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Ice Islands Offshore Newfoundland and Labrador

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ABSTRACT

The presence of ice islands offshore Newfoundland and Labrador is of interest because of the potential threat posed to offshore oil production platforms, particularly considering that towing some of these large ice masses is not physically possible and their shallow drafts allow them to potentially reach sites where oil production currently takes place in the Jeanne d'Arc Basin on the Grand Banks. For example, the Petermann Ice Island A (PII-A) had a waterline length of approximately 12 km and an estimated mass of six billion tonnes when it drifted down the Labrador Coast in 2011, far too big for any tow rope or net for physical management. With a draft of less than 75 m, it was capable of reaching GBS production facilities on the Grand Banks without grounding on the seabed. Fortunately, PII-A stayed relatively close to shore, grounding near St. Anthony for a few days before continuing down the northeast coast of Newfoundland, where it disintegrated. However, if PII-A had drifted onto the Grand Banks, it would have posed a serious threat to oil production activities, particularly bottom-fixed structures, which cannot disconnect and move off location.

Ice islands were relatively rare in the 1980s during the early days of the offshore oil industry on the Grand Banks. Ice islands have become more common since the early 2000's due to a series of calving events at the Petermann Glacier on the northwest coast of Greenland. A historical overview of ice island observations is presented, along with more recent observations. Indications of another calving event capable of producing another large ice island from the Petermann Glacier are shown. Potential mitigation options to reduce risk of future ice islands to offshore oil operations are discussed.

KEY WORDS: Ice, Islands, Occurrence, Risk, Management.

INTRODUCTION

On occasion, ice islands are sighted off the coast of Newfoundland and Labrador (Figure 1). Ice islands are a special class of tabular icebergs characterized by their large size (ranging from hundreds of meters to several kilometers), low freeboard (generally less than 20 m), and an undulating surface. Bowditch (2002) defined an ice island as a piece of glacial ice that rises roughly 10 m above the ocean surface, having an overall thickness of about 50 m, often having a wave-like surface, and a surface area ranging from a few thousand m^2 to hundreds of km^2. An alternate description put forward by Newell (1993) defined Atlantic ice islands as very large, low, flat-topped icebergs having a length that exceeds 500 m if north of latitude 50ºN, or exceeding 300 m if south of that latitude, and emanating from the ice shelves of Northern Ellesmere Island or the east coast of Greenland.

There are a number of reasons why ice islands are of interest. Their large size means that it is difficult, if not impossible, to tow them, so it may not be possible to deflect an ice island from approaching an offshore platform. Large ice islands can calve numerous smaller ice islands and ice island fragments, overwhelming ice management resources. Ice islands may have relatively low drafts, compared with other conventional large icebergs, thus allowing them to drift into the relatively shallow waters of the Jeanne d'Arc Basin. While usually obvious in open water, ice island fragments can be difficult to detect in heavy seas because of their low freeboard, and they pose a particular hazard for shipping. From the air, they can be mistaken for pack ice and, if actually accompanied by pack ice, they can be difficult to detect. While a rare event, the incursion of a large ice island onto the Grand Banks can have serious consequences for bottom-founded structures which cannot move off location. The intent here is to give an overview of ice islands offshore Newfoundland and Labrador, in particular the Grand Banks region, and to provide some indication whether future incursions are possible. For an overview of ice islands in Canada, the reader may refer to Copland and Mueller (2017), Jefferies (1992), Van Wychen et al. (2020), or chapter 3 of Bell and Brown (2018).

Figure 1. Petermann Ice Island (PII-A) off Labrador, June 2011 (C-CORE, 2022)

HISTORICAL OCCURRENCE

An early report of an ice island in the region is from 1884 when the October 4th issue of Harper's Weekly, an American magazine based in New York city, included an article about an ice island sighted near St. John's, Newfoundland. The article included a sketch, produced by J.W. Hayward, of the ice island which was sighted on September 9 from a signal station 10 miles northeast of St. John's (Figure 2). The ice island was estimated to be six to eight miles long, with varying height and breadth, accompanied by 51 other icebergs following in its wake. While not unheard of, September is an unusual time to spot an iceberg off Newfoundland, since icebergs are typically observed in the spring and early summer. As can be seen in Figure 2 (top) the sketch of the ice island shows an irregular surface, which is not typical of ice islands. A search of the archives at The Rooms (https://therooms.ca/) yielded one photograph, taken by Simon Parsons, of an ice island visible from St. John's through The Narrows (Figure 3). There was no specific date attached to this photograph, except "before

1908", the year of Parsons' death. Parsons (1844-1908) was a professional photographer with a studio in St. John's when the 1884 ice island passed by, so it is very likely this is the same ice island. Hence, the irregular ice island surface shown in Figure 2 may be an embellishment, added simply to make the sketch more interesting for readers of Harper's Weekly. Reports of an ice island also appeared in the local newspaper the "Evening Telegram". The September 8th, 1884, issue reported that the schooner *Elizabeth* struck an "island of ice" off White Islands (southern Labrador) and had to be abandoned, and the September 30th, 1884, issue reported the presence of "one berg or half-island appears to be fully five miles long", in addition to 48 other icebergs in the vicinity of Cape Ballard (off the eastern coast of the Avalon Peninsula, between Renews and Chance Cove). The Harpers Weekly (1884) article stated that the ice island "doubtless the same that was seen and reported by Lieutenant Greely's party in higher latitudes". Greeley (1886) reported a 15-mile long "palæocrystic floe" (an ice island) after leaving Cape Baird in the Kennedy Channel in August, 1883. If this is indeed the same ice island, this gives just over a year for transit to St. John's.

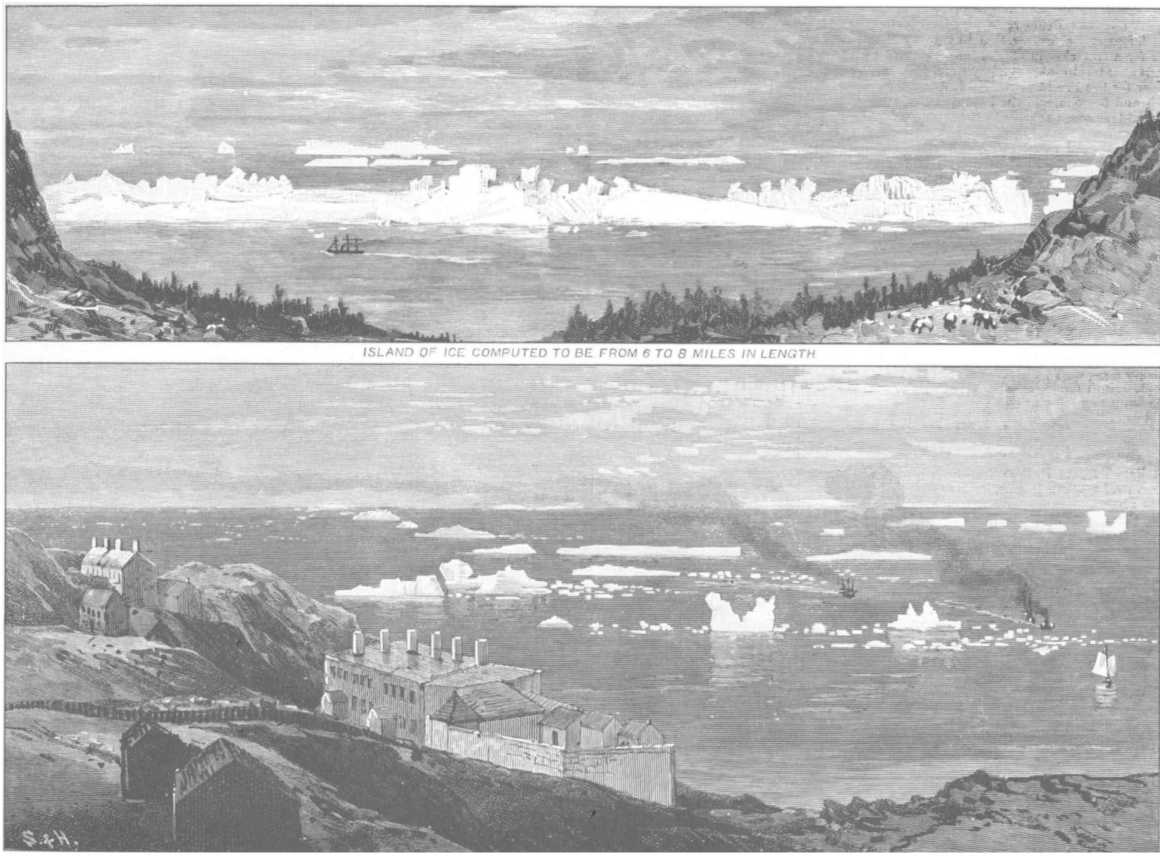

Figure 2. Sketch of ice island and icebergs near St. John's (Harper's Weekly, 1884)

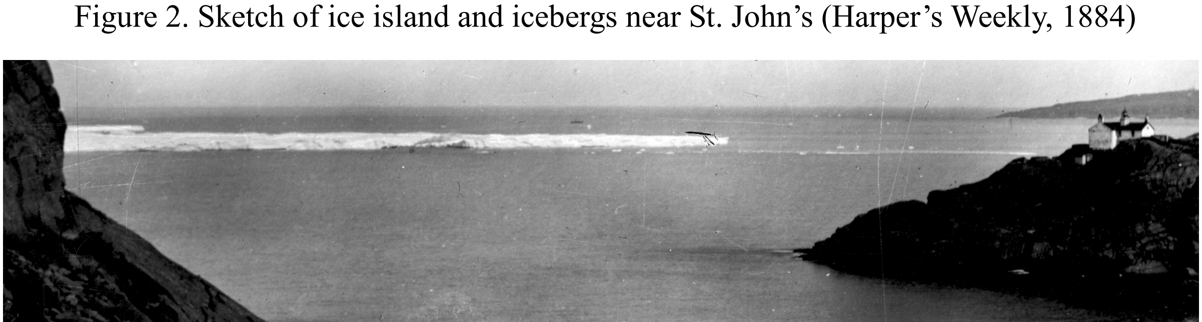

Figure 3. Photograph by Simon Parsons of ice island outside The Narrows, St. John's, NL

Newell (1993) provided a summary of large icebergs and ice islands occurring offshore Newfoundland and Labrador up into Baffin Bay. The largest of these, with waterline dimensions of approximately 18 × 8 km (Nutt, 1966), calved from the Ward Hunt Ice shelf on northern Ellesmere Island during the winter of 1961-1962. It passed through the Kennedy Channel in July of 1963, with fragments reaching the Grand Banks in 1964 (Figure 4). The ice island trajectory was reconstructed by sightings from a variety of sources, (i.e. vessel and aerial sightings) and pieces of the ice island were marked using oil drums and flags for later identification. The ice island broke up along the way, with about 50 fragments of unreported size being identified in April 1964 in the vicinity of the Grand Banks near 46°N, 51°W. The transit time from the Kennedy Channel to the Grand Banks was less than one year. The Ward Hunt Ice Shelf has diminished significantly in size since this event. Figure 5 shows changes in the ice shelves of northern Ellesmere Island, which includes the Ward Hunt ice shelf, from 1906 to 2008 (Antoniades et al., 2011).

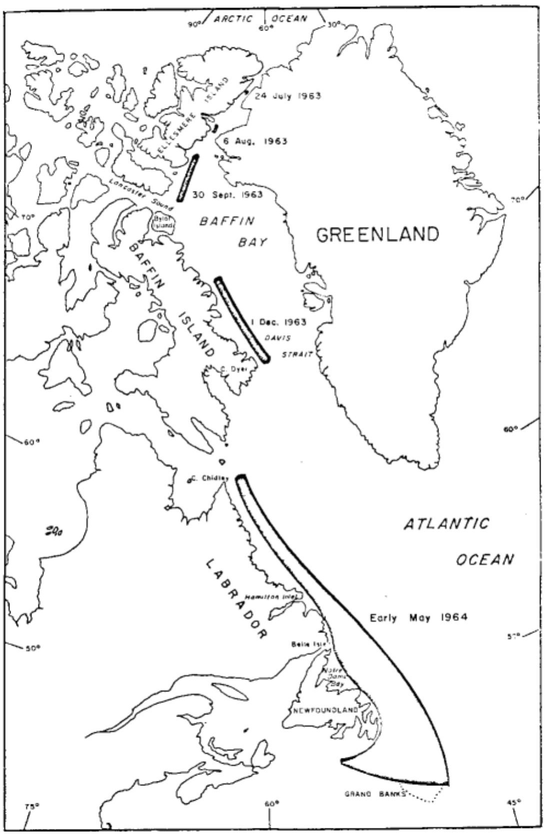

Figure 4. Ice island/fragments trajectory from Ward Hunt Ice Shelf to Grand Banks (Nutt, 1966)

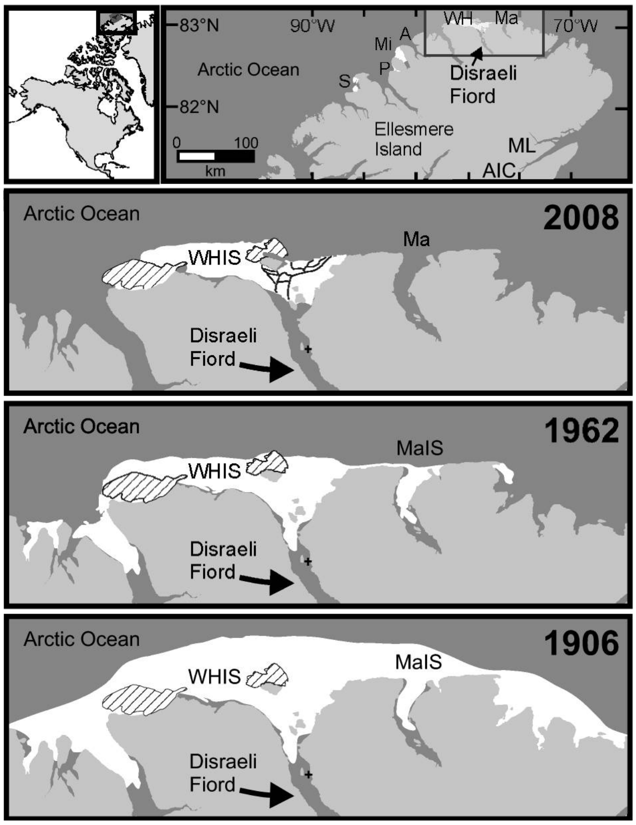

Figure 5. Changes in the ice shelves of northern Ellesmere Island, 1906 to 2008 (Antoniades et al., 2011)

The PERD (Program of Energy Research and Development) Iceberg Sighting Database (BMT Fleet, 2013) contains many reports of ice islands. Figure 6 shows a time series of ice island sightings south of 48°N from 1885 to 2012. Following the Bowditch (2002) definition, ice islands have a minimum waterline length of 300 m, which smaller pieces exhibiting similar geometry labelled "ice island fragments". The 1884 ice island is not included in the database, and therefore is not included in Figure 6. The two largest ice islands were observed in 1899 and 1901 (both 19.3 km, or 12 miles). The PERD database also lists an ice island (waterline length 1,370 m, width 1,005 m) sighted in 1945 in the southern Flemish Pass, which caused damage to 21 vessels in a convoy that encountered it in a thick fog (Stoermer and Rudkin, 2003). Robe et al. (1977) reported a 600-700 m ice island on the northern Grand Banks in June of 1976, but this ice island was not included in the PERD database. It is considered likely that the high rate of ice island presence before 1925 is due to the break-up of ice shelves on northern Ellesmere Island, although other contributing sources are possible.

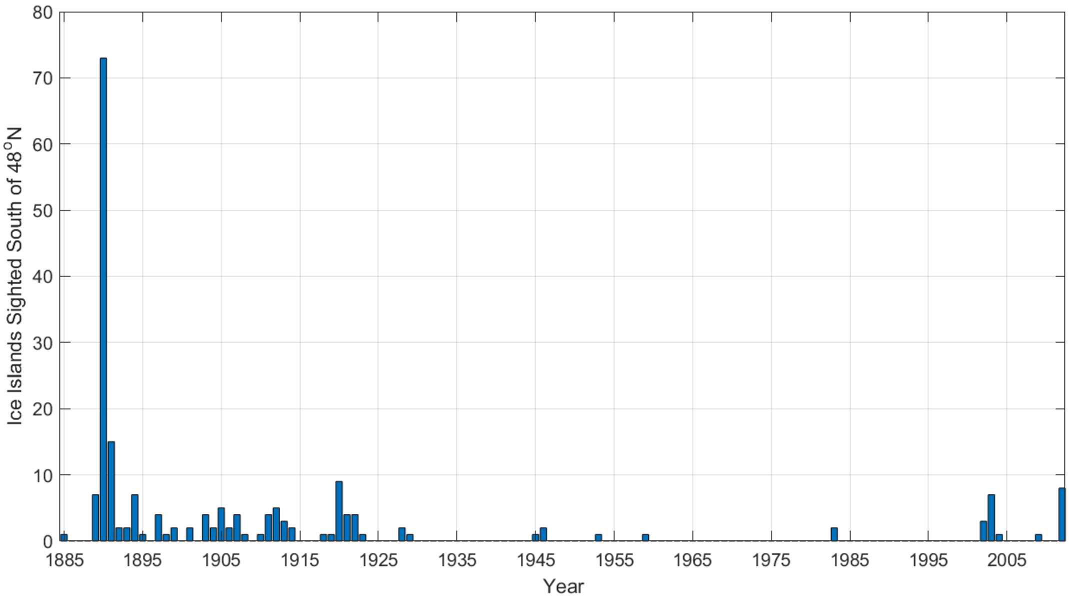

Figure 6. Ice islands sighted south of 48°N, 1885 to 2012 (PERD, 2013)

RECENT ICE ISLANDS

More recent post-2000 incursions of ice islands south of 48°N are thought to be largely due to calving events at the Petermann Glacier, although other sources are possible and cannot be ruled out entirely. Johannessen et al. (2011) document a number of major calving events at the Petermann Glacier between 1960 to 2010, with areas of ice islands produced as follows: 1959-1961 (~153 km^2), 1991 (~168 km^2), 2001 (~71 km^2), 2008 (~31 km^2) and 2010 (~270 km^2). An additional calving event in 2012 produced an ice island with an estimated area of 130 km^2 (Crawford et al., 2016).

Waterline lengths of post-2000 ice islands drifting south of 48°N range from 300 to 900 m, with a mean of 387 m, compared with a range of 300 to 19,312 m and a mean of 1,155 m for pre-2000 ice islands (excluding the extremely large ice islands of 1899 and 1901 results in a mean waterline length of 951 m). An analysis of the 2002 to 2004 trajectory data indicates that ice islands have higher drift speeds than the general iceberg population (C-CORE, 2022). The analysis excludes periods when the icebergs or ice islands/fragments were under tow, or the interval between sightings was less than 45 minutes or greater than eight hours. Overall, the mean drift speed of ice islands (and larger ice island fragments) is approximately 10% greater than that of icebergs, presumably because shallow draft ice islands are more influenced by faster surface currents.

In 2010 the Petermann Glacier calved a very large ice island (Figure 7, bottom left) which promptly broke in two after striking Joe Island, just south of the fjord, creating two ice islands PII-A and PII-B. Also visible in Figure 7 (top right) are five ice islands which calved from the Ryder Glacier. The fate of these ice islands, with areas ranging from 23 to 37 km^2, is unknown. A tracking beacon was installed on PII-A on August 25th, after which it was tracked continuously as shown in Figure 8.

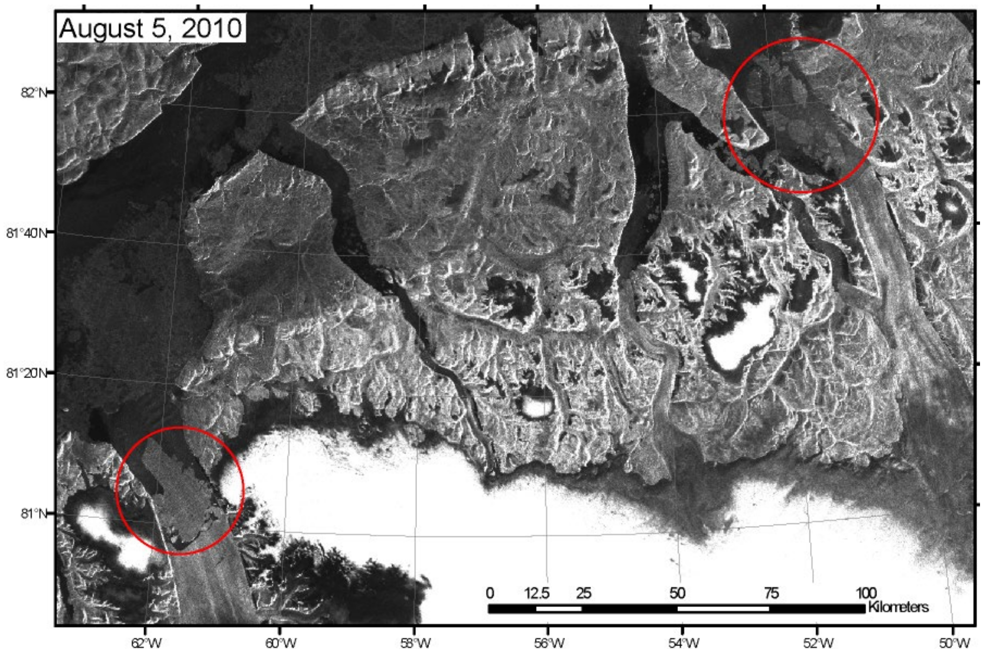

Figure 7. Ice islands calving from the Petermann and Ryder glaciers (C-CORE, 2022)

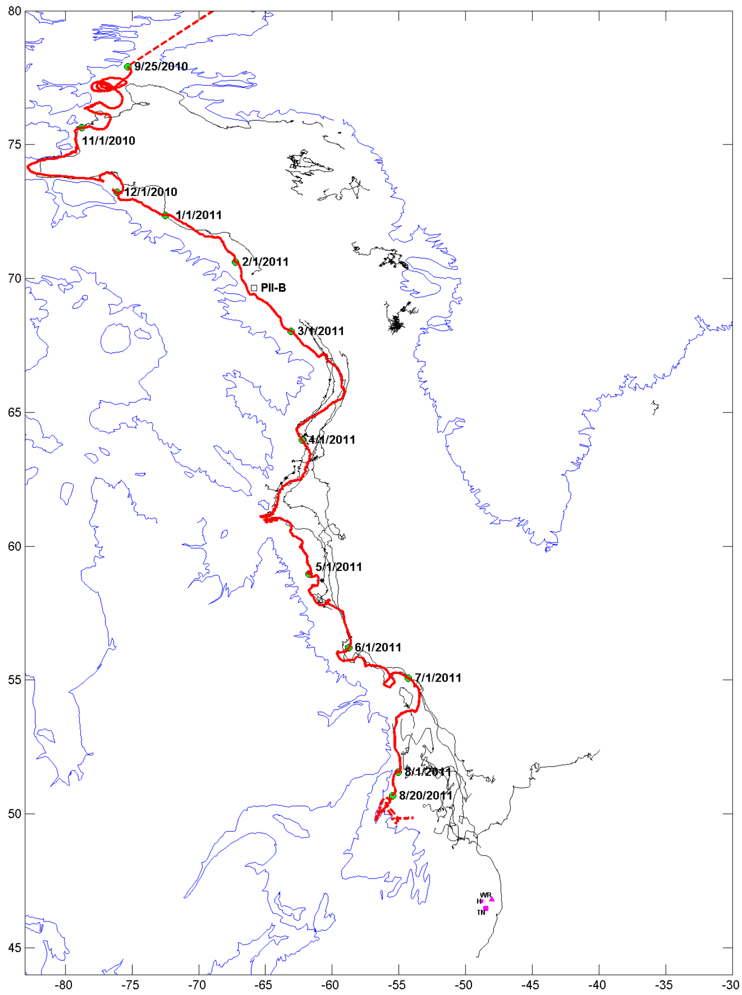

Figure 8. Trajectory of 2011 Petermann Ice Island, PII-A, black lines are iceberg trajectories from the IIP iceberg data buoy program (NSIDC, 2025)

The transit time from the Petermann Glacier to the northeast coast of Newfoundland was approximately one year. In June of 2011, C-CORE led a field program to PII-A while it was on the Makkovik Bank, on the Labrador Shelf, with the objectives of measuring its thickness and deploying additional beacons (Halliday et al., 2012). Thickness measurements for PII-A ranged from 48.3 to 81.2 m (drafts of 39.9 to 69.0). Figure 8 also shows iceberg trajectories collected as part of the IIP Data Buoy program (NSIDC, 2025). On July 1st, PII-A was following similar trajectories of icebergs which drifted into the Orphan Basin and near the Grand Banks, which implies PII-A could have done the same under different environmental conditions. However, PII-A veered to the west into shallower waters after early July, first grounding briefly just north of St. Anthony on the northern Peninsula, fragmenting after striking the Horse Islands further south, and then dispersing as smaller ice islands and ice island fragments along the northeast coast of Newfoundland.

While ice island incursions south of 48°N have been relatively rare in recent years, ice islands are still regularly detected further north on the Labrador Shelf. Figure 9 shows trajectories of ice islands tracked during 2023, and Table 1 gives relevant dimensions. The mean waterline length of these ice islands is 612 m and the mean area 0.16 km^2.

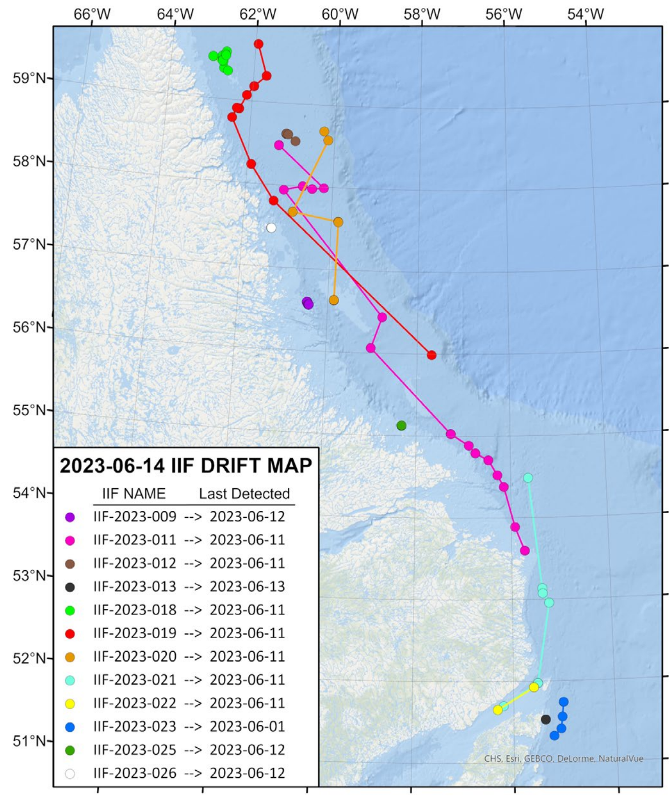

Figure 9. Ice islands trajectories, 2023

Table 1. 2023 ice island dimensions

Name	Length (m)	Area (km^2)
IIF-2023-008	575	0.140
IIF-2023-009	534	0.126
IIF-2023-010	458	0.108
IIF-2023-011	847	0.344
IIF-2023-012	700	0.150
IIF-2023-013	545	0.109
IIF-2023-014	603	0.101
IIF-2023-016	757	0.245
IIF-2023-018	571	0.150
IIF-2023-019	525	0.175
IIF-2023-020	632	0.147
IIF-2023-021	663	0.235
IIF-2023-022	507	0.133
IIF-2023-023	509	0.141
IIF-2023-024	652	0.202
IIF-2023-025	634	0.100
IIF-2023-026	518	0.110

FUTURE ICE ISLANDS

While other glaciers may produce ice islands which would reach the Grand Banks region, the Petermann Glacier is of particular interest because of the association with previous ice island incursions. Figure 10 shows the progression of a crack across the Petermann Glacier from 2016 to 2024, which will likely result in the next major calving event. This crack now reaches almost all the way across the glacier, and is expected to culminate in a calving event in the next few years.

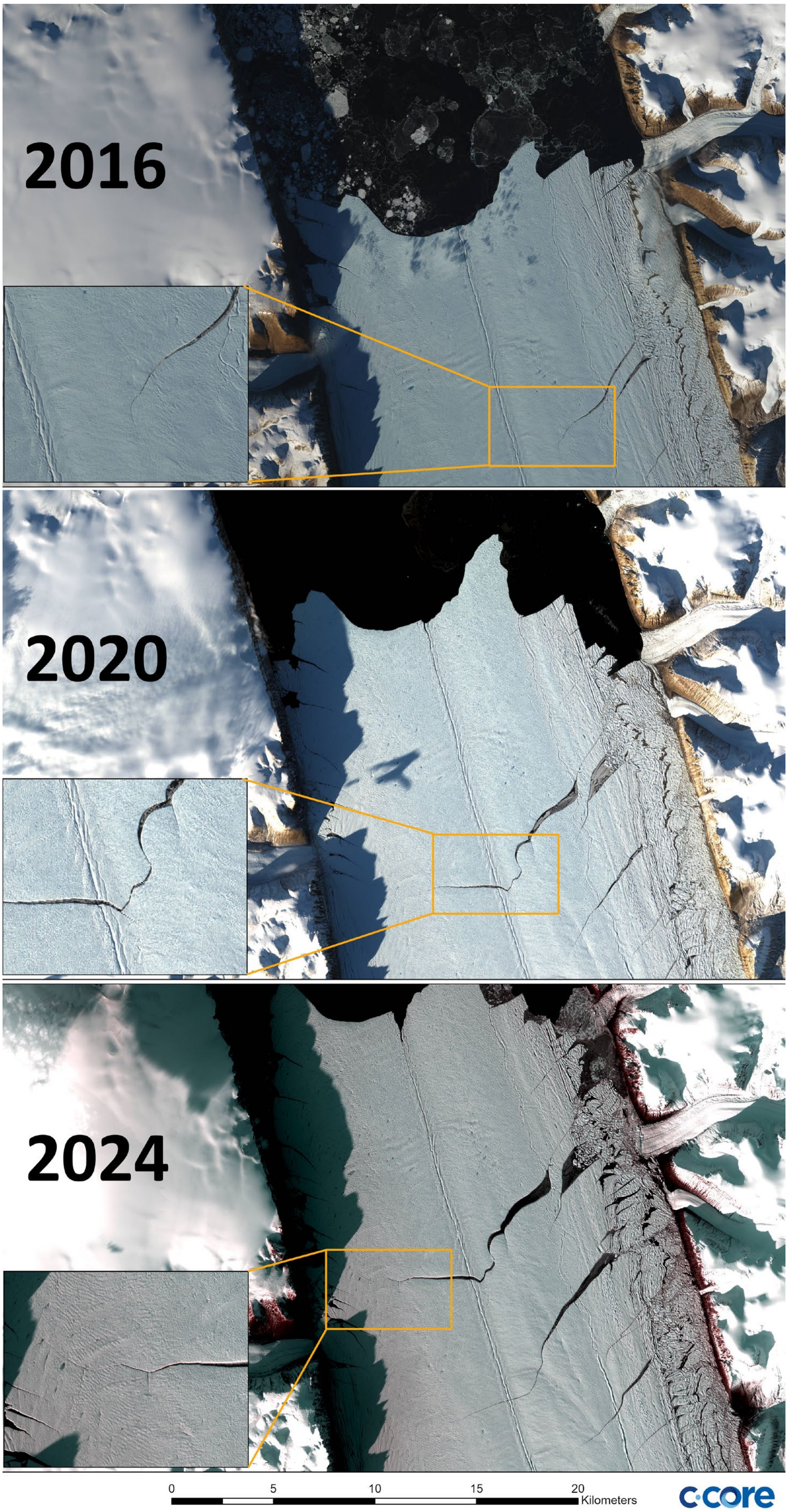

Figure 10. Progression of crack across Petermann Glacier

Figure 11 shows the expected outline and area of the resulting ice island. The estimated 174 km^2 area is smaller than the 270 km^2 2010 event, but larger than the 130 km^2 2012 event, and the 71 km^2 2001 event which resulted in several ice islands on the Grand Banks. The Petermann Glacier is being monitored frequently by interested parties (including C-CORE) to determine when the calving event occurs, and it is expected that the resulting ice island(s) will be tracked via satellite imagery afterwards.

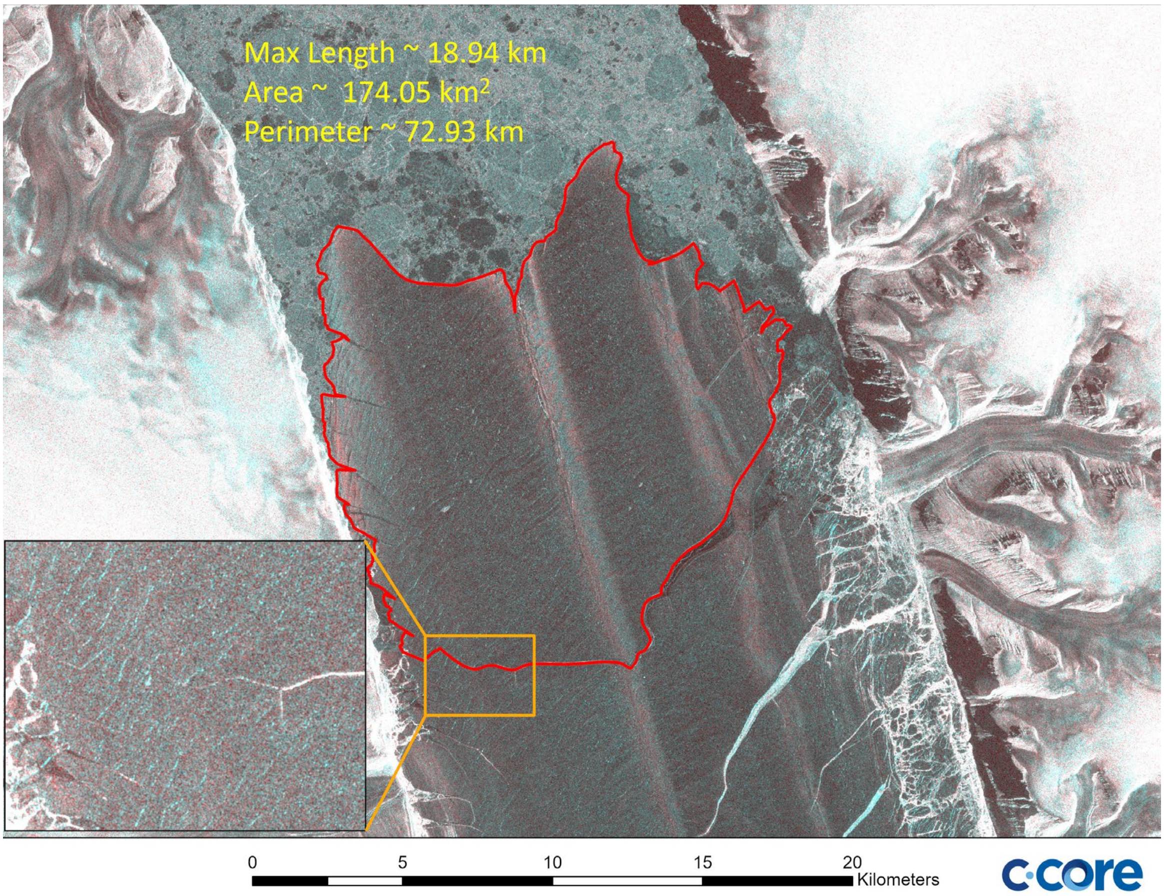

Figure 11. Sentinel-1 IW (20m resolution) image, March 7th, 2025, showing outline and dimensions of potential ice island

POTENTIAL RISK MITIGATION MEASURES

Risk mitigation measures for ice islands vary according the nature of the facility. Any of the risk mitigation measures presented here, if implemented, would be incorporated into an overall risk management framework which would include drift and deterioration modelling and threat analysis, as described by Fuglem et al. (2012). A FPSO can simply move off location in the event of a threatening ice island. While a GBS can withstand significant iceberg impact loads (for example, Windengo et al. (2013) gave a 10^{-4} yr^{-1}, or 1 in 10,000 years, iceberg impact load of 486 MN for the Hebron GBS), ice island interaction loads will be higher due to their mass and geometry. A detailed analysis of ice island loads is beyond the scope of this paper.

Physical ice management (towing) can be used to mitigate ice island risk to an FPSO (Floating Production Storage and Offloading) facility or a GBS (Gravity-Based Structure), and has been demonstrated on the Grand Banks for ice islands up to 500 m waterline length (Ralph et al., 2025), with more powerful ice management vessels now available presenting the possibility of increasing this value. Field trials would allow the success rate for ice island physical management to be better defined, and procedures for ice management operations for ice islands to be refined. Should physical ice management fail, a floating facility such as an FPSO can mitigate the risk by simply disconnecting and moving off-site. However, a GBS would likely require evacuation. Based on the limited number ice island draft measurements to date, subsea facilities such wellheads and flowlines on the Grand Banks are not likely to be threatened by ice islands, although this should be confirmed with additional data collection.

Explosives could potentially be used to break an ice island into smaller pieces which would deteriorate faster and be more easily managed. Attempts by the International Ice Patrol in 1959 (see https://www.navcen.uscg.gov/international-ice-patrol-history) to use explosives (high temperature magnesium and thermite incendiary bombs dropped from an aircraft) on icebergs were unsuccessful (see Figure 12). This failure may simply have been a matter of scale. A large quantity of explosives could be transported (i.e. by helicopter) to an ice island and either placed on the surface or placed in drill holes in a pattern designed to enhance fracturing and calving. However, this option might be rejected due to disruption to wildlife (note the seals visible in Figure 1). Any such operation would need to be done well up-stream to allow resulting pieces of the ice island to disperse and deteriorate. Testing is recommended.

The deterioration rate of an ice island could be enhanced by depositing dark matter (i.e., soot, carbon black, etc.) which would absorb solar radiation. The application of substances for enhancing melting of river ice is well documented (i.e. Tananaev, 2011; Tatinclaux, 1998; Wuebben and Gagnon, 1995). River ice breakup in Siberian rivers (Tananaev, 2011) is enhanced by the application of pieces of coal, coal dust and coal ash. Figure 12 shows the application of coal and coal dust to the Lena River in Siberia using tractors and aircraft. Coal ash has also been used on rivers in the United States. C-CORE (1998) tested the application of carbon black for enhancing iceberg deterioration. During a field trial in June of 1998, 23 kg of carbon black was applied to a bergy bit (8 m waterline length) and melt rates were compared to a control section (no carbon black) and a section with rock salt. The carbon black caused 15 cm of melting in 2.5 hours relative to the untreated surface and the surface treated with rock salt (which both presumably also underwent some undefined degree of melt, but were indistinguishable from each other). This suggests significant deterioration rates can be achieved. As with explosives, any such operation would need to be done well up-stream to allow resulting pieces of the ice island to disperse and deteriorate. Testing is recommended.

Figure 12. Iceberg bombing experiment (source: International Ice Patrol)

Figure 13. Coal and coal dust spread on Lena River, Siberia, 2005, by tractor and aircraft (photo courtesy of Charles Randell)

CONCLUSIONS

A review of the available data shows that, while the ice island presence in the Grand Banks region has decreased since the early 1900's, they still occur periodically. An imminent calving event at the Petermann Glacier will produce another large ice island which may result in incursions of ice islands and ice island fragments into the Grand Banks region, potentially threatening hydrocarbon exploration and production activities. Based on three cases presented here (the 1884, 1961 and 2010 events), the transit time for an ice island from the Kennedy Channel to the Grand Banks could be as low as one year. While an FPSO or floating facility can simply disconnect and move off station, a GBS cannot. As such, an ice island interaction is a low-probability, high-consequence event for bottom-founded structures. While physical ice management (towing) has been demonstrated for smaller ice islands, other strategies must be developed for larger, kilometer-scale, ice islands. Fragmentation using explosives and enhanced deterioration via the application of solar energy absorbing material are suggested, although other approaches may be assessed. Gammon and Lewis (1985) reviewed several alternatives for fracturing icebergs which may be adapted/updated for application to ice islands. Alternatively, more efficient methods for applying forces on an ice island to cause deflection may be considered (i.e. pushing instead of towing, which would also eliminate the need for very long and expensive tow ropes).

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