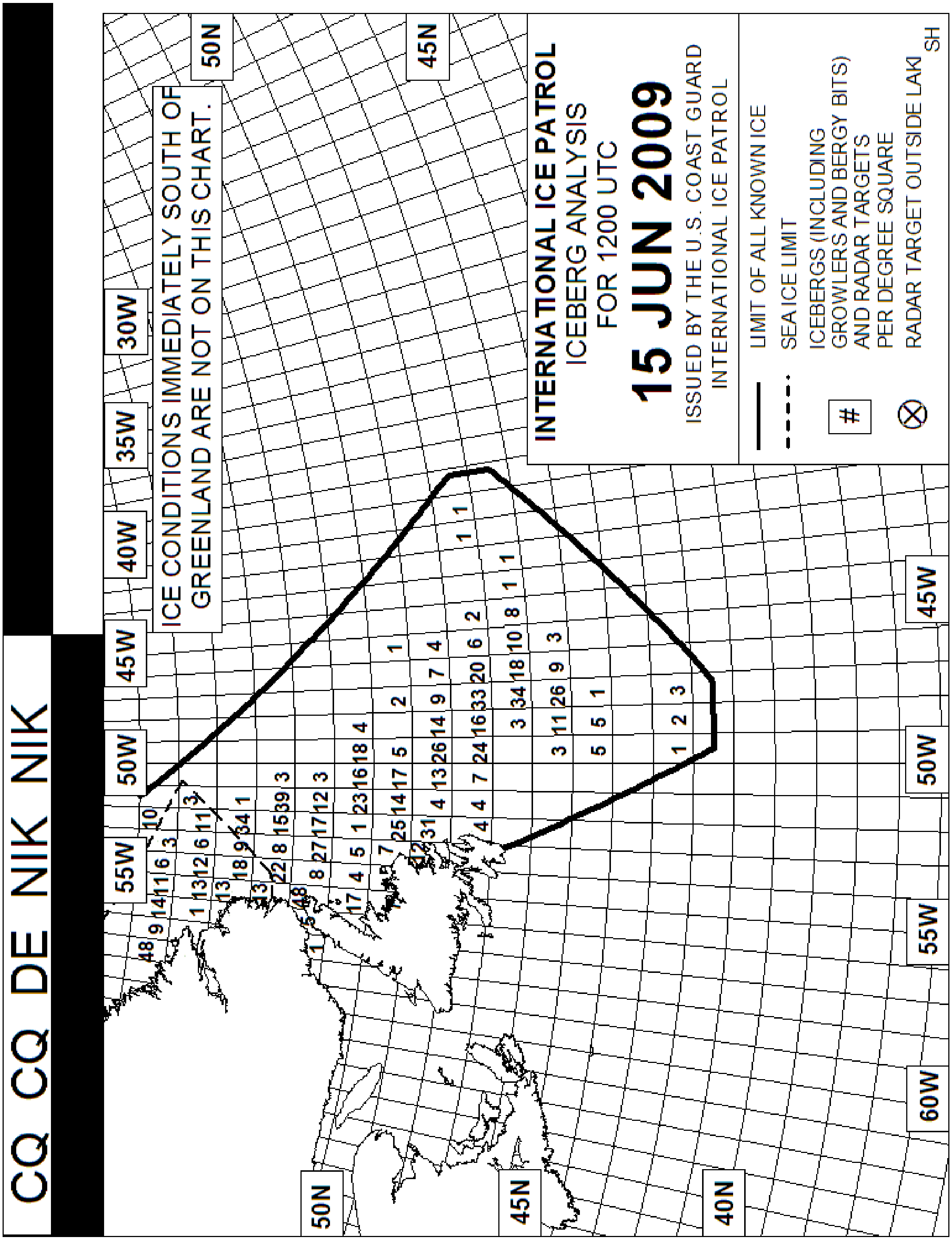

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ICE CONDITIONS IMMEDIATELY SOUTH OF GREENLAND ARE NOT ON THIS CHART.
INTERNATIONAL ICE PATROL
ICEBERG ANALYSIS
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ISSUED BY THE U.S. COAST GUARD
INTERNATIONAL ICE PATROL
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ICEBERGS (INCLUDING GROWLERS AND BERGY BITS) AND RADAR TARGETS PER DEGREE SQUARE
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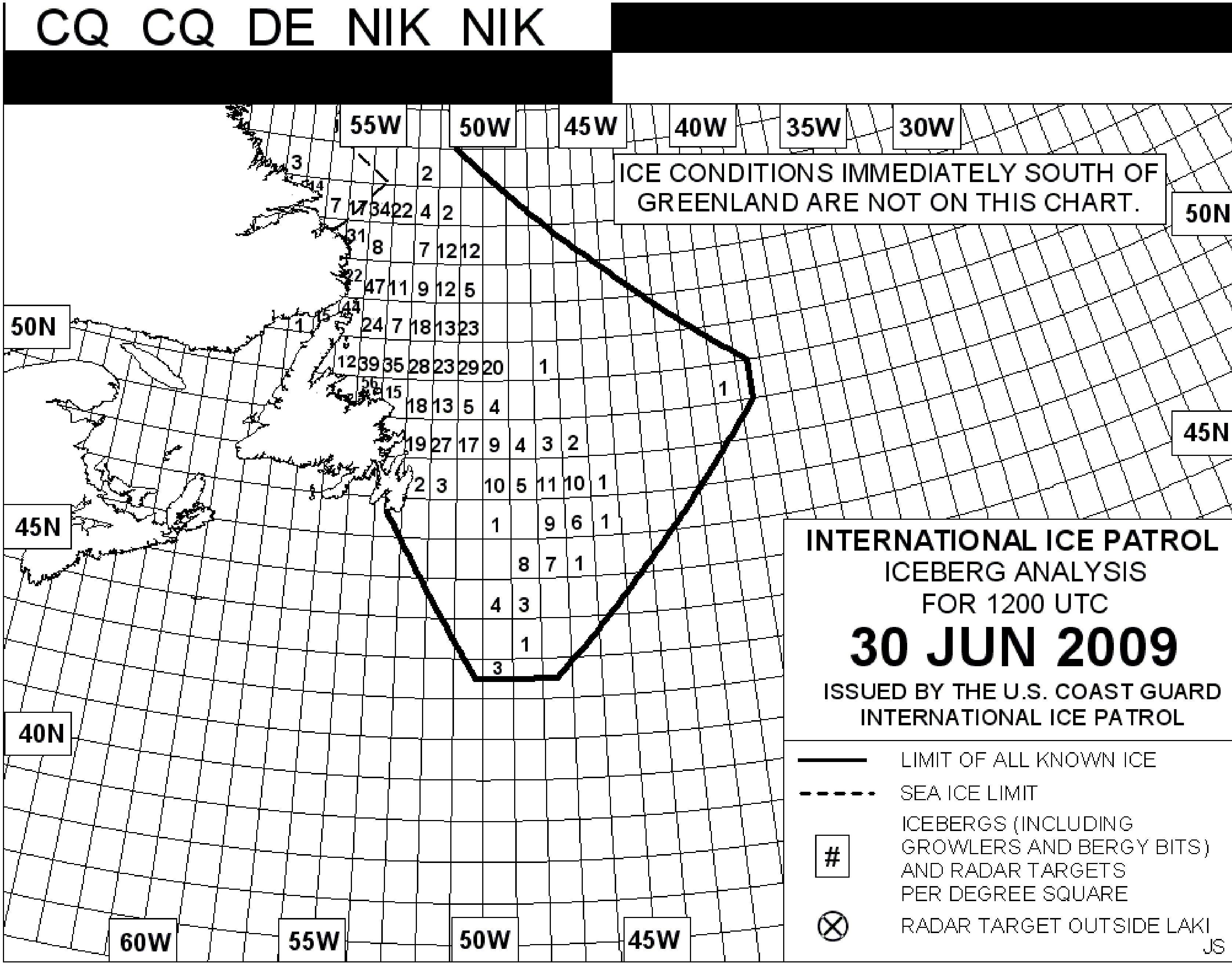
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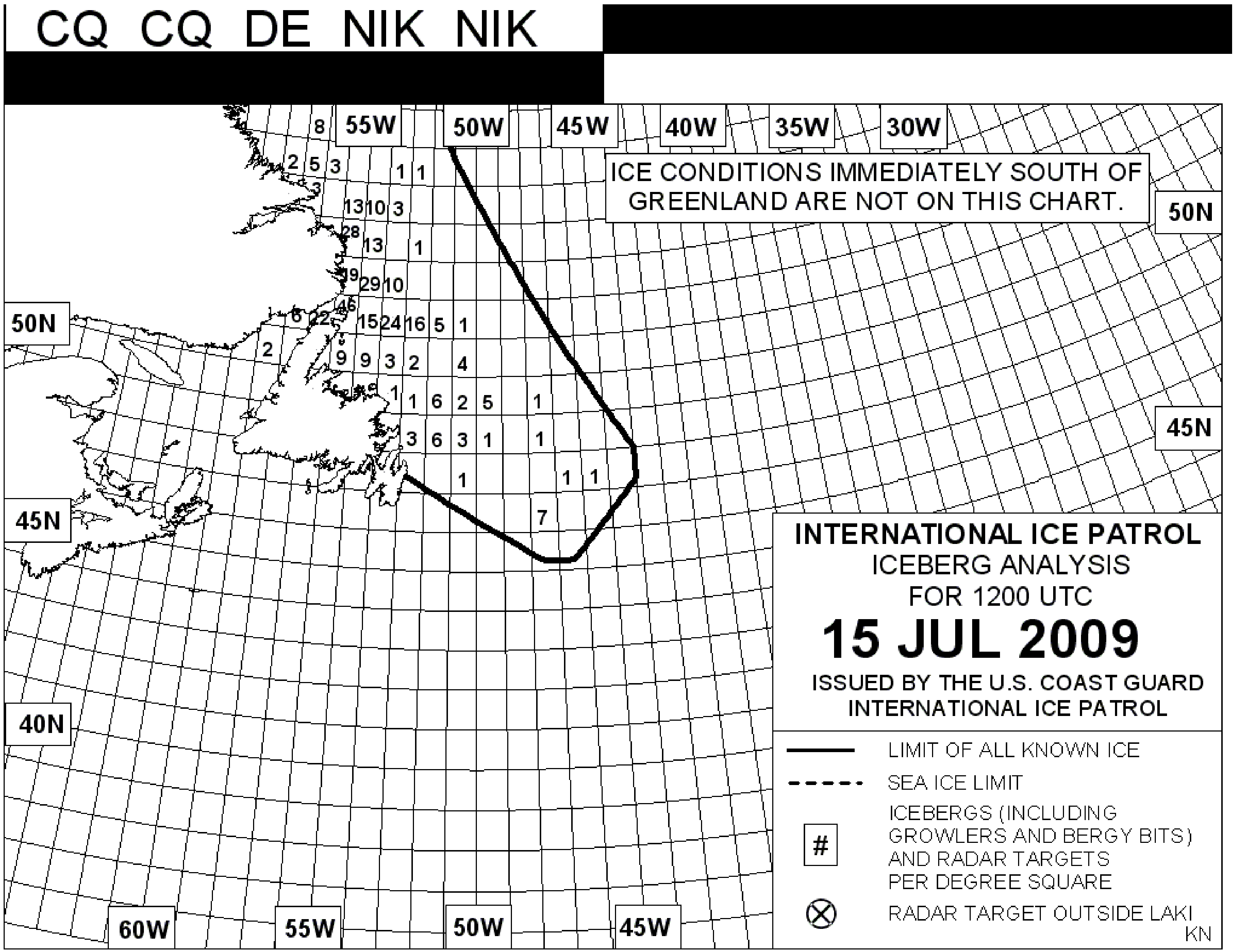
INTERNATIONAL ICE PATROL
ICEBERG ANALYSIS
FOR 1200 UTC
30 JUN 2009
ISSUED BY THE U.S. COAST GUARD
INTERNATIONAL ICE PATROL
LIMIT OF ALL KNOWN ICE
SEA ICE LIMIT
#
ICEBERGS (INCLUDING GROWLERS AND BERGY BITS) AND RADAR TARGETS PER DEGREE SQUARE
RADAR TARGET OUTSIDE LAKI
JS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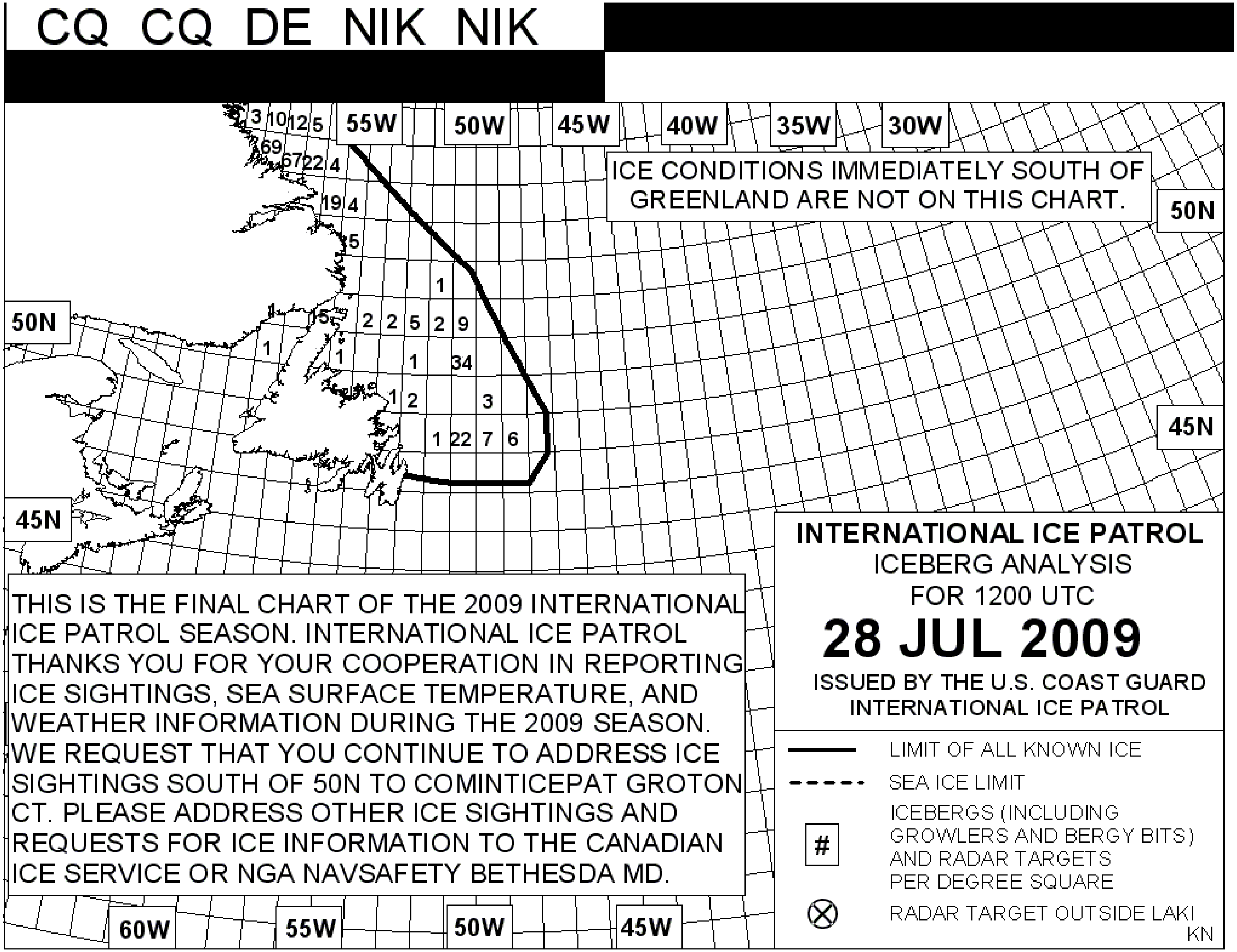
55W
50W
45W
40W
35W
30W
ICE CONDITIONS IMMEDIATELY SOUTH OF GREENLAND ARE NOT ON THIS CHART.
50N
45N
40N
60W
INTERNATIONAL ICE PATROL
ICEBERG ANALYSIS
FOR 1200 UTC
15 JUL 2009
ISSUED BY THE U.S. COAST GUARD
INTERNATIONAL ICE PATROL
LIMIT OF ALL KNOWN ICE
SEA ICE LIMIT
#
ICEBERGS (INCLUDING GROWLERS AND BERGY BITS) AND RADAR TARGETS PER DEGREE SQUARE
RADAR TARGET OUTSIDE LAKI
KN


CQ CQ DE NIK NIK
55W
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ICE CONDITIONS IMMEDIATELY SOUTH OF GREENLAND ARE NOT ON THIS CHART.
THIS IS THE FINAL CHART OF THE 2009 INTERNATIONAL ICE PATROL SEASON. INTERNATIONAL ICE PATROL THANKS YOU FOR YOUR COOPERATION IN REPORTING ICE SIGHTINGS, SEA SURFACE TEMPERATURE, AND WEATHER INFORMATION DURING THE 2009 SEASON. WE REQUEST THAT YOU CONTINUE TO ADDRESS ICE SIGHTINGS SOUTH OF 50N TO COMINTICEPAT GROTON CT. PLEASE ADDRESS OTHER ICE SIGHTINGS AND REQUESTS FOR ICE INFORMATION TO THE CANADIAN ICE SERVICE OR NGA NAVSAFETY BETHESDA MD.
INTERNATIONAL ICE PATROL
ICEBERG ANALYSIS
FOR 1200 UTC
28 JUL 2009
ISSUED BY THE U.S. COAST GUARD
INTERNATIONAL ICE PATROL
LIMIT OF ALL KNOWN ICE
SEA ICE LIMIT
#
ICEBERGS (INCLUDING GROWLERS AND BERGY BITS) AND RADAR TARGETS PER DEGREE SQUARE
RADAR TARGET OUTSIDE LAKI
KN

Acknowledgements

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

Canadian Coast Guard
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Canadian Ice Service
Canadian Maritime Atlantic Command Meteorological and Oceanographic Center
C-CORE
Department of Fisheries and Oceans Canada
German Federal Maritime and Hydrographic Agency
National Geospatial-Intelligence Agency
National Ice Center
National Weather Service
Nav Canada Flight Services
Provincial Aerospace Limited
U. S. Coast Guard Air Station Elizabeth City
U. S. Coast Guard Atlantic Area Command Center
U. S. Coast Guard Atlantic Area Staff
U. S. Coast Guard Automated Merchant Vessel Emergency Response System
U. S. Coast Guard Communications Area Master Station Atlantic
U. S. Coast Guard First District Command Center
U. S. Coast Guard First District Staff
U. S. Coast Guard Headquarters Staff (CG-711, CG-5412, CG-4420)
U. S. Coast Guard Intelligence Coordination Center
U. S. Coast Guard Operations Systems Center
U. S. Coast Guard Research and Development Center
U. S. Naval Atlantic Meteorology and Oceanography Center
U. S. Naval Fleet Numerical Meteorology and Oceanography Center

It is important to recognize the outstanding efforts of the personnel assigned to the International Ice Patrol during the 2009 Ice Season:

CDR S. D. Rogerson
LCDR G. G. McGrath
Dr. D. L. Murphy
Mr. G. F. Wright
Mrs. B. J. Lis
LT K. M. Nolan
LT S. R. Houle
MSTCS J. M. Stengel
MSTCS J. C. Luzader
YN1 D. C. Phillips
YN1 I. O. Gonzalez

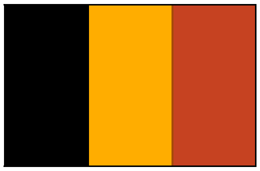
MST1 H. L. Brittle
MST2 W. W. Mendenhall
MST2 S. B. McClellan
MST2 G. J. Woolverton
MST2 S. A. Baumgartner
MST2 W. N. Moran
MST2 S. J. Weitkamp
MST2 A. L. Johnson
MST3 E. E. Brehmer
MST3 M. M. Sanks

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

Appendix A

<u>Nations Supporting International Ice Patrol</u>

Belgium



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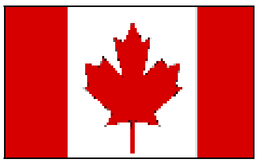

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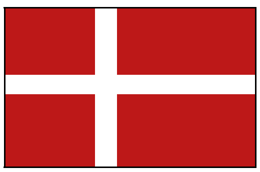
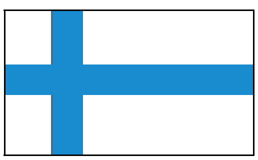


Finland



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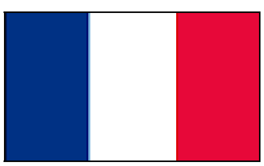
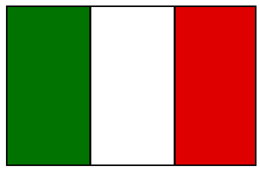


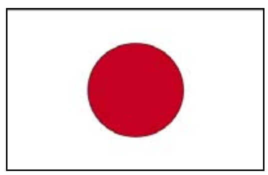
Germany

Greece

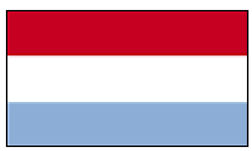
Italy



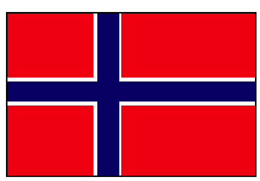
Japan



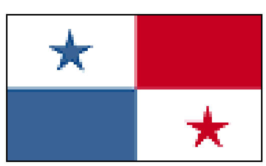
Netherlands



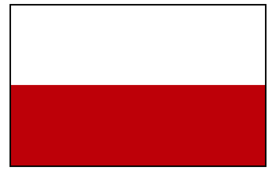
Norway



Panama

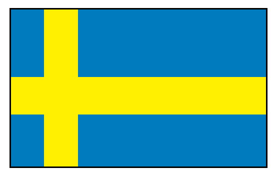


Poland

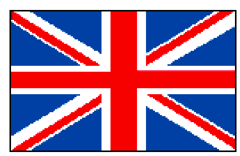


Spain

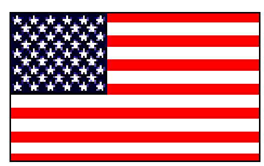
Sweden



United Kingdom



United States of America



Appendix B

Ship Reports for Ice Year 2009
(Oct 1st, 2008 – Sep 30th, 2009)

Ships Reporting By Flag	Reports
ANTIGUA & BARBUDA	
BBC CAMPANA	2
BELUGA ENERGY	3
BEULGA EMOTION	2
FEDERAL MATANE	4
KIRSTEN K	1
NOTOS	8
PUFFIN	4
STELLA MARIS	1
VECHTBORG	7
BAHAMAS	
ALGOMA DISCOVERY	7
ALGOMA GUARDIAN	1
APOLLON	8
ATLANTIC CARTIER	34
CLIPPER ADVENTURER	1
CLIPPER LOYALTY	12
FEDERAL FUJI	3
FEDERAL POLARIS	1
JAEGER ARROW	6
NANDU ARROW	4
RAVEN ARROW	1
SANDVIKEN	1
SARPIKITTUK	1
SEAROSE G	1
BARBADOS	
FEDERAL FRANKLIN	1
FEDERAL MAAS	2
MARINER SEA	2

Ships Reporting By Flag	Reports
BERMUDA	
AURORA	1
CANMAR VICTORY	2
GLORY	12
METHANE KARI ELIN	1
STENA PERROS	19
TAHITIAN PRINCESS	1
TRIUMPH	16
CANADA	
ACADIAN	5
ALGOCANADA	1
ALGOSEA	3
APPOLO	1
ATLANTIC ENTERPRISE	2
ATLANTIC KINGFISHER	1
CAMILLA DESGAGNES	1
CAPE BALLARD	1
CCGS ANN HARVEY	21
CCGS CAPE ROGER	1
CCGS DES GROSEILLIERS	4
CCGS GEORGE R. PEARKES	6
CCGS HENRY LARSEN	4
CCGS HUDSON	5
CCGS PIERRE RADISSON	1
CCGS TERRY FOX	3
CHEBUCTO	1
EMERALD STAR	4
HMCS GOOSE BAY	3
JADE STAR	6
JAN MAYEN	2

Ships Reporting By Flag	Reports
CANADA cont.	
KATSHESHUK	1
MAERSK NASCOPIE	2
MARIA DESGAGNES	2
MATTEA	35
MERSEY PHOENIX	1
MOKAMI	1
OCEAN FOXTROT	1
OCEAN PRAWNS	2
OCEANEX AVALON	13
PETROLIA DESGAGNES	3
ROYAL MARINER	1
SABLE SEA	1
SEA RANGER	4
SIR JOHN FRANKLIN	9
STRAIT EXPLORER	1
TERRA NOVA FPSO	1
TORONTO	2
UMIAK I	31
ZELADA DESGAGNES	1
CAYMAN ISLANDS	
ICE STAR	4
CHINA, PEOPLES REPUBLIC	
CHINA STEEL DEVELOPER	6
CHINA, TAIWAN	
OOCL SAN FRANCISCO	1
CROATIA	
PETKA	3
CYPRUS	
BRANT	2
CAPTAIN GEORGE L.	3

Ships Reporting By Flag	Reports
CYPRUS cont.	
CMA CGM UTRILLO	16
FEDERAL ELBE	1
FEDERAL LEDA	8
FEDERAL PATRIOT	1
FEDERAL PATROLLER	13
GREENWING	1
INGRID GORTHON	2
IRMA	15
IRYDA	5
ISA	2
ISADORA	15
ISOLDA	6
LAKE SUPERIOR	9
NORDPORT	3
NORDTRADE	6
PRINCESS VANYA	4
SEABOARD PIONEER	10
UBC BATON ROUGE	5
DENMARK	
GOTLAND CAROLINA	4
GOTLAND MARIEANN	1
GOTLAND SOFIA	1
GREAT SWAN	3
MARY ARCTICA	7
NAJA ARCTICA	13
NUKA ARCTICA	16
OTILIA	2
PETER FABER	9
DOMINICA	
LEON V	1
DOMINICAN REPUBLIC	
VESTLANDIA	1

Ships Reporting By Flag	Reports
FINLAND	
FUTURA	8
PURHA	3
STENA POSEIDON	16
FRANCE	
PETER FABER	6
GERMANY	
MARIA S. MERIAN	7
MSC UGANDA	1
GIBRALTAR	
TRANSHAWK	3
VALERIE	4
GREECE	
CAP DIAMANT	4
CAP GEORGES	5
CAP GUILLAUME	3
CAP LAURENT	4
CAP LEON	16
CAP PHILIPPE	30
CAP PIERRE	1
CAP THEODORA	10
DAPHNE	2
FILIKON	4
GOLDENEYE	14
MINERVA ANTONIA	3
MSC YOKOHAMA	1
OLYMPIC MERIT	2
GREENLAND	
SARFAQITTUK	4

Ships Reporting By Flag	Reports
HONG KONG	
CSK FORTUNE	2
FEDERAL KIVALINA	2
FEDERAL NAKAGAWA	3
FEDERAL PROGRESS	3
FEDERAL RIDEAU	3
FEDERAL VENTURE	1
GOLDEN LYDERHORN	2
GOLDEN SAGUENAY	1
HAWKE BAY	2
OOCL BELGIUM	3
OOCL MONTREAL	1
WHISTLER	2
ISLE OF MAN	
BBC KARAN	4
BBC KUSAN	2
GOOD HOPE MAX	4
ITALY	
COSTA ATLANTICA	2
LAGUNA D	2
MICHELE IULIANO	14
NORTH POINT	1
KOREA	
C. SUMMIT	1
LIBERIA	
ALEKSEY KOSYGIN	1
APOSTOLOS	1
AVIONA	2
CAP BIANCO	4
CONTI BENGUELA	1

Ships Reporting By Flag	Reports
LIBERIA cont.	
COSMIC JEWEL	1
EVA N*	116
FEDERAL MATTAWA	1
HARMEN OLDENDORFF	1
HEDWIG OLDENDOFF	16
HS TOSCA	14
INDEPENDENT VENTURE	1
JONNI RITSCHER	3
LEADER	1
MOSEL N	1
MSC SCOTLAND	1
NARODNY BRIDGE	5
NS STREAM	1
OKHTA BRIDGE	9
OMEGA EMMANUEL	1
ROBIN	2
SANKO HARMONY	1
SANKO HERITAGE	1
SCF NEVA	2
SCF YENISEI	8
TARANG	1
TEATRALNY BRIDGE	11
VULKAN	6
YUCATAN	2
LITHUANIA	
SVILAS	14
LUXEMBOURG	
CRYSTAL EMERALD	2
KERLAZ	2
MALAYSIA	
STANSLAW KULCZNSKI	1

Ships Reporting By Flag	Reports
MALTA	
AEGEAN CASTLE	4
AMBER VITA	7
ATLANTIC ACACIA	10
CESTENI	5
MARGARA	1
PETKA	1
PORT ESTORIL	3
POWSTANIEC STYCZNIOWY	1
ZERAN	1
ZEYNEP A	5
MARSHALL ISLANDS	
ARIONAS	1
BALDOCK	1
DEEP PIONEER	23
GULF AHMADI	1
MARINER SEA	1
OMEGA PRINCE	1
OVERSEAS REGAL	1
PELJESAC	6
PUZE	1
SALACGRIVA	6
SEA RANGER	1
SONGA DIAMOND	1
TYCO RESOLUTE	12
USMA	1
VALDIVIA	14
VALENTIA	6
VEREINA	1
YASA NESLIHAN	1
NETHERLANDS	
EDISONGRACHT	2
EGALANTIERSGRACHT	1

Ships Reporting By Flag	Reports
NETHERLANDS (cont.)	
FLINTERDUIN	1
HAPPY RIVER	1
MAERSK PALERMO	31
NASSAUBORG	2
ONEGO TRADER	5
ONEGO TRAVELLER	4
REYKJAFOSS	4
VECHTBORG	1
NETHERLAND ANTILLES	
CATHMA	5
KWINTEBANK	1
VECHTBORG	6
NORWAY	
BRANNSPROEYTA	1
BERGE ATLANTIC	32
ELLEN KNUTSEN	5
HELICE	1
OPHELIA	2
RAVNANGER	3
SPAR JADE	1
TURID KNUTSEN	13
PANAMA	
ANDROS WARRIOR	1
FEDERAL SAKURA	2
GLOBE UNITY	2
KATERINA WARRIOR	1
KIRTI	2
LOWLANDS OPAL	2
LOWLANDS SUMIDA	1
MAERSK MATSUYAMA	1
MAPLE CREEK	1
MSC ANAHITA	1

Ships Reporting By Flag	Reports
PANAMA cont.	
MSC JORDAN	18
MSC KOREA	6
MSC SERENA	5
NORTH FIGHTER	1
OCEAN CRESENT	1
PACIFIC BANGAO	4
PACIFIC BANGXIANG	1
PRINCESS NADIA	1
SILVER RIVER	1
SUNNY GLORY	1
SWIFT CRO	1
WINDSOR ADVENTURE	2
PHILIPPINES	
FALCON TRADER 1	5
FEDERAL AGNO	2
PORTUGAL	
JOANA PRINCESA	1
RUSSIA	
BORIS LIVANOV	11
KASLA	5
SINGAPORE	
ALAM MESRA	1
ALAM PERMAI	3
APL JADE	1
CHELSEA	2
GARIMA PREM	2
MT BEN	1
SICHEM EDINBURGH	9
SICHEM MANILA	1
SICHEM MONTREAL	1
TORM SARA	1

Ships Reporting By Flag	Reports
SWEDEN	
TRANSMAPLE	5
SWITZERLAND	
MAERSK JUAN	1
THAILAND	
WARALEE NAREE	1
TURKEY	
INCE ATLANTIC	1
UKRAINE	
DOBRUSH	7
UNITED KINGDOM	
BARMBEK	8
HELEEN C	1
HURST POINT	8
JEAN CHARCOT	1

Ships Reporting By Flag	Reports
LUCIANA DELLA GATTA	7
MAERSK PATRAS	19
NEW ORLEANS EXPRESS	1
REINBEK	1
TORRENS	1
WELLSERVICER	3
UNITED STATES OF AMERICA	
ENDURANCE	1
HENRY B. BIGELOW	1
MAERSK MISSOURI	6
UNKNOWN	
ANY SHIP	21
VANUATU	
LEGIONY POLSKIE	6
SZARE SZEREGI	9

*DENOTES CARPATHIA AWARD WINNER

UNITED KINGDOM cont.

Appendix C

Aerial Iceberg Reconnaissance Platforms (2008-2009)

LT Scott R. Houle and MST1 Horace L. Brittle

Introduction

In 2009, the International Ice Patrol (IIP) underwent a major transition in aircraft and sensor(s) used to conduct iceberg reconnaissance operations in the vicinity of the Grand Banks of Newfoundland. This transition resulted in the swift implementation of the HC-130J aircraft with ELTA-2022 radar and the abrupt termination of the HC-130H with SLAR/FLAR dual radar suite for use in IIP reconnaissance operations. Although the transition was a very sharp move from one platform with known capabilities to another with very different and unknown capabilities, it was met with a high level of professionalism and sense of urgency by all involved and resulted in a successful implementation of the new system. The 2009 reconnaissance operations were conducted with a keen eye and ambitious deadlines to quickly learn and implement the new systems and processes required to conduct effective aerial iceberg reconnaissance.

IIP Reconnaissance Requirements

IIP's primary search area near the Grand Banks of Newfoundland "which extends to approximately 400 miles offshore, has notoriously poor weather, including persistent foggy and stormy conditions"[1] and often prevents any visual only reconnaissance due to fog banks and low cloud ceilings in the search area.

It is because of this that IIP's Airborne Reconnaissance Requirements require an aircraft with a radar/sensor suite with the following capabilities:

- Ability to search up to 140,000 NM^2 along the limit of all known ice (LAKI) every 14 days.
- Capable of detecting icebergs and vessels in low and no visibility.
- Detect small icebergs (>15 meters in length and 5 meters in height) in 3 meter seas (significant wave height), with a probability of detection of 0.95.
- Detect all vessels with a length of 10 meters or greater.
- Radar with an inverse synthetic aperture radar (ISAR) mode or other sensor(s) capable of discriminating between icebergs, vessels, and other objects in low and no visibility. (This requirement includes the need for qualified operators who can accurately interpret displayed signal returns.)
- Real time display of target-data on the aircraft separate from pilot displays and with independent controls.
- The ability to apply basic image enhancement techniques (zoom, filter, etc.) on specific targets.
- One window on each side of the aircraft large enough to give IIP's qualified Ice Observers a comprehensive view of the search area including below the aircraft.

- Aircraft navigational accuracy of +/- 250 meters.
- Integrated communications system (ICS) with isolated IIP mission circuit consisting of a minimum of 4 connections.
- Flight data must be transmitted to IIP operations center within 6 hours of landing time.

The HC-130H aircraft equipped with SLAR/FLAR radar combination provided these capabilities. However the systems had become antiquated and increasingly difficult to maintain and support. Because of this, the Coast Guard decided to make the transition to the HC-130J aircraft with ELTA-2022 radar and associated mission system that promises to satisfy IIP's reconnaissance requirements with slight adjustments in tactics and procedures.

Initial Testing

In September of 2008, the Coast Guard Office of Aviation Forces (CG-711) began testing the new HC-130J with ELTA-2022 radar and mission system for use in the conduct of iceberg reconnaissance in cooperation with Air Station Elizabeth City, Air Station Clearwater and IIP. The testing was conducted in Davis Strait between Baffin Island and Greenland using both visual ground truth testing of a small iceberg (5-15m high and 15-50m long) as a test subject. A missionized HC-130J and an HC-130H with SLAR/FLAR dual radar combination were used to conduct the test.

The test results suggested that the missionized HC-130J long range surveillance aircraft equipped with the ELTA-2022 360° radar and associated mission system is capable of detecting and identifying small icebergs as previously defined in IIP's area of operations. However, preliminary testing was insufficient to accurately determine the maximum range that a small iceberg could be positively detected and identified >95% of the time.

The 2008 CG-711 test report[2] recommended conducting iceberg reconnaissance using 20 NM flight track spacing at an air speed not to exceed 250 kts ground speed and at an altitude between 1,000 and 5,500 feet above ground level (AGL). It also recommended additional probability of detection testing be conducted to refine the capabilities of the new aircraft and sensor suite in IIP's AOR. It also described specific sensor settings to be used while conducting iceberg reconnaissance for IIP. Additional information regarding the initial testing can be found in the original test report.[2]

Additional Testing Conducted During 2009 Ice Season

On 03 June 2009 during IRD 8, IIP conducted additional probability of detection testing as recommended by the 2008 CG-711 test report. The testing was conducted approximately 120 NM northeast of St. John's using visual ground truth testing of a small iceberg with a missionized HC-130J. The test was designed to be very similar to the September 2008 testing conducted by CG-711. Figure 1 is the graphic from the completed test.

This testing resulted in the collection of 12 data points obtained at a closest point of approach of 20 NM. An additional 24 data points were obtained when the test target was acquired and lost by the radar for each pass. Data from this test evolution will be analyzed and combined with other available probability of detection test data prior to the commencement of the 2010 Ice Season. Preliminary results of this test suggest that the 20 NM track spacing recommended by the 2008 CG-711 test report will be necessary when operating at an altitude of 5,500 feet AGL to ensure a 95% probability of detecting all small icebergs and larger.

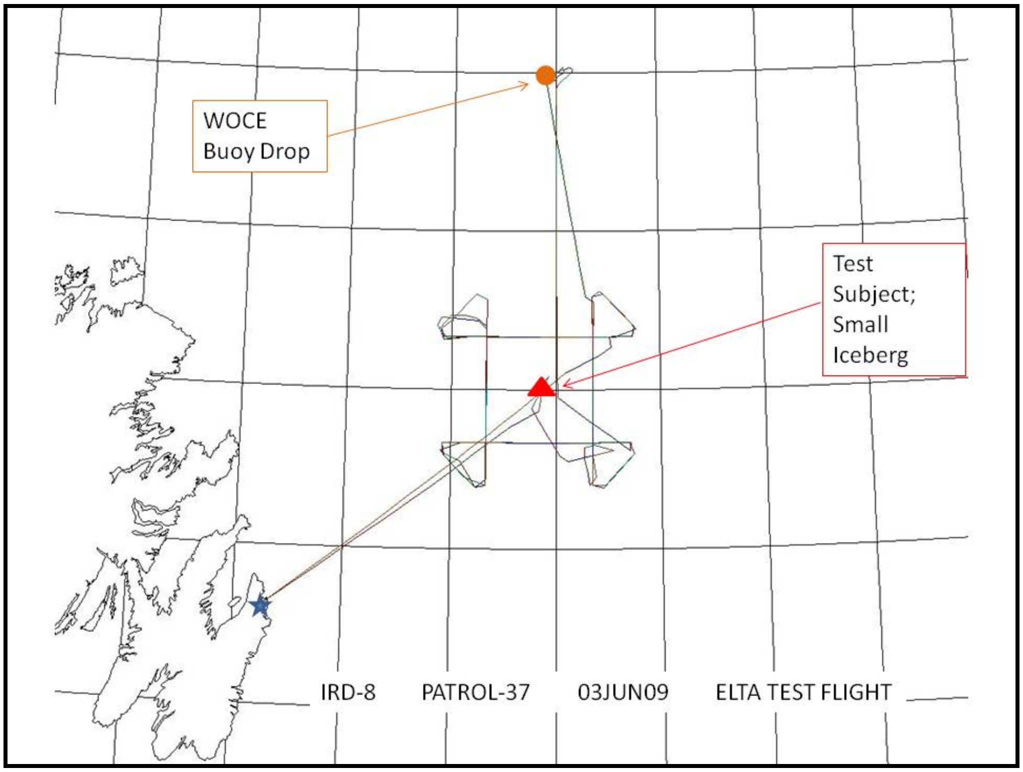


Figure 1. IIP Flight track of ELTA Radar Test.

Future Testing

IIP plans to continue working with CG-711, Air Station Elizabeth City, and the Research and Development Center to identify opportunities for additional testing to further refine the capability of the ELTA-2022 radar. This testing will be conducted in conjunction with 2010 IRDs as operations allow.

Summary

Despite the aggressive implementation schedule of the HC-130J with ELTA-2022 radar and associated mission system, CG-711, ECAS, IIP and other partners were successful in incorporating the new systems into IIP iceberg reconnaissance operations. Initial reconnaissance tactics and standard operating procedures were developed and implemented ensuring readiness for the 2010 Ice Season. All involved parties remain committed to further development of these systems. IIP is prepared to continue visual only patrols as necessary with reduced coverage and increased risk to the maritime community to complete its mission until the new systems can be fully implemented into IIP operations.

References

[1] International Ice Patrol, (2009). *IIP Airborne Reconnaissance Requirements.*

[2] Coast Guard Office of Aviation Forces (CG-711), (2008). *HC-130J Ice Patrol Suitability Test Report.*

Appendix D

Commercial Reconnaissance Study

LT Scott R. Houle

Background

In 2008 the International Ice Patrol (IIP) initiated a study to determine the feasibility of using commercial reconnaissance in IIP operations. The study was initiated in response to an increased demand for Coast Guard C-130 long range surveillance aircraft hours and the need to conduct aerial iceberg reconnaissance as efficiently as possible at the best value to the public. The desired outcomes of this study were to (a) determine the availability of reconnaissance aircraft operating similar to IIP in the current market, (b) determine the potential for aircraft operating in the current market to be transitioned to operate similar to IIP, (c) determine the capabilities of these aircraft and their sensor suites (i.e., radar/mission system), and (d) determine the cost associated with integrating commercial reconnaissance into IIP operations, including initial and routine operating costs.

Methods

IIP contracted Potomac Management Group (PMG), a U.S. Coast Guard Research and Development Center contractor, to conduct the study with assistance from IIP personnel and deliver the results in the form of two separate documents: (1) Market Survey Report and (2) Implementation Strategies for Commercial Iceberg Reconnaissance.

Market Survey

The market survey was intended to "assess the general availability of commercial airborne maritime reconnaissance services and, more specifically, identify companies that currently provide ice/iceberg reconnaissance services, or have the capability of adapting their current airborne reconnaissance operations to provide these services. This was accomplished through an Internet/literature search and the dissemination of a Request for Information (RFI) to the commercial aviation community published on the Federal Business Opportunities (www.fbo.gov) web site."[1]

The market survey identified only two commercial airborne maritime reconnaissance services currently available on the open market with the potential of providing ice/iceberg reconnaissance services for integration into IIP reconnaissance operations. Only one of these providers is currently in operation with the necessary aircraft, sensors, personnel, training and area knowledge necessary to begin providing services in a reasonably short period of time. The other provider would require additional time, resources and assistance to begin providing services. However, the aircraft proposed by both companies included the Bombardier Dash-8 and the Beechcraft King Air B-350 aircraft, suggesting that these aircraft are capable, with the appropriate configuration and tactics, of conducting iceberg reconnaissance in accordance with IIP's reconnaissance requirements.

Despite the limited response to the market survey, the available data suggests that "a viable ice/iceberg reconnaissance capability could potentially be supplied by the commercial aviation community."[1] The recommendation submitted by PMG with the completed market survey is that "both the Bombardier Dash-8 and the Beechcraft King Air B-350 aircraft be considered as the candidate commercial aviation platforms to be used in Task 2 (Deliverable 2) of this study, which will examine various scenarios and costs for utilizing commercial aviation services to supplement International Ice Patrol (IIP) iceberg reconnaissance."[1]

Implementation Strategies for Commercial Reconnaissance

The implementation strategies for commercial reconnaissance focused on two fundamental questions based on the findings of the market survey. "First, is it feasible to conduct iceberg reconnaissance in the western North Atlantic with commercial aircraft and sensors? Second, are there potential cost savings."[2] The remainder of this section quotes Deliverable 2 of the PMG report answering both of these important questions.

"An examination of IIP's reconnaissance operations found the number of aircraft hours used has varied widely over the 26-year period that IIP has been using radar-equipped aircraft for iceberg reconnaissance, from 198 to 697 hours, with an average of 463. These totals include patrol, logistic, and transit hours between the continental U.S. and the IIP Ice Reconnaissance Detachment's (IRD) forward operating base in St. John's Newfoundland, Canada. In some years, e.g. 1985, approximately 500 hours were used for iceberg patrols alone.

The analysis also showed that, because of the wide year-to-year variability in the location and number of icebergs, there are no standard IIP search areas and patterns that can be used to evaluate the capability of commercial aircraft. The location of the search areas depends on two factors: the severity of the iceberg season and the time during the season. As a result, a composite set of "representative" flight tracks was created to compare the capability and cost of the aircraft. Three years were chosen as examples of light, moderate, and severe iceberg seasons: 2004, 2000, and 2008, respectively. Within these years, a composite set of flight tracks that an IRD would search was created for conditions typical of early, mid, and late in the season. The resulting set of nine IRD scenarios formed the base of further analysis.

Four candidate aircraft were identified for detailed analysis using the nine IRD scenarios: the Lockheed HC-130H (which is currently being used by the USCG and serves as the baseline capability), the Bombardier Dash-8 and Beechcraft 350ER (which were proposed in responses to the market survey), and the Beechcraft B200 (which is currently being used by a commercial organization for ice reconnaissance). Detailed operating capabilities and costs for all these aircraft were not readily available, so independent estimates of aircraft capabilities and costs were developed for the analysis. In addition, several simplifying assumptions were made: same radar capability (detect a small iceberg within 30 NM of both sides of the airplane), same search speed (250 kts), and a set annual flight time of 500 hours for all aircraft.

All three commercial aircraft were able to conduct the searches in the nine IRD scenarios. In some cases, however, the commercial aircraft required multiple sorties in a day to complete a search that a HC-130H could complete in one sortie. Thus, with the assumptions of this study, conducting iceberg reconnaissance with commercial aircraft is feasible. For the nine IRD scenarios, all three candidate commercial aircraft were significantly less expensive to operate than the HC-130H, with the Dash-8 approximately 70% of the HC-130H costs and both Beechcraft aircraft about 50%.

Four implementation options for iceberg reconnaissance and benefits and risks of each are identified: Status Quo (USCG conducts all reconnaissance), All Commercial (commercial aircraft and observers used exclusively), Commercial Aircraft/USCG Observers (USCG provides observers aboard commercial aircraft), and Commercial/USCG mix (both Commercial and USCG aircraft are utilized shifting to more commercial over time).

A simple cost analysis shows that, over a 10-year period, all three commercial options resulted in a significant savings, from $28.9 M for the All-Commercial option to $16.6 M for the Commercial/USCG mix. For simplicity, this analysis was based on 500 hours per year for both the USCG and the commercial resource, and assumed that the Dash-8 would be the commercial aircraft utilized. These figures represent relative cost savings for comparison purposes and are not precise estimates of the actual savings associated with each option.

The study concludes with two recommendations. First, the USCG should conduct a proof-of-concept study to evaluate the capability and effectiveness of commercial iceberg reconnaissance. Second, the USCG should conduct a detailed financial analysis of the four implementation options."[2]

Conclusion

Based on the findings of the study and recommendations made by PMG, IIP may conduct both a proof of concept and detailed financial analysis pending a decision by the U. S. Coast Guard to proceed and the appropriate funding to move forward.

References

[1] Potomac Management Group (PMG), Inc., (2008). *A Study to Determine the Feasibility of Using Commercial Reconnaissance in International Ice Patrol Operations*, Deliverable 1.

[2] Potomac Management Group (PMG), Inc., (2008). *A Study to Determine the Feasibility of Using Commercial Reconnaissance in International Ice Patrol Operations*, Deliverable 2.

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