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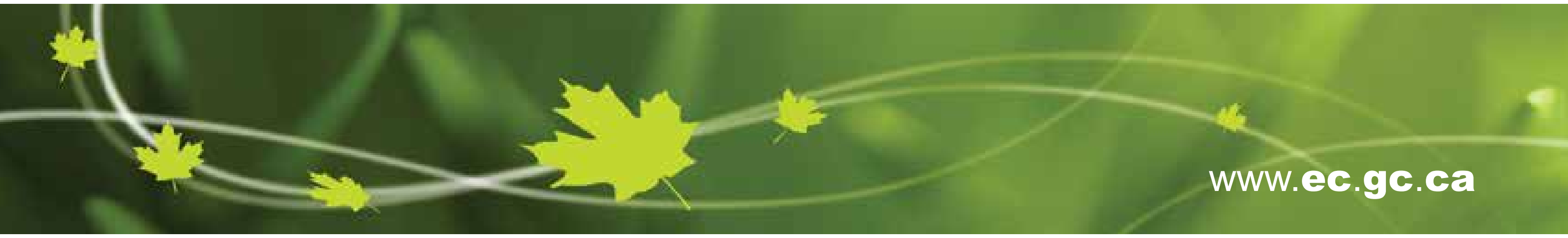

National Marine Weather Guide
Arctic Regional Guide

Canada

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Cover Photo credits
Cover Left: Sail boat waiting in safe harbour. Photo: Nicolas Peissel
Cover Center: Ship being led by Canada Coast Guard icebreaker. Photo: Jacques Collin
Cover Right: Akpait National Wildlife Area. Photo: Garry Donaldson

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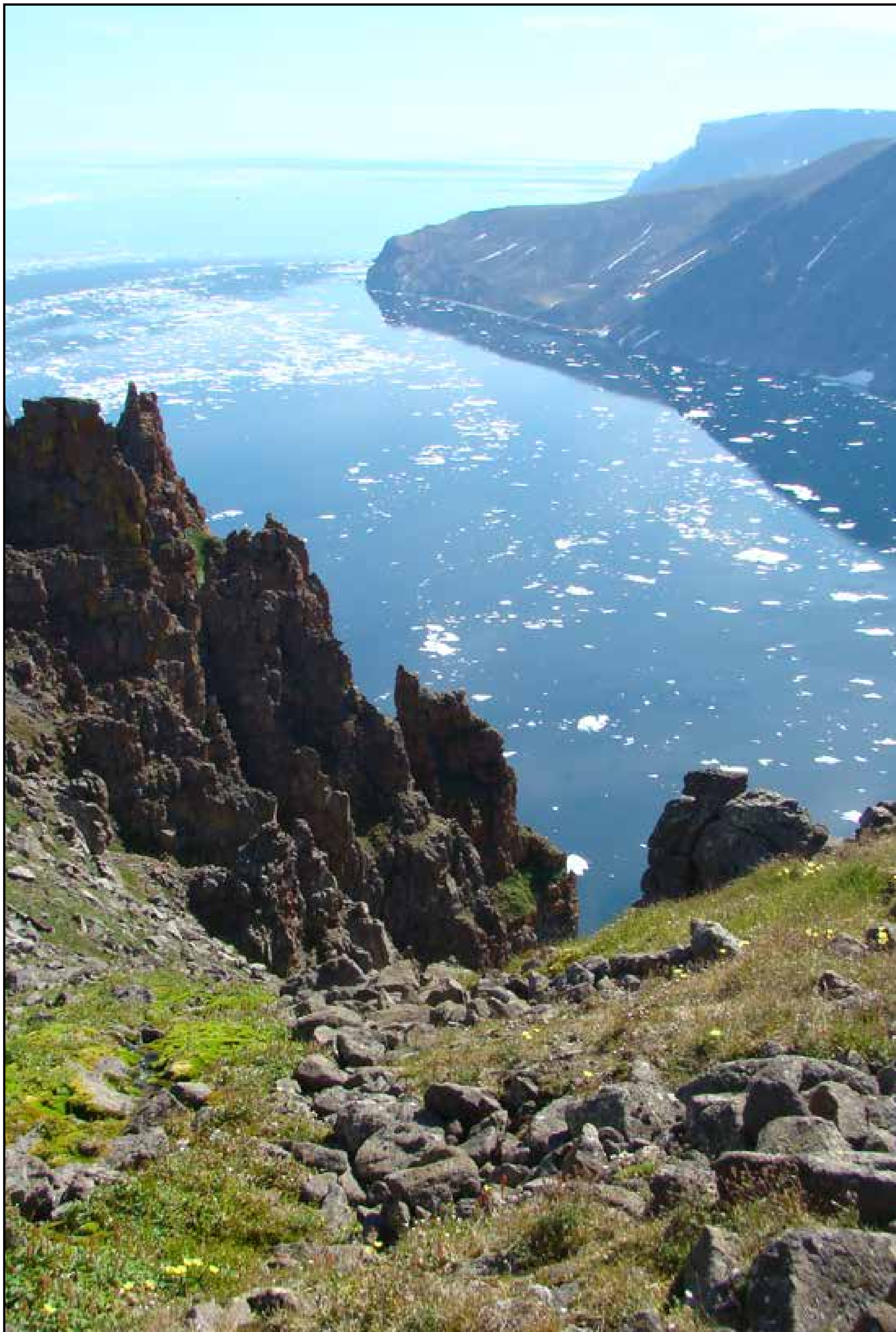

Akpait National Wildlife Area (NWA), Baffin Island, Nunavut. Photo courtesy of Garry Donaldson.

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ARCTIC REGIONAL GUIDE PART 1: INTRODUCTION

1. Introduction

This chapter contains information on local weather effects for waters in Arctic Canada that are identified as "marine transportation corridors," as well as for the northwestern portion of the Northwest Passage. The guide is intended for use only during the active marine season, when ambient weather and ice conditions do not limit the time within which the Canadian Arctic is open for marine operations. In general, this season is longest in the south—beginning in May and ending in November in Davis Strait—and shortest in the northwest.

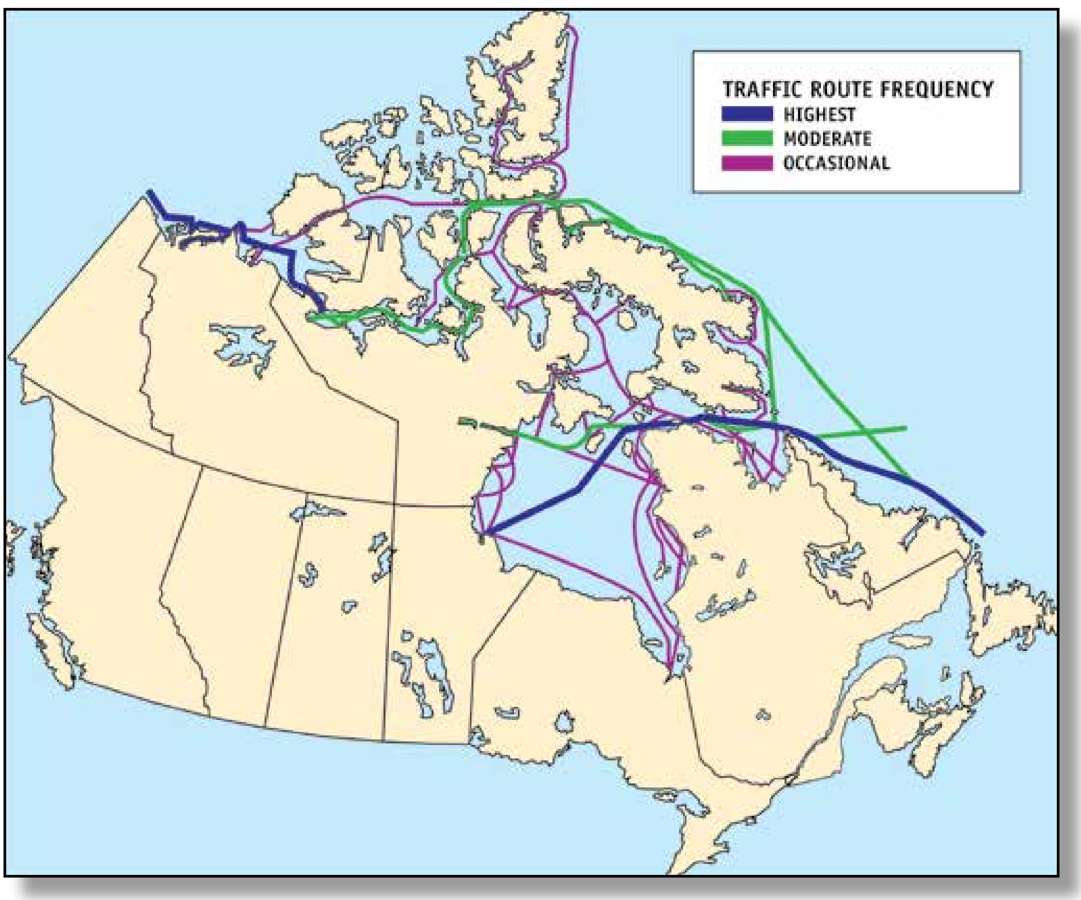


Figure 1: Marine transportation corridors in northern Canada.

1.1. Using This Guide

The maps in this guide indicate the type and location of effects through the use of special symbols, as defined in the following chart. It is recommended that the chart be printed for cross-referencing purposes in using this guide. The meteorological theory behind these effects is described in detail in the Met 101 section of the *National Marine Weather Guide*.

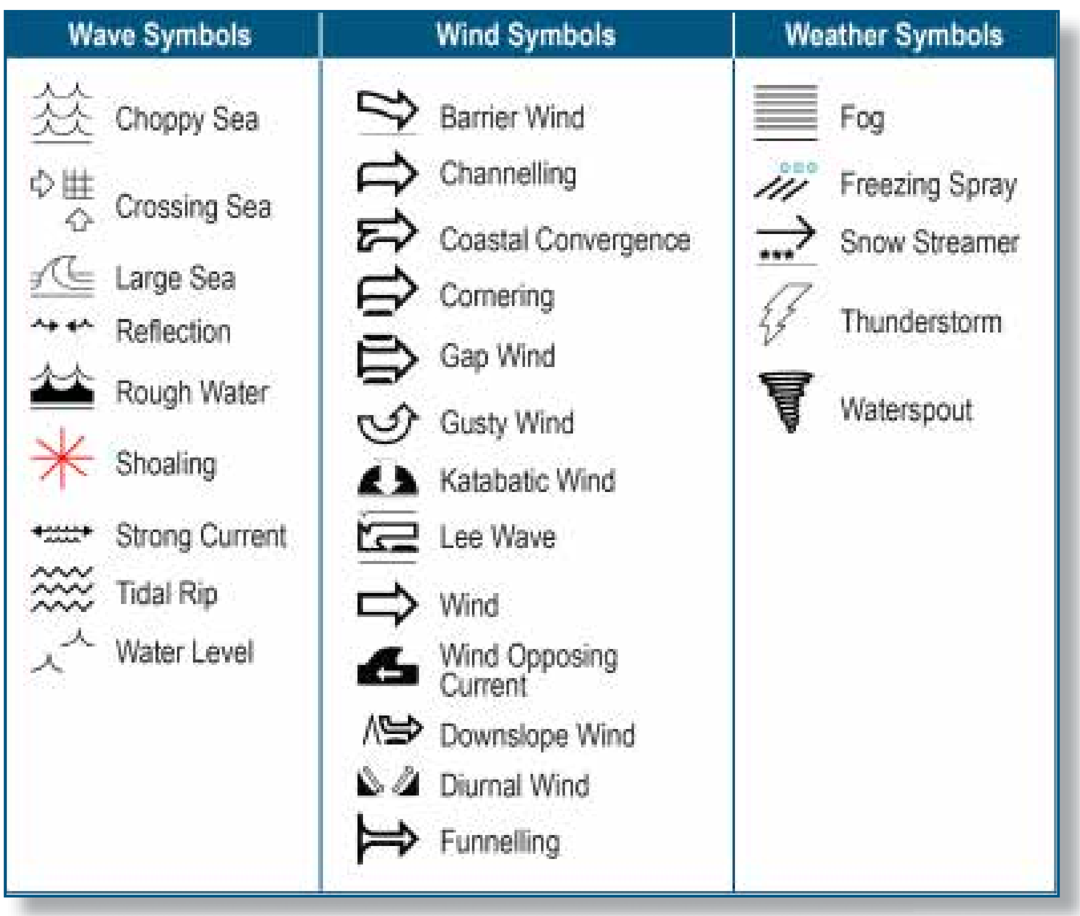


Figure 2: Description of local effect symbols used in remaining chapters of guide.

Some images in the guide depict synthetic aperture radar (SAR) winds, which are remotely sensed, satellite-based, high-resolution estimates of the wind field derived from C-band radar observations in areas where few, if any, observing platforms are located.

Times are represented in Coordinated Universal Time (UTC), which is common to all global locations. In meteorology, most analyses occur daily at 00:00, 06:00, 12:00 and 18:00 UTC.

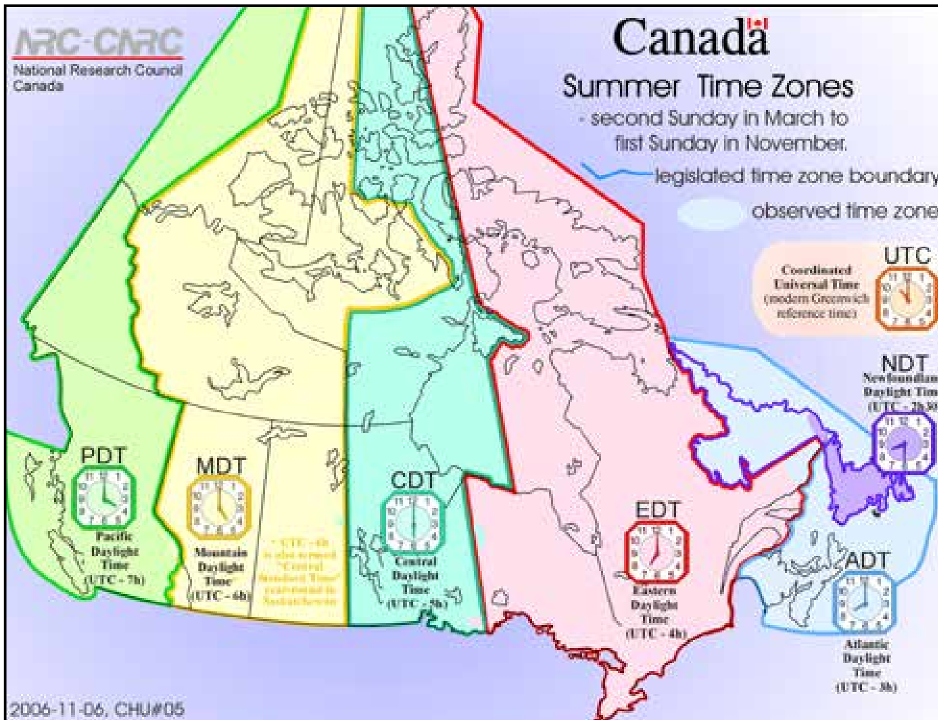


Figure 3: Offset between Coordinated Universal Time (UTC) and local times in Canada.

1.2 Marine Weather Services

Environment and Climate Change Canada issues marine forecasts for the Canadian Arctic waters during the active (open-water) season, closing the areas when ice levels reach a certain threshold and no ships are transiting the area. Closed forecast regions are re-opened during the times when ships require forecasts to transit those affected areas.

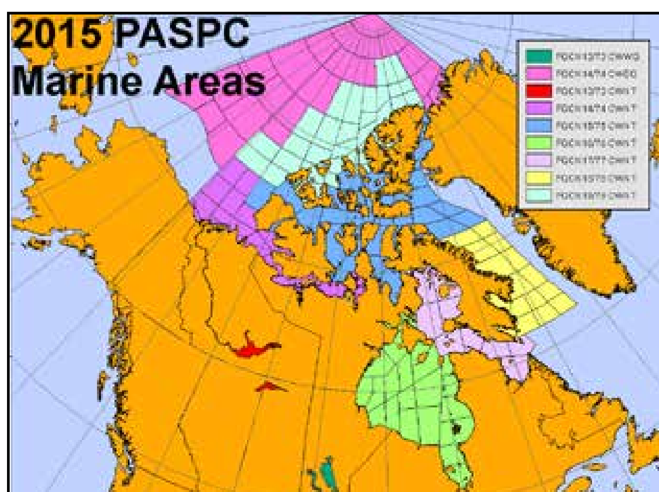


Figure 4: Areas of the Arctic where Environment and Climate Change Canada issues marine forecasts.

2. Geography

The Canadian Arctic extends from a longitude of approximately 60°W to 141°W and a latitude of 60°N to 90°N (the North Pole). It encompasses 20 percent of the Arctic Ocean, and its coastline—which stretches from the western reaches of the Beaufort Sea to the eastern shores of Ungava Bay and includes the Canadian Arctic Archipelago—is longer than that of all of Canada's ocean-fronting provinces combined. Canada's arctic waters are also home to the world's largest inland sea, Hudson Bay, and some of the country's largest lakes and rivers.

The geography of the Arctic varies greatly, encompassing the Arctic Cordillera mountain range in the east and western mountain ranges in the Yukon, the thousands of islands that comprise the Canadian Arctic Archipelago, and the vast expanses covered by the Arctic and Hudson Bay lowlands.

The Canadian Arctic offers mariners a variety of land and seascapes. Its complex topography, interaction with synoptic weather patterns, and distance from communities with infrastructure and support make it essential for mariners to be constantly aware of changing ice, wind, and weather conditions in order to navigate safely in this remote region of the country.

Photo of ship in safe harbour.

Iceberg in Arctic waters.

Ship being lead by Canada Coast Guard icebreaker

3. Weather

3.1 Storms

The formation, movement, and dissipation of arctic low-pressure systems are determined by a number of factors, including topography, sea-ice concentration, and a sharp contrast in temperature over a short distance. Because of this, favoured areas for the formation of lows include the lee side of mountains, expanses of open water that are warmer/colder than the surrounding land, and the ice edge. In the Arctic, low-pressure areas occur year round but tend to happen more often in certain places, depending on the time of year.

Mariners' Tips:
The average speed of an arctic low-pressure centre or cyclone is 18 kt; however, extremes can vary from nearly stationary to 40 kt.

Maps combining numerous sequential plots of low-pressure centres over time indicate areas where mariners can expect to experience more severe weather conditions, on average. While storms can still occur in other areas, meteorologists refer to these preferred pathways for storm motion as "storm tracks". These tracks tend to shift more southward as the active marine season progresses.

Sail boat near glacier. Photo courtesy of Nicolas Peissel.

The Canadian Coast Guard Heavy Arctic Icebreaker, Louis S. St-Laurent, conducts research in the Arctic Ocean during an Office of Naval Research-sponsored study of the seasonal ice zone. (U.S. Navy photo by John F. Williams/Released) https://creativecomm

To define these tracks, Environment and Climate Change Canada undertook a detailed examination of surface-pressure maps from 2000 to 2012 using the Arctic System Reanalysis (ASR)—a gridded data set composed of a mix of observations and model output. Recent research has proven the ASR effective at identifying low-pressure areas over the Arctic as well as and providing a more complete lifecycle of the storms. Its grid spacing is 30 km.

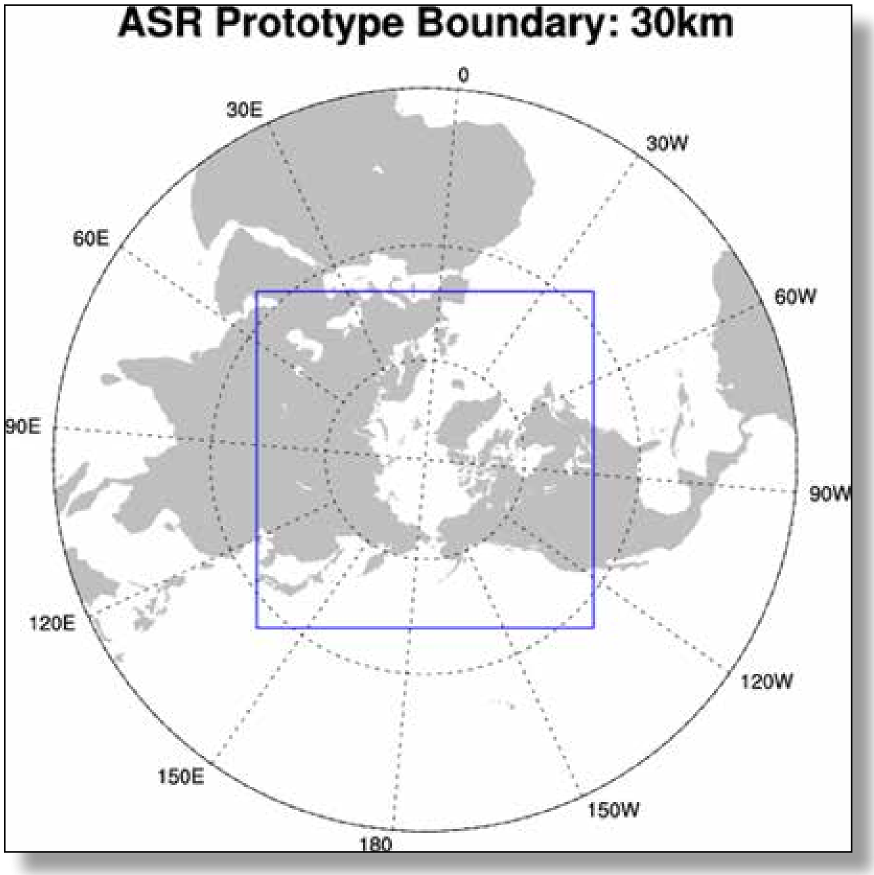


Figure 5: Domain covered by the Arctic System Reanalysis data set.

Because storm tracks move with the progression of seasons, two plotted maps were created for the active marine season: one covering the period from June through August and the other, from September through November. Only storms that maintained a closed, low-pressure centre for at least 48 hours were included. The storms were grouped together using statistical averaging—the shaded areas along each side of the storm track indicating the envelope within which 75 percent of them fell. It should be noted that the strongest winds and most adverse weather and waves typically occur ahead and to the right of the low centre or, following the passage of the low, to the west of its track.

Of particular relevance to mariners from June to August are storm tracks affecting the Arctic Archipelago (numbers 1, 2, 5, 6, 9, and 10), including much of the Northwest Passage, as well as those affecting Hudson Bay, Southern Baffin Island, and the northern Labrador Sea (numbers 3, 4, 8, 14, 15, and 16). Few storms over the Beaufort Sea last more than 48 hours at this time of year.

From September to November, the development of storm tracks across Alaska and the Yukon affects waters in the Beaufort Sea and the Western Archipelago (numbers 10, 13, 18, and 19), while more defined tracks moving northeast from the Prairies affect Hudson Bay and Baffin Island. The impact of lee cyclogenesis can be seen in the Mackenzie Valley, with storms forming and then tracking eastward across northern Hudson Bay (numbers 2 and 11). Storms tracking across Atlantic Canada (numbers 7, 8, and 15) frequently move across the Labrador Sea into Davis Strait, causing significant winds and weather for much of Baffin Island.

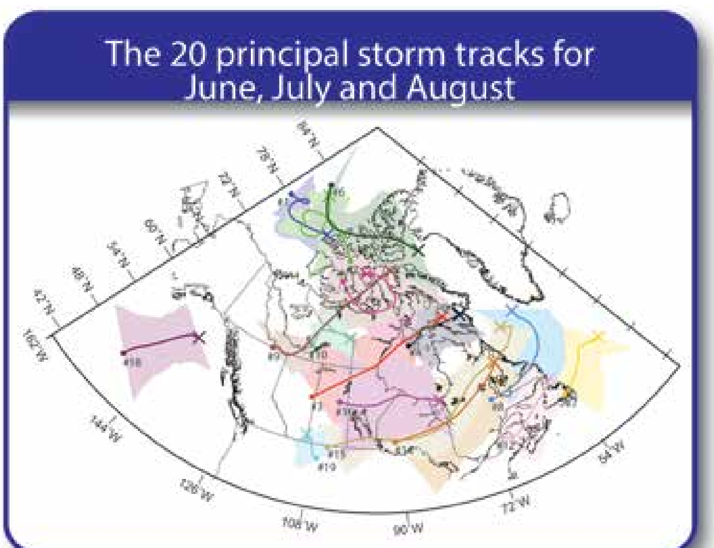


Figure 6: The 20 principal storm tracks for June, July and August.

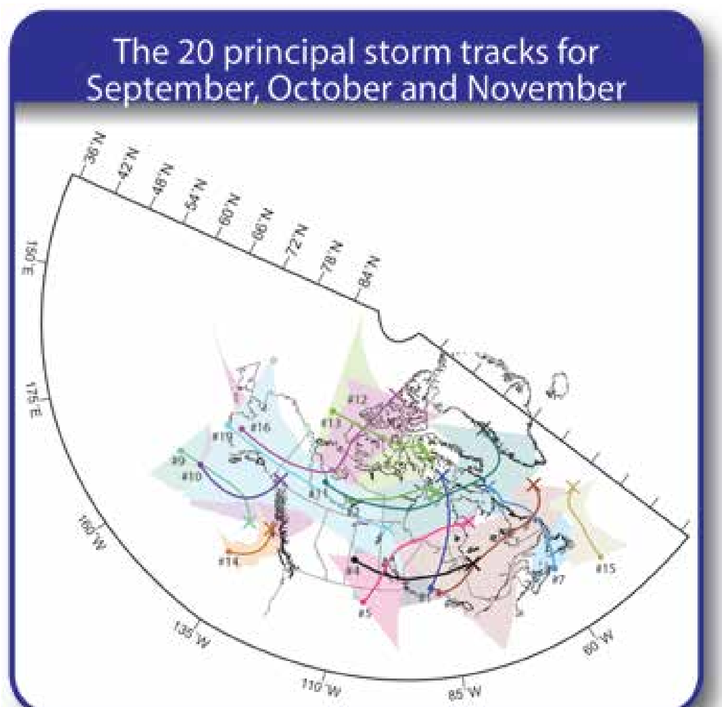


Figure 7: The 20 principal storm tracks for September, October and November.

Mariners' Tips:
In much of the Arctic, as many as 80 to 95 percent of summer days are overcast, making the region one of the cloudiest in the Northern Hemisphere.

3.2 Precipitation

Much of the Arctic receives little precipitation, with some areas seeing annual totals as low as those of the Sahara desert. Amounts do vary widely by region, however, with the Hudson Bay, Hudson Strait, and Davis Strait areas receiving the most precipitation and the Western and High Arctic, the least. In the Central Arctic, almost all precipitation falls as snow in winter, with some snow also occurring in summer. Rain makes up 40 to 50 percent of the total that falls over the Southern Arctic—most of it occurring from May through September—but only 30 percent of that received over the higher latitudes, where most arrives in July and August. Drizzle tends to be the most frequent form of precipitation over large areas of the Arctic's oceans.

Precipitation over land is strongly influenced by topography, with the highest amount occurring over the higher terrain regions of southeastern Baffin Island and, to a slightly lesser degree, Ellesmere Island. Steady snow melt caused by solar radiation usually begins by mid-June, although marked differences occur from year to year. Snow cover in the Central Arctic is re-established in late August.

Frequencies of freezing precipitation in the Arctic are quite low and rarely last more than a few hours. The heaviest freezing rain events tend to occur during the months of September and October, when most observing sites reported an average of less than 25 hours of freezing rain. Although the brevity of these events typically minimizes their impact, freezing rain can cause icing on the superstructure of vessels. Freezing drizzle is a much more common phenomenon that generally occurs only in below-freezing temperatures above -10°C. In the Arctic, it forms most frequently on the southwest side of Hudson Bay, where the air mass is colder than the warmer sea water. The chance of freezing drizzle is usually greatest before sunrise, when temperatures are lowest, and gradually tapers off over the course of the morning and into the late afternoon. While it generally has only a minor impact on mariners, it can cause problems if it builds up on decks and rigging.

3.3 Fog

Fog can be problematic in many parts of the Arctic, especially during the spring and summer months—with the frequency of both fog and low clouds peaking in June and July. It occurs frequently over the cool waters of the Arctic Ocean, especially during the ice-free months of summer, most often in a belt parallel to the coastline, where strong horizontal temperature and moisture gradients exist between ice, water, and land. Temperature, wind, sea-state, and ocean currents also play a role in the development of local fog, which has unique seasonal and daily trends.

Advection fog frequently occurs over the sea and adjacent coastal areas when warm air masses from southern Canada move into the Arctic and pass over ice and cold water. It is most frequent from June to September, when the winds are light and the temperature contrast between the ocean and air is greatest. It is especially widespread when additional moisture is added to the air through evaporation from pools of meltwater on the sea ice. As the season advances, it becomes patchier—increasing in frequency and density where drifting ice floes are present and decreasing over ice-free waters and land.

Steam fog (also known as sea smoke or evaporation fog) forms when very cold air passes over areas of open water in the form of fractures, leads, and polynyas. Often observed in the Arctic from October to April, it is relatively localized and does not usually persist more than a few kilometres downwind of these areas. From a distance, steam fog is a useful indicator of the presence of open water.

Radiation fog is most common in fall or early winter. It forms at night, when the surface layer of the air is cooled by outgoing radiation, most frequently in clear, calm conditions over cold snow or ice-covered surfaces (including pack ice). Often seen over lakes and along river valleys, where the air movement is minimal, this generally thin and shallow fog burns off in the daytime when there is land nearby.

Ice fog—which is composed of tiny ice crystals—occurs only during the colder time of the year, when temperatures are less than -15°C. It is most likely to occur in the vicinity of settlements, industrial infrastructures, and areas of transportation activity.

Mariners' Tips:
With offshore winds, fog does not usually form adjacent to large land areas, with narrow channels remaining relatively fog-free when there is a brisk flow along the water.

4. Sea State

4.1 Sea-Surface Temperature

The seasonal variation of sea-surface temperatures in the Canadian Arctic during the active marine season shows a significant gradient in the south and little variation in the north. For example, in Hudson Bay, the temperature in July can range from -2°C in the north to 10°C in the south.

4.2 Currents

Currents in the Arctic Ocean are key to understanding where ice may form and how it moves. Because ice is only about 10 percent less dense than water, most of it is floating and responds quickly to a change in current. Currents fluctuate widely with seasons, storm frequency, wind direction, and sea-ice concentration. Water movements near shore are also strongly affected by tidal motion, surface-water runoff, and local, terrain-influenced winds.

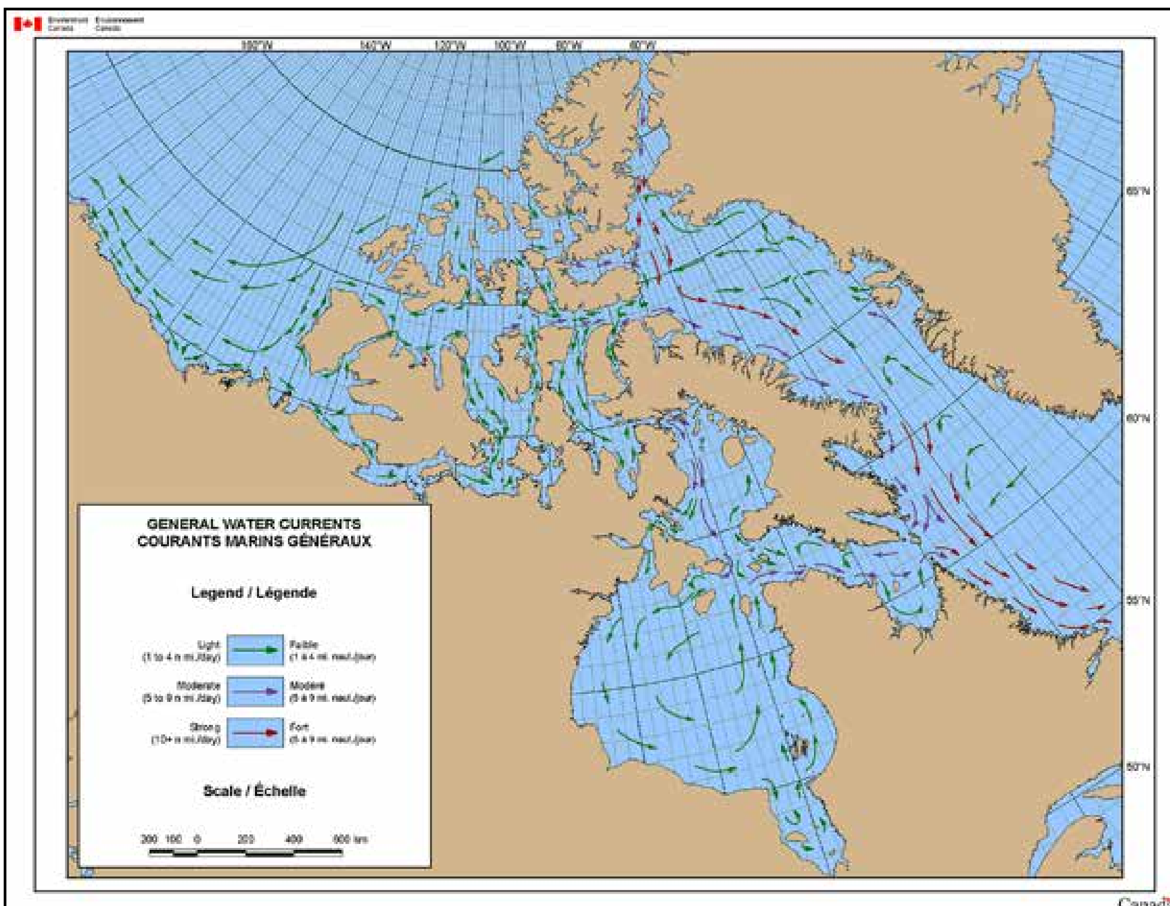


Figure 8: General water currents in the Canadian Arctic.

The main force behind the circulation of water in the Canadian Arctic is the North Atlantic Current system, through which vast quantities of water from Iceland and Scandinavia are driven by density and wind into the Arctic Basin. After circulating in the Arctic Ocean, most exits via the East Greenland Current (which runs between Greenland and Iceland) while some filters out through the Canadian Arctic Archipelago and Nares Strait. Surface water leaving the Arctic is fresher and quite cold (-1°C). One consequence of this temperature difference is that Norwegian ports located at a latitude of 70°N are reachable by sea all year round while, on the other side of the Atlantic, sea ice and icebergs reach 40°N, just south of the Grand Banks of Newfoundland, before melting.

The oceanic circulation system in Baffin Bay is of particular importance to Arctic navigation. Its counter-clockwise flow carries relatively warm water northward along the west coast of Greenland and across the north end of Baffin Bay, where it is joined by outflow from the Arctic Basin that has filtered through the islands of the Canadian Arctic Archipelago or Nares Strait. The current carries cold water from the Arctic Basin southward at a relatively fast pace, flowing along the east coast of Baffin Island coast before becoming the Labrador Current.

In the Western Arctic, the clockwise rotation of the Arctic Ocean (called the Beaufort Gyre) results in a net east-to-west flow in the southern Beaufort Sea. The speed of the current is moderate, with wind-induced currents and discharge from the Mackenzie River capable of affecting both the speed and direction of currents in the Beaufort Sea. Within and adjacent to the Archipelago, each major island or island group is surrounded by a clockwise current. Because of the net transport southward—and for dynamic reasons—the southward and eastward portions of these currents are broader and stronger than others.

In the shallow waters of Hudson Bay, there is a counter-clockwise gyre, driven by wind and terrestrial runoff, that flows out along the south side of Hudson Strait and joins the inner section of the Labrador Current. While circulation patterns are relatively constant, they may vary considerably at local or regional scales. Water movement near shore is strongly affected by tidal motion, surface-water runoff, bathymetry, and local winds. Wind-generated currents are important in many of the smaller water bodies surrounding the Arctic Islands and vary with wind velocity, fetch, water depth, and local topographic relief.

4.3 Tides

Tides are complex and can have a major impact on local marine operations. In very broad terms, tidal ranges are lowest in the Western Arctic (less than 1 m) and highest in the east, where they can average 2 to 3 m. Local anomalies may alter the range between high and low tides and create strong tidal currents in some areas—in particular, narrow channels. Tidal ranges are particularly large and important in Frobisher Bay, where they can reach up to 12.6 m, and the Leaf River basin of Ungava Bay, where the maximum tidal range approaches 17 m. The Canadian Hydrographic Service provides tidal predictions on the Fisheries and Oceans web site.

4.4 Waves

Waves in the Arctic often don't travel as far as those in other oceans because the islands of the Arctic Archipelago and the permanent sea ice around the North Pole block their paths of propagation and prevent the build-up of long swells. Sea ice has a profound effect, as waves cannot form in complete ice cover and those that move into areas where the ice concentration is 15 percent or higher (called the Marginal Ice Zone) decay quickly.

Sea state can still be a hazard to the marine community, however, especially in areas where winds are channeled or waves oppose the tidal currents. In most waters in the Canadian Arctic, the highest waves occur in the fall months, when the winds tend to be strongest. Since ice inhibits the transfer of momentum, the largest waves can be expected in Davis Strait when the winds are high and the ice cover minimal.

4.5 Freezing Spray

The main cause of icing on a ship's superstructure is freezing sea spray, which can be a hazard during the second half of the active marine season, especially to smaller vessels. The result of a combination of strong winds, low temperatures, and high waves, it occurs prior to freeze up. The potential for hazardous ice accretion on a vessel is most pronounced in areas east of Baffin Island, where open water and lack of ice coverage do not inhibit wave development.

Sail boat with glacier background. Photo courtesy of Nicolas Peissel.

5. Sea Ice

In northern Canadian waters, ice is present in many areas for much of the year and, in some, does not melt completely. In the Canadian Arctic Archipelago, air temperatures reach above freezing for only a brief period of time, so freeze-up can begin as early as August.

Ice conditions in the Arctic Ocean can vary depending on the location and time of year, with the concentration of ice generally decreasing and openings in the ice pack and around the coastline generally increasing in the summer months. Since sea ice is located at the interface between the ocean and the atmosphere, it can also reduce direct interactions between the two.

Sea ice forms largely as a result of the removal of thermal energy from the sea and decays as a result of the addition of thermal energy from solar radiation. Variations in these energy transfer processes are largely controlled by atmospheric events. In general, ice coverage grows in the fall and early winter, reaching a limit whereby the thermal energy available in the water column does not permit further expansion. Conditions then remain much the same for the next several months.

In the spring, the main heat-transfer process is radiation. The increasing height of the sun in the sky allows solar radiation to add heat energy to the water. As the snow melts, an increasing infusion of warm air creates a net increase in thermal energy at the surface. Hastening the melt process is the effectiveness of puddles of meltwater on the ice surface and areas of open water (polynyas and leads) in capturing incoming short-wave radiation. As the ice warms up and begins to shrink, it develops internal stresses that are amplified by any discontinuities within it. The exposure of the resulting cracks and openings to the effects of waves, currents, winds, and tides initiates further break-up of the ice sheet.

Wide variations in ice conditions can occur from week to week or year to year, with the entire nature of the ice cover sometimes differing from one year to the next. For example, ice in the Amundsen Gulf remains light and mobile some years and in others consolidates with embedded old ice. While Parry Channel consistently develops a consolidated ice cover in western Barrow Strait, its eastern edge can lie anywhere from Bylot Island to Somerset Island and may break up and reform more than once over the winter season. Similar variations occur in the timing of consolidation in Nares Strait, although its extent is remarkably consistent. The width of the pack ice off Labrador and in Davis Strait is sensitive to extended periods of on- or off-shore winds.

The Canadian Ice Service (CIS) has provided detailed information on the location, type, and concentration of sea ice for more than 40 years in order to improve marine safety and protect the marine environment in the North. For access to its charts, please visit the CIS website.

Mariners' Tips:
On coasts where the tidal range is significant, the presence of a narrow "boulder barricade" parallel to and several hundred feet from the shoreline is a conspicuous sign of sea-ice action. While visible during low tide, these boulders represent a navigational danger at high tide, when they are submerged. The pushing and rafting of boulders by the movement of sea ice is also responsible for the development of boulder-covered flats that are exposed at low tide near the heads of arctic bays. These flats are associated with strong tidal currents and confused seas, and also pose anchoring hazards.

5.1 Freeze-up

In August, summer comes to a swift end in the areas north of Parry Channel. New ice begins to form around the lingering ice floes from previous winters almost as soon as the air temperature drops below freezing. This new, first-year ice thickens rapidly and, by early October, is mixed with first-year ice from the previous winter—which, on October 1, is reclassified as second-year ice. Since salt gradually evacuates from sea ice through the formation of vertical brine channels, ice becomes gradually harder with age. As a result, second-year ice is much harder than recently formed first-year ice.

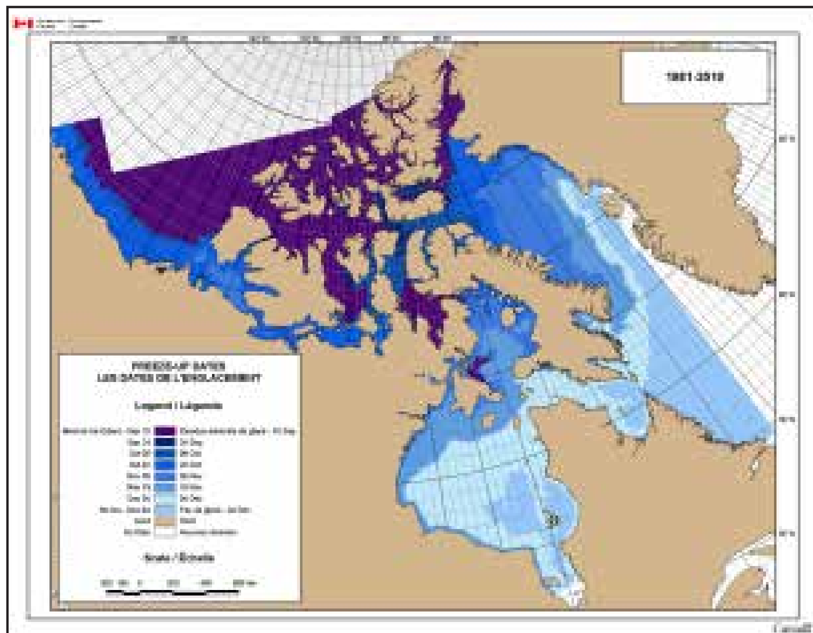


Figure 9: Average freeze-up dates for the Canadian Arctic for the period 1981-2010.

In December, the first-year ice normally becomes a consolidated sheet with embedded multi- and second-year ice. This old ice is often predominant in the Canadian Arctic Archipelago, except around Baffin Island. The rest of the Canadian Arctic becomes encumbered with ice moving with weather systems and currents, except in offshore portions of the Labrador Sea.

Fast ice becomes well established along the coasts of Baffin Island, Greenland, and Labrador, sometimes reaching widths of up to 50 km in some areas. Offshore, the pack remains mobile throughout the winter, with floes ranging from 20 m to 10 km across repeatedly freezing together and breaking apart.

5.2 Break-up

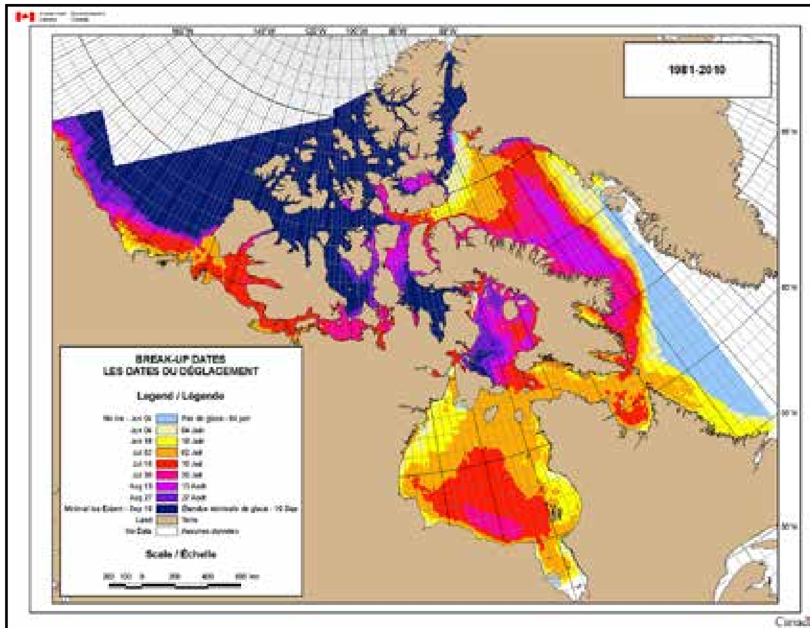


Figure 10: Average break-up dates for the Canadian Arctic for the period 1981-2010.

During a typical winter, frigid air masses develop over the ice-infested High Arctic and its nearby continental areas and are carried over the adjacent seas by passing weather systems. In spring, as the sun's elevation increases and the land warms up, the intensity of cold-air outbreaks quickly diminishes. In the southern reaches of the sea-ice extent, ice formation ceases, although winds and currents generally continue to push the existing ice toward warmer waters, where convection in the water column provides a steady supply of warmer water to melt the ice. Break-up begins to occur in James Bay near the end of April and gradually spreads northward during May and June. At the same time, melting snow begins to form puddles on the surface of consolidated ice, while the thin ice in polynyas disappears. In June and July, with the continued absorption of solar heat by polynyas and meltwater pools, decay and break-up have spread southward and throughout much of the Canadian Arctic.

Mariners' Tips:
Mariners navigating through open-water leads are urged to exercise extreme caution and to attempt to anticipate the effects of winds and currents on lead conditions.

At the end of the melt season, usually in early September, only James Bay, the southern two thirds of Hudson Bay, and the Labrador Sea are always completely clear of sea ice. The Arctic Ocean ice pack has retreated to 90 to 130 km off the coast (in the Beaufort Sea), and high concentrations of ice remain in Nares Strait, Norwegian Bay, Queens Channel, Viscount Melville Sound, M'Clintock Channel, and Victoria Strait. Ice usually remains in Committee Bay and the southern Gulf of Boothia and, in many years, does not melt completely in such areas as Foxe Basin and northwestern Davis Strait.

5.3 Ice Thickness

Over the course of a single winter, undisturbed bare ice can grow to a thickness of 240 cm in northern portions of the Canadian Arctic Archipelago and up to 200 cm in the Central and Western Arctic. Further south, in James Bay and along the Labrador coast, locally developed ice can reach a maximum thickness of about 120 cm.

Multi-year ice in the Archipelago reaches a thickness of 300 to 450 cm; however, fragments of the ice-shelf, which have formed over many years from fresh- and sea-water ice on the northwestern shore of Ellesmere Island, can exceed 2000 cm. These fragments are similar to tabular icebergs but not of land origin. The distinctive features found in some of these fragments in recent years indicate that they have travelled long distances over time.

5.3.1 Old Ice

Old ice is the general term used for ice that has survived at least one summer's melt. It includes both second- and multi-year ice, which are difficult to identify separately. The presence of old floes in an area of predominantly first-year ice has a direct impact on the penetrability of the ice, even by the most powerful ships, as ice becomes harder with age. The Canadian Ice Service tracks the concentration and frequency of old ice throughout the year and includes this information in its marine ice charts.

In September, floes may include a mixture of old ice from earlier years, first-year ice from the previous winter, and recently formed ice, which reaches the first-year stage of development by the end of the month. Because first-year ice from the previous winter is reclassified as second-year ice on October 1, the amount of old ice in the October ice charts increases.

Two charts indicate the presence of old ice based on its median concentration: one shows old ice in the 1 to 10 tenths range; the other, in the 4 to 10 tenths range. Traces of ice are not considered in these charts, as there is a small chance of 1 tenth or more of old ice occurring in western Davis Strait and most of Baffin Bay at any time of the year.

In May, the median concentration of old ice indicates an elongated area of 1 to 3 tenths of old ice in southwestern Baffin Bay that extends southward to western Davis Strait. This pattern changes little until about mid-July, when the old ice begins to melt, leaving the area generally free of old ice in August and through the fall. During the melt season, the amount of old ice on CIS charts actually increases because the loss of thinner ice allows old floes that were formerly dispersed throughout the pack to come together.

In Foxe Basin, the median concentration of old ice rises above zero only in the Igloolik-Fury and Hecla Strait areas; however, climate data indicate that old floes do infest many sectors of the Basin. The increase in the frequency (not amount) of old ice in October shows areas where clearing did not occur by the end of September. Both the amounts and frequency of occurrence of old ice are notable in the southern Gulf of Boothia and Committee Bay, as well as in M'Clintock Channel, Larsen Sound, and Victoria Strait.

The median old ice concentration in western Barrow Strait increases from 1 to 3 tenths to 4 to 6 tenths after October 1, when first-year ice is reclassified as second.

In Sverdrup Basin, old ice is usually predominant; however, in warm summers, break-up can leave large areas where first-year ice predominates the following year. In the eastern parts of Norwegian Bay, old-ice concentrations and frequencies can drop as low as the 1 to 3 tenths range. In Eureka Sound, small amounts of old ice usually persist through the melt season.

In the Beaufort Sea, the Arctic Ocean's ice pack is a dominating feature, with a small percentage frequency of old ice always present, except in the shallows of the Mackenzie Delta. Although the amount and frequency of old ice increases with distance from the coast, concentrations near the coast also increase when the first-year pack in that area melts in the summer.

Mariners' Tips:
Arctic whiteout is a phenomenon that occurs when the sun is near the horizon and both the snow/ice surface and the clouds have a uniform whiteness, making it difficult to distinguish the horizon or accurately judge distances by sight. Whiteouts occur most frequently in spring and fall.

Arctic wildlife. Photo courtesy of Nicolas Peissel.

ARCTIC REGIONAL GUIDE PART 2: BEAUFORT SEA AND AMUNDSEN GULF

6. Beaufort Sea and Amundsen Gulf

This section provides information on local weather, wind, sea state, and ice conditions for the seven main marine regions in the Beaufort Sea and Amundsen Gulf: Yukon Coast, Mackenzie, Tuktoyaktuk, Baillie, Amundsen, Banks, and Holman. Each region experiences its own wind and wave regimes, which are strongly influenced by coastal topography, pressure patterns, temperature, ice extent, and weather conditions.

Figure 1: Marine regions in the Beaufort Sea and Amundsen Gulf area of the Canadian Arctic.

6.1 Yukon Coast, Mackenzie, and Tuktoyaktuk Marine Regions

Along the Yukon coast, the foothills of the Richardson and British Mountains transition into a 10- to 20-km wide, gently sloping and treeless coastal plain that leads to the Beaufort Sea. Because of its topography, the winds tend to blow parallel to the coast for much of the year. While the strongest winds are likely to occur in the winter, they are also possible throughout the summer.

Thunderstorms are rare but have been observed at various sites along the coast. There are few protective harbours aside from Pauline Cove (Thetis Bay), on the southeast side of Herschel Island. While ice conditions vary from year to year and depend greatly on the previous days' winds, an ice pack lies about 90 km north of Herschel island through much of the summer.

Mackenzie Bay is a favored location for low-pressure systems to develop, redevelop, and intensify, fueled by strong temperature contrasts. A typical pattern is for southeast winds to bring warm air ahead of a low, with northwest winds to the west of the low tapping into the ice-chilled air of the Arctic Basin. In summer, in particular, this feed of cold air creates or enhances cold fronts. These fronts are often very shallow, creating an inversion in the lowest levels of the atmosphere that traps moisture below. Cold fronts routinely make their way into the Mackenzie Delta and can, on occasion, dip south past Inuvik and reach Norman Wells.

Figure 2: Local effects for the Beaufort Sea.

High-pressure systems over the Beaufort Sea (which precede and trail lows) are often laden with low cloud and fog, which are pushed onto the mainland in northerly and northeasterly winds. On the western side of a high, the winds veer to the south, bringing clear skies inland.

Since the weather pattern remains fairly stable in the summer, moisture tends to be trapped near the surface, resulting in frequent low stratus cloud and fog. Due to the mixing of cold and warm air between Atkinson Point and Baillie Islands, visibility in the area is rarely more than 8 km in the summer.

The Tuktoyaktuk area is often affected by low-pressure systems that develop over the Mackenzie Valley and move northeast across the Amundsen or Coronation gulfs. Easterly to northeasterly winds occur with the approach of these systems. Storms that form well to the north, over the Beaufort Sea, and sometimes track through the High Arctic Islands also impact winds in the area. In such situations, southwest to northwest gradients are experienced ahead of and behind the passing low, respectively. Although not common, thundershowers can occur on the mainland from June into early August and peak in July. They typically form in the Richardson Mountains, west of the Mackenzie Delta, and drift eastward.

At the end of September, snow streamers often develop over the open water in a cold northwest flow. In the spring and summer, the northwesterly winds bring in low cloud, while easterly winds tend to bring fair weather.

Navigating the ice floes. Photo courtesy of Nicolas Peissel.

Mariners' Tips:
Conditions over land and sea are quite different from one another. Wind speed is nearly always greater over the sea, with as many as twice the number of gales occurring there than on land. Temperatures are also less variable and almost always lower at sea in the summer.

6.1.1 Winds and Weather

6.1.1.1 Flow Patterns

A southeasterly flow is generated ahead of lows approaching the Beaufort Sea from the west. Moderate to strong winds can be produced in the southern and southeastern sectors of these storms, which can also cause large waves, depending on the free-of-ice fetch over the open water.

A southwesterly flow develops ahead of systems moving east to northeast from the Gulf of Alaska, causing strong southwesterly winds to blow offshore. These winds are caused by the barrier created by the downslope flow from the Richardson and Barn mountains.

A northeasterly and easterly flow develops ahead of a low-pressure system that approaches the Beaufort Sea from the west (Gulf of Alaska) or a redeveloping low over the Northwest Territories.

Figure 3: Average winds in June, July, and August, based on RADARSAT imagery.

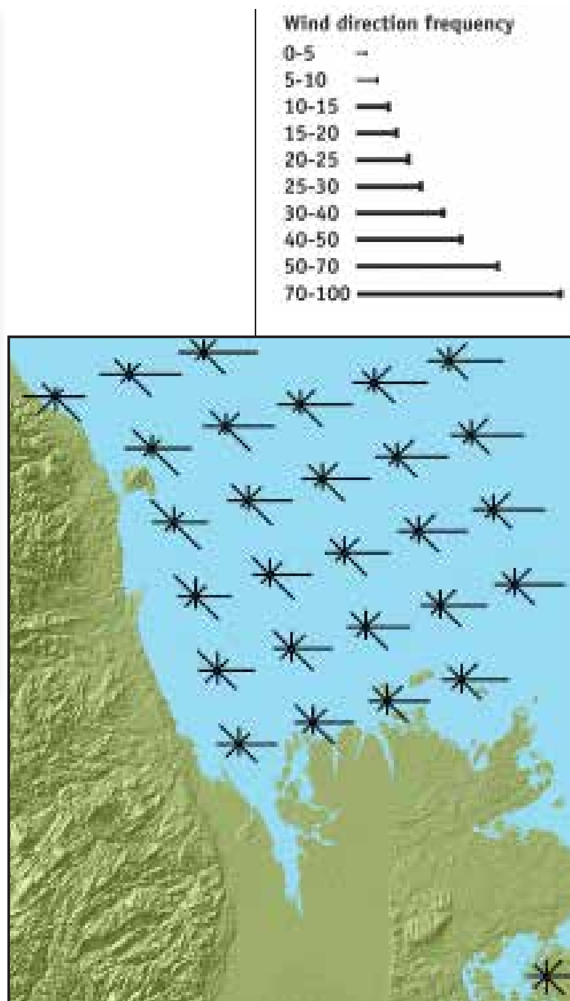


Figure 4: Average winds in September, October, and November, based on RADARSAT imagery.

6.1.1.2 Beaufort Sea

When a low or trough moves eastward or southeastward from the Beaufort Sea and a ridge builds behind it, it is usually followed by a burst of northwesterly winds. Coastal storm-surge flooding is caused by strong northwesterlies during the open-water season, which occurs in late summer and fall. The impact of these storms depends on the wind speed and direction as well as the extent of ice-free, open water. The maximum storm-surge elevation is about 2.5 m along much of the sea's western coastline.

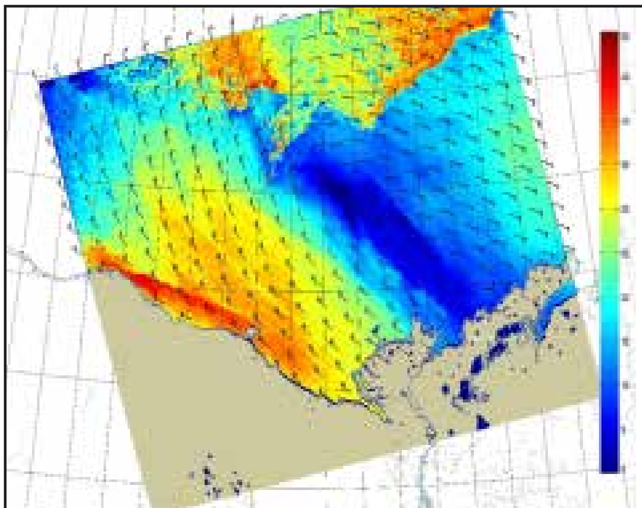


Figure 5: Radarsat derived winds from October 7, 2014.

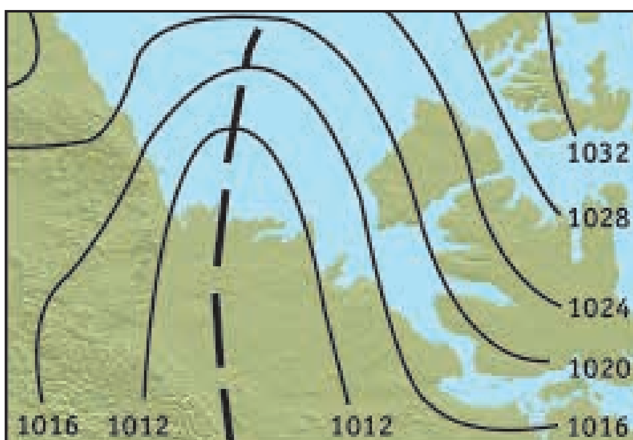


Figure 6: Surface analysis from October 7, 2014.

RADARSAT image (above) and surface analysis (below) from October 7, 2014, showing strong winds along the west coast of the Beaufort Sea, with speeds of 47 kt observed at Herschel Island, 34 kt at Komakuk Beach, and 39 kt at Shingle Point.

6.1.1.3 Yukon Coast

In a southeasterly flow, strong winds often develop along the Yukon coast. The coastline is steep enough to deflect east or northeast winds over the Beaufort Sea, causing them to turn northwesterly and run along the coastline. This results in gusty, turbulent conditions near the coast, with winds up to 40 kt as far as 50 to 100 km offshore.

Passing low-pressure systems often strengthen east of the coast in the Mackenzie Delta. As a ridge of high pressure builds in the wake of these systems, a band of strong, gusty northwest winds can develop along the coast as they converge against the mountains, accelerate, and sweep into the flat and relatively treeless Delta area.

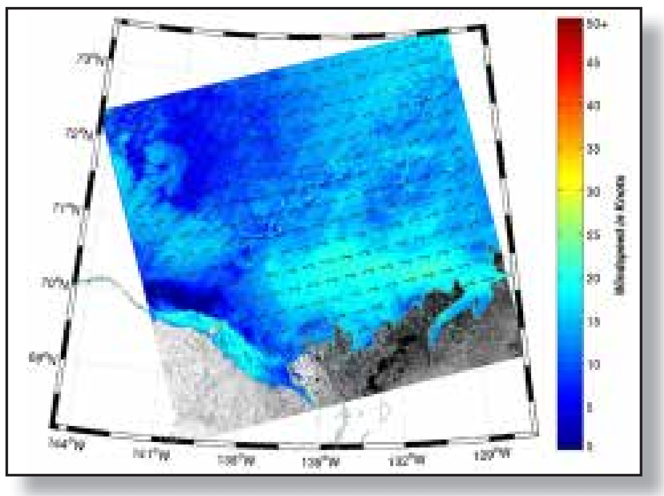


Figure 7: Radarsat derived winds from August 7, 2010 at 2:20 UTC.

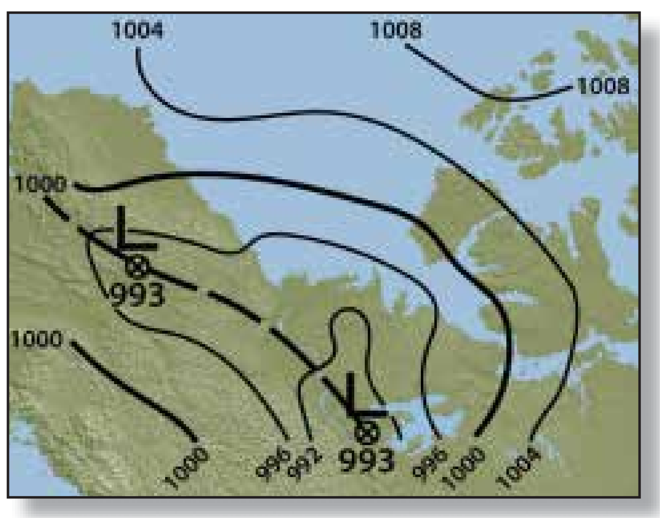


Figure 8: Surface analysis from August 7, 2010.

RADARSAT image (above) and surface analysis (below) showing strong northwest winds developing along the Yukon coast as a result of a storm that redeveloped over the Northwest Territories on August 7, 2010. East winds over the Beaufort Sea had turned northwest when they reached the British and Richardson Mountains. Wind speeds of 22 kt were observed at Herschel Island and 20 kt at Shingle Point.

Komakuk Beach, Barter Island, and Herschel Island see strong northwesterlies following the passage of lows, with cold air at low levels surging along the coast and into the Mackenzie Delta. These large pools of cold air can enhance wind speed, even if the pressure pattern does not indicate strong winds.

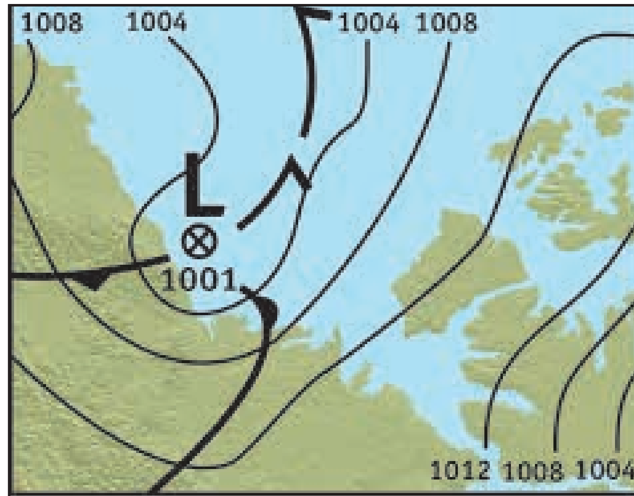


Figure 9: Surface analysis from August 2, 2001.

Although the pressure pattern did not suggest strong winds, as this storm moved southeast, wind speeds increased along the Yukon Coast. Herschel Island reported northwest winds of 25 kt (gusting to 30 kt) and Shingle Point, winds of 22 kt. The temperature difference before and after the cold front passed was nearly 10° C.

6.1.1.4 Herschel Island

Although it is only about 8 km wide and 13 km long, Herschel Island is visible from a long distance at sea, as it rises to a height of nearly 180 m. Pauline Cove, on the southeastern side of the island, is exposed to southwesterly winds due to its shape and geographical location. The island is often shrouded in fog—in particular, in late summer.

West and northwest winds can produce a cornering effect off the northeastern side of the island, as friction from the rougher terrain deflects them toward an area of lower pressure. If these winds are deflected offshore, they converge with the prevailing winds over the water, resulting in a band of increased wind speeds. West and northwest winds are also affected by funneling in Workboat Passage, increasing in speed as they are squeezed through the narrow gap between the island and mainland.

Figure 10: Wind distribution in a northwesterly flow around Herschel Island.

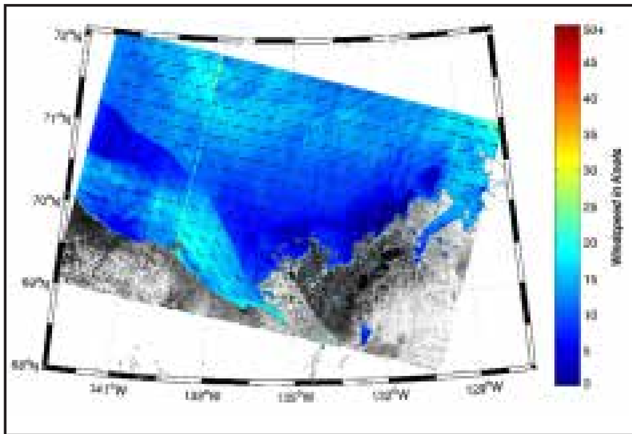


Figure 11: Radarsat derived winds from September 4, 2011 at 15:41 UTC

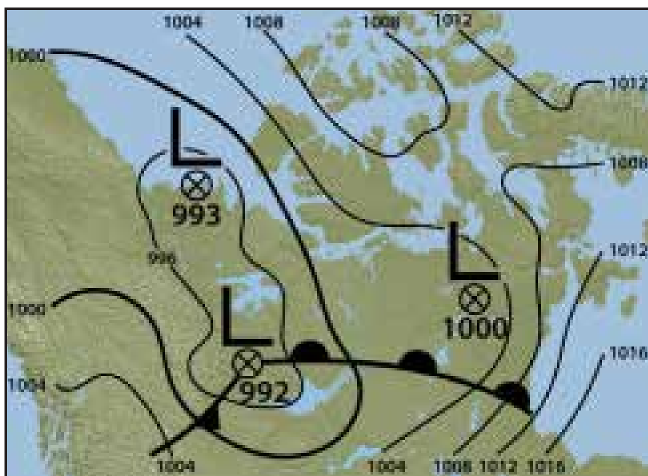


Figure 12: Surface analysis from September 4, 2011.

RADARSAT image (above) and surface analysis (below) showing wind distribution in a northwesterly flow pattern around Herschel Island on September 4, 2011.

Moderate and strong winds are observed on both sides of the island.

Significant Event:

A rise in water level at Herschel Island could herald the arrival of a major storm from the Beaufort Sea, as it did on September 13, 1970, five hours before such an event resulted in a storm surge of 2 to 3 m in Mackenzie Bay. Ship reports in the area indicated winds of up to 45 kt and waves as high as 5 m, with Tuktoyaktuk and Cape Parry reporting westerly winds of up to 46 kt and 25 kt, respectively.

6.1.1.5 Blow River and Babbage River

Although strong prevailing winds tend to come from the northwest and east along the Yukon Coast, strong local outflows also blow from the Blow River and Babbage River valleys. These winds are generated in a southwesterly flow, when a low is approaching from the west and the pressure ahead of the system is falling. The resulting southwest winds blow offshore into Mackenzie Bay, their speeds often increased by funneling through the river valleys.

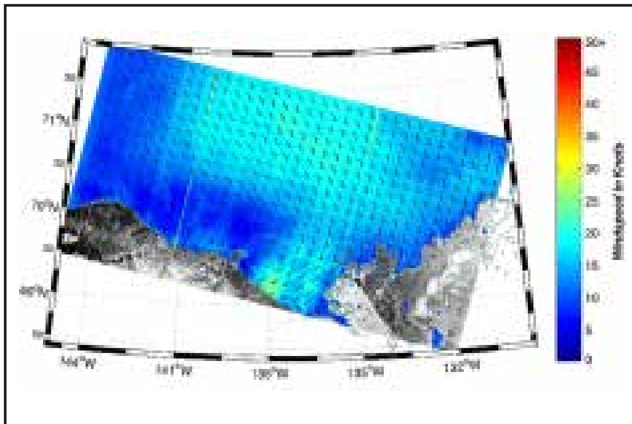


Figure 13: Radarsat derived winds from October 2, 2012 at 15:50 UTC.

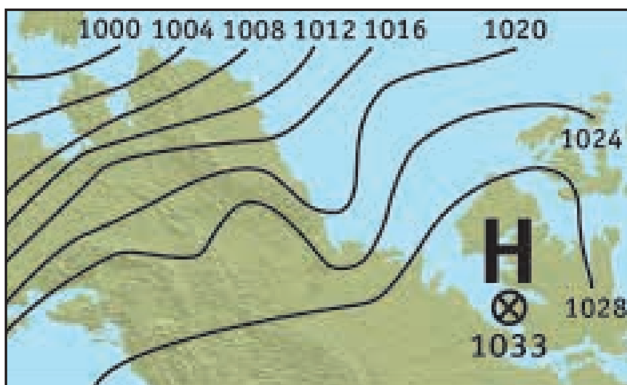


Figure 14: Surface analysis from October 2, 2012.

RADARSAT image (above) and surface analysis (below) from October 2, 2012, indicating strong outflow and funneling from the Blow River in a southwesterly flow.

6.1.1.6 Shingle Point

Shingle Point often sees strong southwesterly winds when a low is approaching from the west and the pressure ahead of it is falling, while Herschel Island may still blow easterly. These winds, which can reach speeds of up to 40 kt, are caused by the orographic effect of the downward flow of air over the Richardson and Barn mountains.

6.1.1.7 Pelly Island

There are two clearly dominant directions for winds at Pelly Island: those from the west to northwest, and those from the east to southeast. Although the former occur less frequently than the latter, they represent the highest wind speeds for all months—averaging 12 to 16 kt and peaking at up to 50 kt—and are associated with the area's most destructive storms. East to southeast winds typically see wind speeds of 8 to 12 kt, although peak wind speeds can reach up to 40 kt in some months.

6.1.1.8 Tuktoyaktuk

Tuktoyaktuk is located on the shore of Kugmallit Bay, on a long, flat peninsula bounded by Liverpool Bay to the south and the Beaufort Sea to the north. A small, shallow natural harbour offers fair shelter from weather and waves.

The strongest winds in Tuktoyaktuk come from the northwest, generated behind low-pressure systems that pass or redevelop over the Beaufort Sea. A strong easterly or southeasterly flow is often generated ahead of such lows. In the summer, winds can blow anywhere from the northwest to the southeast but are generally light. They tend to increase in speed in the fall, when they blow predominantly from the northwest or the southeast, the northwest winds being stronger. Local traditional knowledge suggests that high winds from the northwest and east also bring more storms.

Aerial photo of Tuktoyaktuk. Photo courtesy of the Government of the Northwest Territories.

6.1.1.9 Cape Dalhousie and Liverpool Bay

The most destructive storms and winds in Cape Dalhousie come from the west and can raise water levels by 1.5 m or more, submerging offshore sandbars and inundating coastal areas. Snow falls as early as August but melts rapidly and remains from September to late April.

Good weather with southeasterly winds heralds a low-pressure system approaching or evolving in Mackenzie Bay. West of the low, or as it moves off, brisk northwesterly winds, low cloud, fog, and some precipitation are common.

In Liverpool Bay, strong west winds are the most destructive and can raise water levels by 0.5 m.

Figure 15: Local effects for the shoreline of Beaufort Sea.

Mariners' Tips:

According to local lore on weather conditions at the delta of the Anderson River, in Liverpool Bay, the following generally hold true:

An east wind comes gradually, while a west wind may come fast.

When the land looms low, a west wind is coming; when it looms high, expect winds from the east or northeast.

If loons fly and cry, beware of storms.

If a wind blows strongly for several days and then calms down without changing direction, it may blow strongly again from the same direction.

6.1.2 Sea State, Shoals, and Ice Conditions

6.1.2.1 Beaufort Sea and Yukon Coast

Sea State

Strong northwest or west winds in the Beaufort Sea cause very high, above-normal sea-level elevations during the open-water season. Open-water conditions and strong west winds are key ingredients for a major storm surge in coastal areas—in particular, in late August, September, and October, when the pack-ice edge has retreated further north. There may be little or no warning of a storm, and wind velocity may increase from light to gale force within minutes; however, a rise in water level before the local wind-regime changes can be taken as a warning. Maximum wave size is reached within a few hours of the onset of a westerly storm.

Wave energy in the Beaufort Sea is largely controlled by wind direction and the available fetch across open water. The latter varies throughout the summer season, as it depends on the position of the Arctic ice pack. Winds in the Beaufort Sea have a bimodal pattern, the two dominant directions being from the northwest and east. The dominant direction for wave approach, in terms of total power, is from the northwest. Wave power from severe storm waves (i.e., higher than 2 m) shows an even more pronounced dominance of waves from the west and northwest. Wave heights rarely exceed 4 m, and wave periods are generally less than 8 seconds.

Northwest and east winds also dominate the waters off the Mackenzie Delta during the open-water summer season. Northwest storms that blow onshore generate strong waves and high water levels, inducing coastal engineering disasters and erosion. Strong winds from the east, blowing offshore of the Delta, cause upwelling, turbulence, and mixing of the water column from surface to bottom. Bottom drag and breaking waves in the shallow waters along the coast—in particular, at the Delta and Kugmallit Bay—greatly reduce wave height in the area. The large quantities of silt deposited in the Delta by the Mackenzie River make navigation extremely difficult.

Shoals

Many shoals are found near the coastline in Mackenzie Bay, including throughout the extensive Delta area and at Shingle Point, Phillips Bay, and Sabine Point.

Ice Conditions

Through August, melting gradually moves the ice edge seaward, allowing easy navigation until freeze-up begins. In an ordinary year, the pack will retreat from 80 to 160 km from the Alaskan coast and 160 to 800 km from the Canadian mainland. The seasons and ice conditions vary greatly from year to year, depending mainly on the prevailing winds in any particular summer. West winds push ice from the Beaufort Sea toward the land; if they prevail through much of the summer, even shallow-draught vessels may have great difficulty forcing a passage along the coast. East or southeast winds carry the main pack away from the land and, in some years, have been known to drive it so far offshore that direct passage could easily be made from Point Barrow to Cape Bathurst. Pauline Cove, on Herschel Island, is an area where ice can move in and out rapidly—in some years, lingering there through the open-water season.

6.1.2.2 Tuktoyaktuk and Area

Sea State

Easterly winds cause low water levels while westerlies cause high ones in the area around Tuktoyaktuk. The community experiences dramatic shoreline erosion during storm surge events, which tend to occur with persistent northwesterly winds in the late summer months (July to September), when ice coverage in the Beaufort Sea reaches its annual minimum. Tidal fluctuation is generally less than 1 m; however, even minor changes have a significant impact on water level. Strong west winds between Warren and Tuft points have been known to raise water levels to cover the spit at Warren Point.

Significant storm surges have often occurred when strong storms have coincided with periods of exceptional fetch, usually in late summer and early autumn. One such event occurred between August 28 and 31, 1987, when retreating pack ice in the Beaufort Sea created an ice-free fetch of almost 500 km. Prolonged northwesterly winds of over 27 kt generated wave heights of 4 m at an oil-well drilling site 45 km offshore and a storm surge of 1.4 m at Tuktoyaktuk. This weather pattern, with northwesterly winds over the Beaufort Sea and a deepening low over the Arctic Islands, generates the most powerful storms in the region.

Shoals

There are many shoals in Kugmallit Bay, from Tuktoyakuk to Cape Dalhousie—including at Flagpole Point, Topkak Point, and Warren Point (where the Beluga Shoals extend northward).

Ice Conditions

At Tuktoyaktuk Harbour, freeze-up can be expected any time between September 26 and Oct 15. Outside the harbour, it occurs about a week later. Break-up usually occurs between June 18 and 28, with the ice moving out slowly or melting in place, as there is little water movement due to the tides. After break-up, the ice may refreeze and develop pressure ridges.

Significant Event:

During a severe storm on September 14, 1970, two small vessels in open water between Tuktoyaktuk and the ice edge reported wave heights of 7.6 m in 80 to 100 kt winds.

6.2 Baillie and Amundsen Marine Regions

Amundsen Gulf is the southeastern extension of the Beaufort Sea. Approximately 400 km in length, it is bordered by Victoria Island on the east and separates Banks Island (to the north) from the Canadian mainland (to the south). The same weather systems that move or develop over Mackenzie Bay also affect the Amundsen Gulf area, including the Baillie, Amundsen, Hallman, and Banks marine regions. These systems move eastward through the Gulf, creating stronger northwesterly or southeasterly winds due to channelling between the mainland and the Banks and Victoria islands. Violent winds blow from the upland surface down the seaward slope of the mainland Melville Hills in a southerly flow.

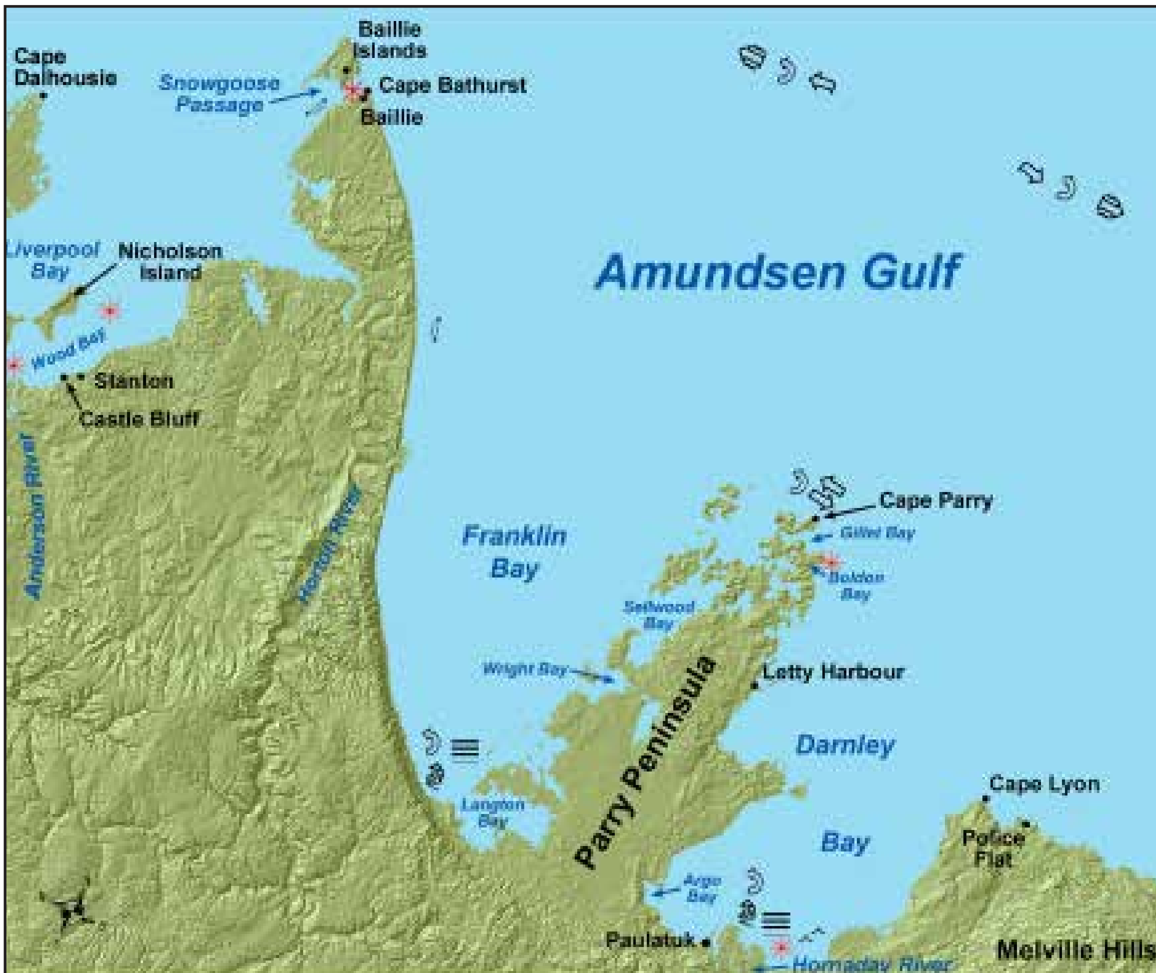


Figure 16: Local effects for the Amundsen Gulf.

Local flow is strongly dependent on geographical location, the characteristics of the body of water, and orographic features of the coastline areas. East winds are dominant in spring and early summer, while west winds stronger than 20 kt become more frequent from July to October. Strong winds from the west to northwest are often responsible for the intrusion of multi-year pack ice over coastal waters.

Figure 17: Local effects for the Amundsen Marine Region.

6.2.1 Winds and Weather

6.2.1.1 Flow Patterns

Easterly and southeasterly flows usually generate strong to moderate winds over the Amundsen Gulf due to channelling and gap-wind effects between the mainland on one side and the Banks and Victoria islands on the other.

Westerly and northwesterly flows often generate gales and strong to moderate winds due to channelling and gap-wind effects as the air masses enter the Amundsen Gulf in between the mainland and Victoria Island.

Figure 18: June, July, and August average winds, based on RADARSAT imagery.

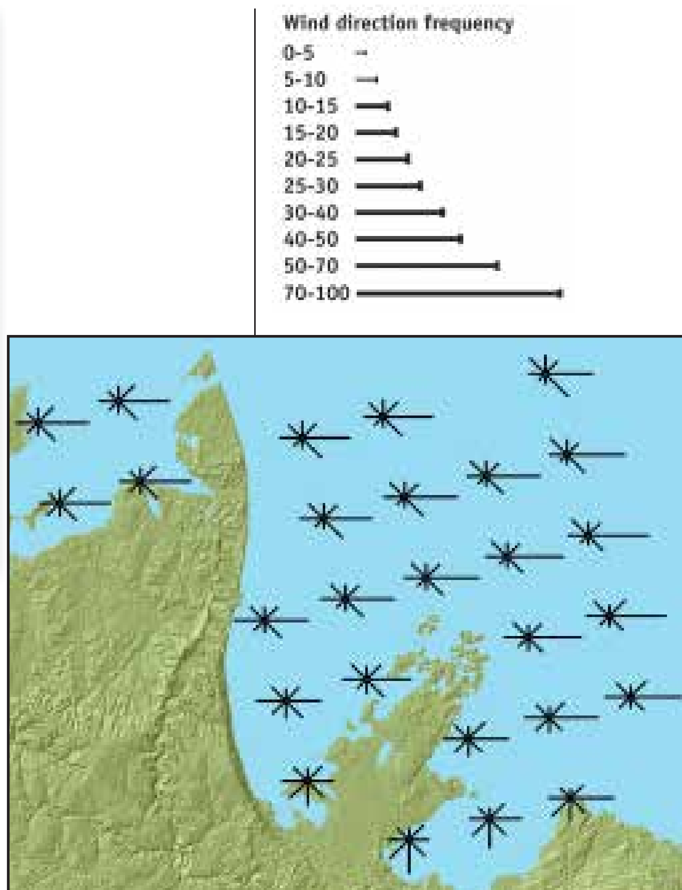


Figure 19: September, October, and November average winds, based on RADARSAT imagery.

6.2.1.2 Franklin and Darnley Bays

Violent south winds, often reaching speeds of 45 to 55 kt, blow from the upland surface at elevations of 450 to 600 m down the seaward slope of the Melville Hills into Franklin and Darnley Bays. These gale-force winds—which on rare occasions reach hurricane force—are a coastal phenomenon, their effects concentrated in a belt extending 8 to 16 km from shore. They occur soon after freeze-up or when the land is colder than the sea. Due to the lulls between them, these winds are known locally as “pumping winds”.

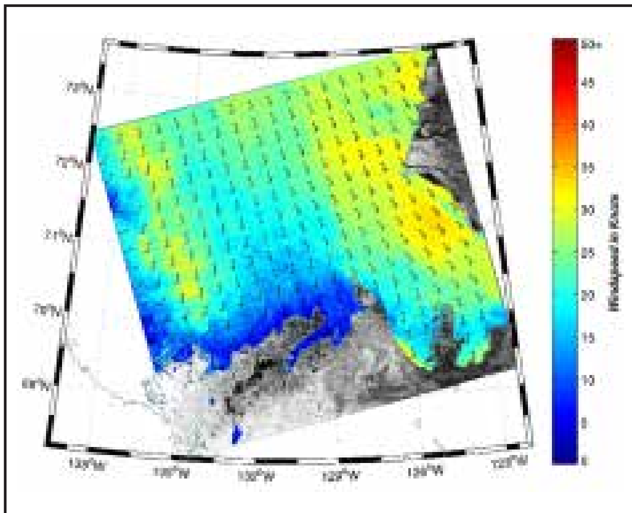


Figure 20: Radarsat derived winds from September 24, 2012 at 01:59 UTC.

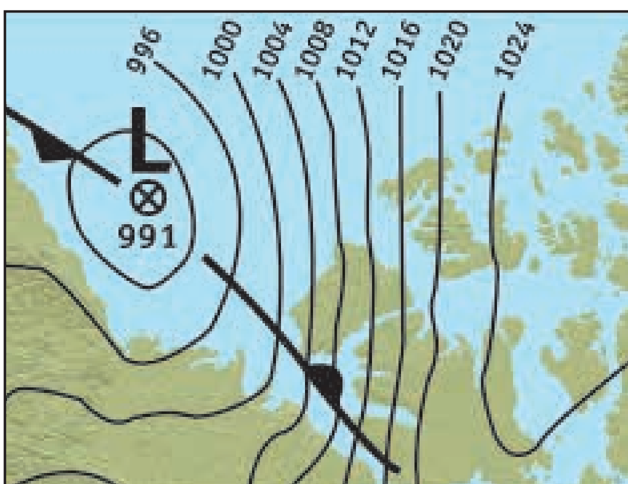


Figure 21: Surface analysis from September 24, 2012.

RADARSAT (above) and surface analysis (below) showing strong south winds of 30 kt at the heads of Darnley and Franklin bays on September 24, 2012, while a storm was over the Beaufort Sea. At the same time, the Paulatuk observing site reported winds up to 18 kt.

6.2.1.3 Parry Peninsula

Figure 22: Local effects for the area near Parry Peninsula.

The Parry Peninsula is bounded on the west by Franklin Bay, on the north by Amundsen Gulf, and on the east by Darnley Bay. The northern portion of the peninsula consists of many islands with deep fiords running into the land from both sides. The western coast of Franklin Bay is steep and rocky, offering vessels almost nowhere to make a surf landing.
At Langton Bay, on the west side of the Peninsula, the prevailing wind is from the south due to the downslope effect of the Melville Hills. Phenomenal local gales, with wind speeds up to 45 to 55 kt, can blow steadily in the Bay for weeks as a time off the plateau to the southwest. Langton Bay averages 20 days of fog between mid-July and mid-October.

Cape Parry is a headland at the northern tip of the Parry Peninsula that projects into the Amundsen Gulf. Winds at the cape—and its westernmost point, Police Point—generally blow from the northwest or east in the summer. The strongest come from the east, reaching speeds of up to 30 kt due to the channelling and gap-wind effects between Banks Island and the peninsula. In such events, southern parts of Franklin Bay and Darnley Bay usually experience calm to light winds when channelling and gap-winds are occurring in Amundsen Gulf. In the fall, easterly and northwesterly winds generated by low-pressure systems from the Beaufort Sea strengthen even further. Cow Cove, located 5 km southwest of Cape Parry, offers shelter from easterly winds. Strong onshore westerly to northwesterly winds are reported to raise heavy surf on the beach at Cow Cove. Breaking seas occur in bad weather between Sardlat Island and two nearby islets. Letty Harbour also offers protection from winds.

Figure 23: June, July, and August average winds, based on RADARSAT imagery.

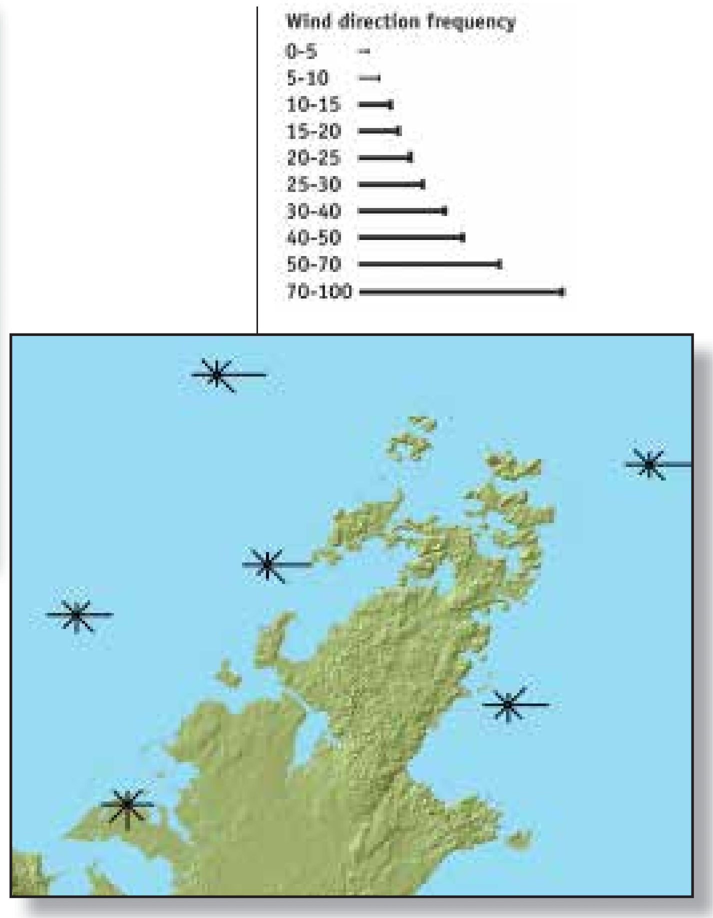


Figure 24: September, October, and November average winds, based on RADARSAT imagery.

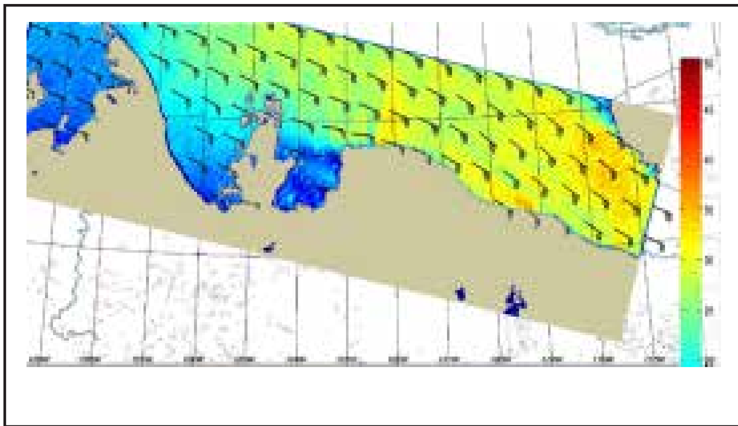


Figure 25: RADARSAT derived winds from October 6, 2014 at 14:53 UTC.

RADARSAT image on October 6, 2014, at 14:53 UTC showing calm conditions in the southern parts of Franklin Bay and Darnley Bay during periods of gap winds and channelling in the Amundsen Gulf.

Anchoring onto ice floe. Photo courtesy of Nicolas Peissel.

6.2.1.4 Paulatuk

Aerial photo of Paulatuk. Photo courtesy of the Government of the Northwest Territories.

Paulatuk is located on the south shore of Darnley Bay in the Amundsen Gulf. It is approximately 10 km north of a steep, 300-m escarpment (the Mellville Hills) that runs east to west. Although winds at Paulatuk during the summer are generally light and blow mostly from the west to northwest or northeast, strong downslope winds can sometimes blow from the south. In the fall, winds tend to strengthen and come more frequently from the west to northwest or south.

Mariners' Tips:
Sea level is raised by westerly winds and lowered by easterlies. As such, the approach of strong westerly winds can sometimes be detected many hours beforehand by an abnormal rise in the water level.

In general, northwest winds bring snow and low temperatures in winter and rain in summer, while east winds tend to bring fair weather. Argo Bay (located 10 km west of Paulatuk) offers good protection from all winds with its long sand spit.

Mean annual precipitation is estimated as 25 mm, with snow known to fall in any month except July. From 2 to 5 mm of rain may fall in July and August, in either a drizzle or a downpour. Thunderstorms, although uncommon, do occur. Paulatuk sees an average of 20 days with fog during the summer, July being the foggiest month.

6.2.2 Sea State, Currents, Shoals, and Ice Conditions

6.2.2.1 Sea State

- **Amundsen Gulf:** Strong west winds can raise the water level in Amundsen Gulf by as much as 1 to 2 m, flooding low-lying coastal areas.

- **Paulatuk Harbour and Wood Bay:** Easterly winds lower water levels and westerly winds raise them. The former offers good protection from waves as well as gravel areas where boats can land.

> **Mariners' Tips:**
> Franklin Bay's western and southern shoreline consists of unbroken cliffs up to 30 m high. Easterly winds can create large waves that crash against the cliffs, posing a serious navigational hazard for small boats.

6.2.2.2 Currents

- **Nicholson Island (Liverpool Bay):** Erratic tidal currents occur near the island.
- **Cape Bathurst:** In northwesterly winds of 20 kt or more and in east to southeast winds, greatly enhanced surface currents occur around Cape Bathurst and along the eastern shore of the Bathurst Peninsula to the Horton River. Speeds of 2 to 3 kt are common and as high as 6 kt had been measured.
- **Baillie Islands:** North of the islands, two opposite currents (southeast and northwest) meet, creating a large, clockwise eddy.
- **Police Point and Booth Islands:** Strong currents run between the two areas.
- **Cape Parry:** A strong current is reported off the cape.
- **Tysoe and Clifton Points:** Currents up to 4 kt have been reported parallel to the coast near these points.

6.2.2.3 Shoals

- **Cape Bathurst:** As the seas build due to shoaling, so does the steepness of the waves in this area of shallow water.
- **Snowgoose Passage:** This narrow area between Baillie Island and Cape Bathurst has high tidal currents that can intensify through shoals and silts.
- **Wood Bay:** Shoaling is widespread in this bay.
- **Wright Bay:** Shoaling is a hazard in these waters on the eastern side of Franklin Bay.
- **Gillet Bay and Boldon Bay:** Shoals are present in both bays.
- **Hornaday River:** Shoals are found some distance offshore, near the entrance to the river.

6.2.2.4 Ice Conditions

The Amundsen Gulf is closed to navigation from freeze-up through to break-up. Freeze-up usually commences in sheltered areas toward the end of September and, in the more exposed sectors, in late October or early November. The first significant deterioration of the ice occurs sometime in late June or the first half of July along the western side of the gulf. Depending on the prevailing winds, there is great variability in the extent and location of open water in the summer season, which is seldom entirely free of winter or old polar ice. Strong west or northwest winds may bring ice in from the Beaufort Sea at any time and pack it heavily along the southern shore.

- **Cape Parry:** From approximately November to June, the waters around the cape are completely ice-covered to a maximum depth of 2 m. From roughly July to October, they are open, with some brief incursions of ice floes from the north. Prior to the break-up of fast ice around the shores of the Parry Peninsula in July, areas of the Amundsen Gulf are already in open water.

- **Paulatuk:** Freeze-up usually occurs in mid-October and break-up between July 1 and 15. The shoals and sandbars at the entrance to the harbour prevent the heaviest of pack ice from entering, so it is completely ice-free in the summer and usually clear of floating ice well in advance of Darnley Bay.

- **Langton Bay:** Ice conditions in Langton Bay are consistent with those of the rest of the western part of the Amundsen Gulf. In normal years, there is no drifting ice in the bay from early August to freeze-up.

- **Franklin and Darnley Bays:** Franklin Bay and Darnley Bay remain ice free well into December. If, during the start of freeze-up, winds are from the southwest, south, or southeast, any ice that forms drifts out to sea and the surface of the water near the shores remains open. If this situation persists into November, the temperature of the land could be 15 to 26°C colder than that of the water. If, during this period, winds are from the north or northwest, ice will drift into the bay, preventing local gales from occurring.

6.3 Banks Marine Region

Banks Island is the most westerly of the Arctic islands. The Banks Marine Region includes waters south and west of the island's southwestern coastline.

6.3.1 Winds and Weather

6.3.1.1 Flow Patterns

Easterly and southeasterly flow is generated ahead of low-pressure systems moving east to northeastward or southeastward—the same systems that affect the marine regions to the west. Westerly and northwesterly flows develop behind storms.

6.3.1.2 Sachs Harbour

Sachs Harbour. Photo courtesy of the Government of the Northwest Territories.

The community of Sachs Harbour is located on the southwestern portion of Banks Island, the westernmost of the Arctic Islands, surrounded by the Amundsen Gulf and the Beaufort Sea. The Canadian mainland lies approximately 200 km to the south.

High-pressure systems over the Beaufort Sea preceding and trailing low-pressure systems are often laden with low clouds and fog. North and northeast winds are offshore and favor good weather conditions for the harbour. The dominant wind direction during summer (June to August) is primarily from the north; during the winter (November to February), it is from the southeast. Strong winds tend to come from the southeast or northwest, with the former occurring more often than the latter, especially in the fall. The normal range of tides is affected by winds, with strong northwesterlies capable of raising the water level by about 1 m. Low cloud and fog form over the Beaufort Sea in the summer and, in certain wind conditions, can move inland and persist over the community for extended periods.

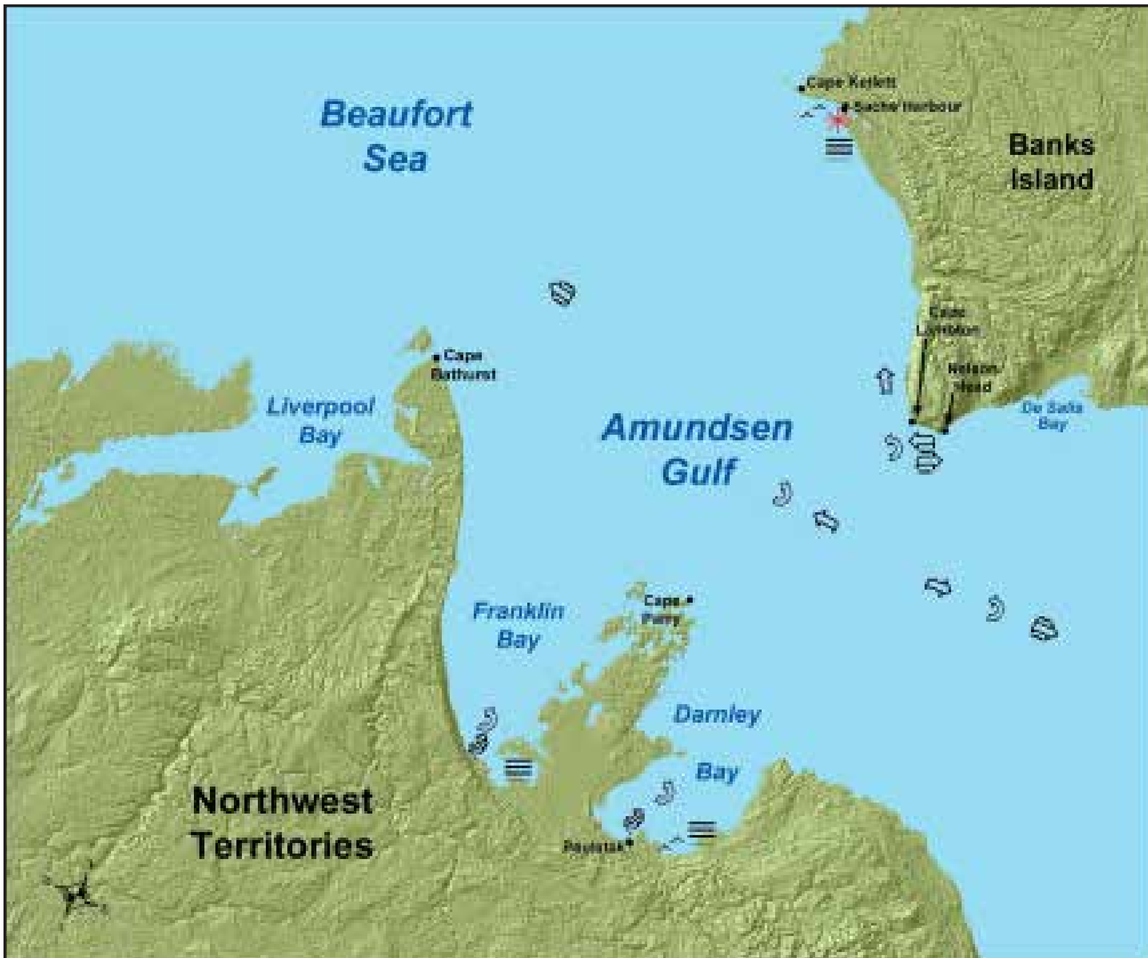


Figure 26: Local effects for the Amundsen Gulf near Cape Perry.

6.3.1.3 Cape Lambton

Cape Lambton is a headland located at the southern tip of Banks Island that projects into the Amundsen Gulf, rising almost vertically from the sea. A local magnetic anomaly has been reported in vicinity of the coast near the cape (Geological Survey of Canada report). The most frequent corner effect is observed here with east and southeast winds. As these winds blow around the cape, they slow down on its windward side and speed up on its leeward. These strong winds can extend up to 160 km from the headland.

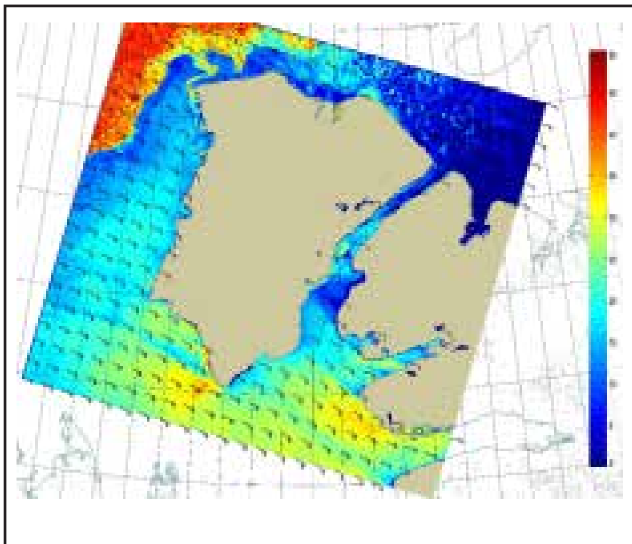


Figure 27: RADARSAT image showing a strong cornering effect that occurred with easterly winds at Cape Lambton on October 6, 2014 at 14:52 UTC.

There is cornering around Cape Lambton with westerly or northwesterly winds, with the band of stronger winds extending east and southeast of the headland.

6.3.2 Sea State and Shoals

- **Banks Island:** Strong west winds bring high tides to the western coast of the island, causing ice to pile up along the coast. In southeast and east winds, low tides carry the ice back out to sea.
- **Cape Lambton and Nelson Head:** Strong north winds blowing off the top of the cliffs can create eddies near these locations.
- **Sachs Harbour:** Shoaling is a hazard.

6.4 Holman Marine Region

The Holman Marine Region is located over the northwestern parts of the Amundsen Gulf and includes the area between Banks Island (Cape Lambton) and Northwestern Victoria Island (Cape Baring).

Figure 28: Local effects for the Amundsen Gulf.

6.4.1 Winds and Weather

6.4.1.1 Ulukhaktok

Aerial photo of Ulukhaktok. Photo Courtesy of the Government of the Northwest Territories.

The community of Ulukhaktok is located along the west coast of Victoria Island on the shores of the Amundsen Gulf, between Queens Bay and Kings Bay. Queens Bay is slightly wider and offers easier anchorage and sailing than Kings Bay, however the latter is better sheltered by the hills from the easterly winds.

In the past, strong east winds arrived at a similar time each spring; however, westerly winds are now reportedly more common at that time of year. East winds no longer seem to follow a regular pattern and often come on suddenly, without warning. They are also stronger than they used to be—in particular, northeast-east winds, as they are influenced by the topography of Victoria Island. The timing and nature of ice break-up has also become unpredictable.

During the summer, west winds are most common and are generally light. During the fall, winds strengthen and come mainly from the east, with fewer cases from the northeast and southeast. During the spring and summer, south and southeast winds can bring low cloud and fog to the site.

6.4.1.2 Minto Inlet and Prince Albert Sound

A relatively weak southeasterly flow can generate moderate to strong winds over Prince Albert Sound and Minto Inlet, west of Wollaston Peninsula, due to channelling and, likely, gap-wind effect. When north or northeast winds blow along the inlets, winds can be channeled by the surrounding topography. Northeast winds can be turned easterly and increase in speed when blowing over these waters. In a favourable synoptic set-up, the gap-wind effect can also enhance wind speed in the inlets, creating stronger winds in the area close to their exits.

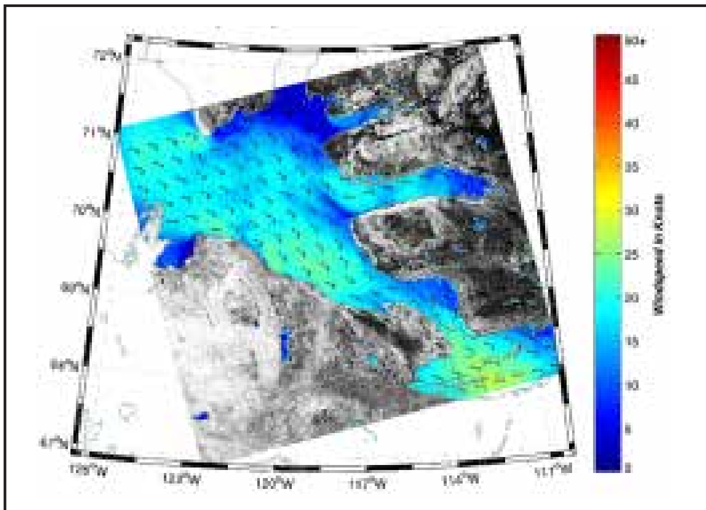


Figure 29: RADARSAT derived winds from July 31, 2012 at 01:10 UTC.

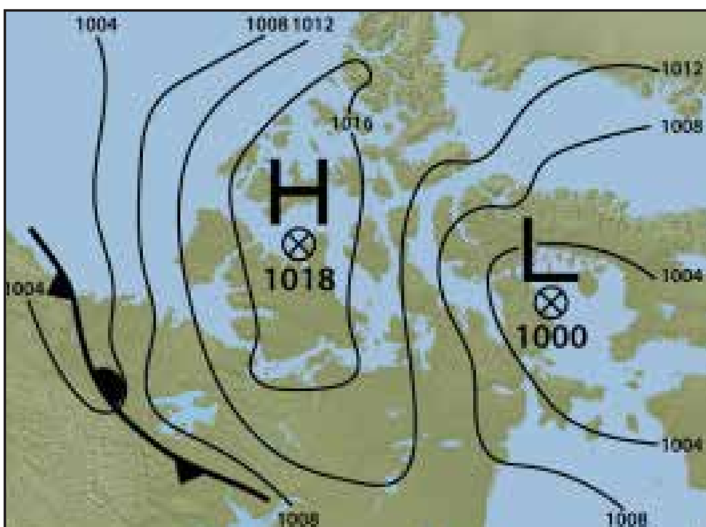


Figure 30: Surface Analysis from July 31, 2012.

RADARSAT image (above) and surface analysis (below) from July 31, 2012, showing channelling through Minto Inlet and Prince Albert Sound and cornering around the southern tip of Banks Island with a weak southeast flow.

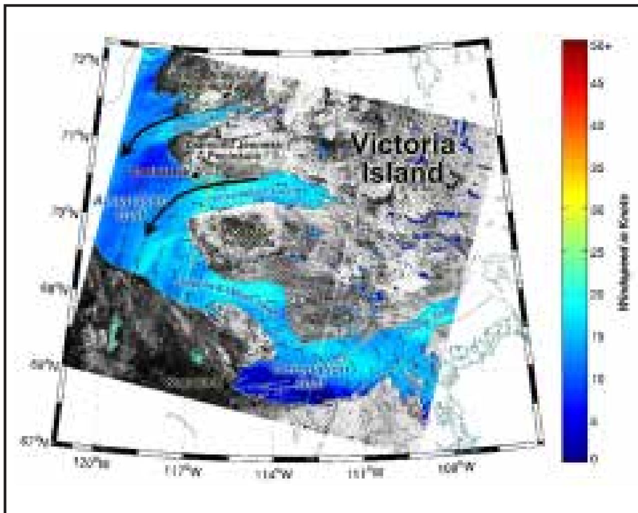


Figure 31: RADARSAT derived winds from October 19, 2012 at 14:14 UTC.

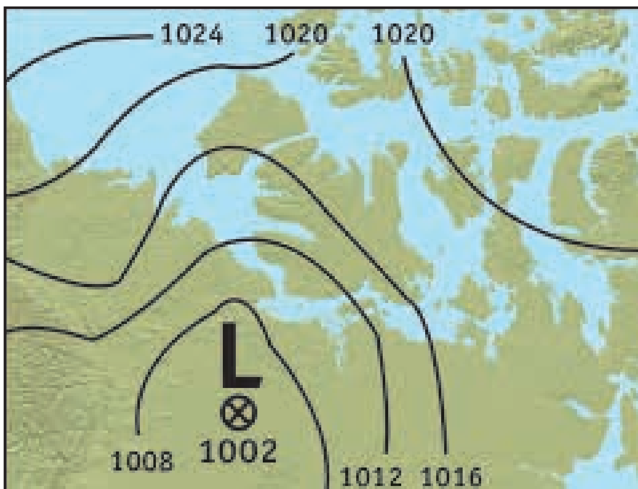


Figure 32: Surface Analysis from October 19, 2012.

RADARSAT image (above) and surface analysis (below) from October 19, 2012, showing easterly outflow winds near 20 kt from Minto and Prince Albert Sound, under the influence of a low-pressure trough and enhanced by the topography of Victoria Island.

Mariners' Tips:

Gap winds can catch vessels off guard as they are passing the mouths of Minto Inlet and Prince Albert Sound.

In a southeasterly flow, the topography of southwestern Victoria Island can redirect the wind, creating an area of lighter winds within the area up to 30 km northwest of Cape Baring. RADARSAT imagery has provided evidence of downslope winds adjacent to the shore and lee waves downwind of Cape Baring, indicating fluctuations in wind speed.

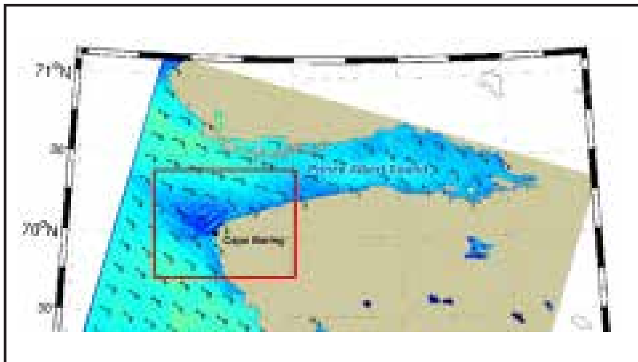


Figure 33: RADARSAT derived winds from September 4, 2013 at 14:32 showing a narrow band of moderate winds near the coast of Cape Baring.

6.4.2 Sea State, Shoals, and Ice Conditions

6.4.2.1 Sea State

Waters in the Queens and Kings bays are relatively shallow. In recent years, residents have observed stronger waves and a greater frequency of coastal storms on the former, with water levels also reaching further onto shore during high tides and storm events than they did before. More frequent south winds in summer and more severe storms have been reported to create very rough ocean conditions. Strong east winds create higher waves and increased coastal erosion on the western side of Queens Bay.

6.4.2.2 Shoals

Shoals are present in Walker Bay and in the area between the Victoria and Banks islands.

6.4.2.3 Ice Conditions

- **Ulukhaktok:** A striking feature of the tidal waters in this area is the long period of seasonal ice cover caused by the relatively shallow water. Freeze-up generally occurs in the Queens and Kings bays near the end of October, with ice thickness increasing over the winter to about 2 m. In an average year, break-up can be expected between July 1 and 15 and freeze-up between October 1 and 10. The speed and direction of the wind affects sea ice dynamics in the bays. Strong northeast and east winds break up the ice, usually in the late spring; however, east and northeast winds have also been experienced in recent years in the fall and winter. This has delayed freeze-up and caused premature break-up and the creation of open-water leads. West winds can push the broken ice back into the bays, making navigation impossible.

- **Victoria and Banks Islands:** As a result of the predominant north winds and wind-generated currents, ice moves southward through Prince of Wales Strait. The shoals between the Victoria and Banks islands, however, can have a barrier effect on its movement, causing large quantities to end up grounded in the area.

- **Walker Bay:** Under average conditions, break-up occurs in July, with the entire bay clear of ice by August. During the first two weeks of September, however, it starts to freeze up. These conditions vary considerably from year to year.

- **Minto Inlet:** Conditions are similar to those in Walker Bay, except that the ice tends to disperse more slowly from the entrance and central part of the inlet. Considerable variation in ice conditions occurs from one season to another.

- **Prince Albert Sound:** Leads generally begin to form along the shores of the sound in July, with heavier concentrations remaining in the central area. By the first half of August, the shores and central area are virtually ice-free, with some lingering near the entrance and innermost reaches. By mid-September, concentrations along the shore begin to increase, with complete ice coverage possible by the end of the month—in particular, among the islands in the northwestern part of the sound.

Pack ice in Beaufort. Photo courtesy of Nicolas Peissel.

ARCTIC REGIONAL GUIDE PART 3: KITIKMEOT

7. Kitikmeot Coast Marine Area

This section provides information on local weather, wind, sea state, and ice conditions for the marine regions of the Kitikmeot Coast area, which have been grouped as follows by similarities in their wind regimes and weather patterns: Dolphin; Bathurst; Coronation and Dease (including Kugluktuk and Cambridge Bay); Maud and St. Roch (including Gjoa Haven and Taloyoak); and Boothia and Committee (including Kugaaruk).

Figure 1: Marine regions of the Kitikmeot Coast area.

Several different types of weather patterns and storms affect the Kitikmeot Coast area. One pattern observed frequently, especially in the summer and fall months, occurs when lows and troughs develop over the Beaufort Sea or Alaska and move eastward, following the coast of the Canadian mainland. Such situations are preceded by a south to southeast flow and followed by a northwest to north flow. Another common pattern occurs when a storm develops over the southern Mackenzie Valley or the Great Slave Lake/Bear Lake areas and moves north to northeast. In such cases, a strong arctic high is often in place west of Kugluktuk. This can result in very strong north to northeast winds at Kugluktuk, which, combined with fresh snow from the storm, can produce blizzards.

Another situation that occurs involves storms originating over the High Arctic Archipelago or polar seas and tracking southeastward, in which the area of high pressure west of the storm leads to a strong north to northwest flow behind the low. Storms that track west and northwest of the Hudson Bay and Foxe Basin areas primarily affect the eastern Kitikmeot region. The strong northwesterly flow often generated in the wake of these systems is responsible for many gale-force winds in the region.

Centres of high-pressure systems in this region usually move slowly and irregularly during the summer, resulting in the circulation being generally light and northerly at that time of the year. The area east of Victoria Island is susceptible to disturbances tracking through it and is often a graveyard for storms.

Onshore winds along the coastlines are deflected in directions nearly parallel to the shore, causing them to increase in speed. Similarly, the prevailing wind directions in straits and fiords usually follow the channel and increase in speed as it narrows. Skies in the area are typically overcast 50 percent of the time in the summer but 70 to 80 percent of the time by September and October. Only in July and August do air temperatures typically rise above freezing throughout the day.

Mariners' Tips:
In general, the probability of fog is lower over a narrow strait if there are cross winds or the strait is oriented at a right angle to the prevailing winds. Late in the season, poor visibility is much more likely to be caused by snow than fog.

7.1 Dolphin Marine Region

Dolphin and Union Strait lies in both the Northwest Territories and Nunavut, between the mainland and Victoria Island. It links Amundsen Gulf, to the northwest, with Coronation Gulf, to the southeast.

Figure 2: Local effects for the Dolphin Marine Regions.

7.1.1 Winds and Weather

Winds are routinely stronger than the weather pattern predicts, suggesting a strong channelling effect by the surrounding topography in Dolphin and Union Strait.

Figure 3: June, July, and August average winds, based on RADARSAT imagery.

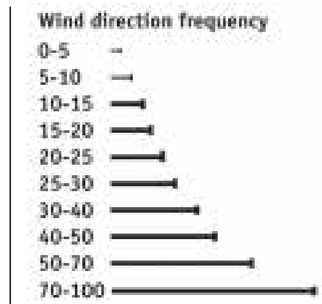


Figure 4: September, October, and November average winds, based on RADARSAT imagery.

Dolphin and Union Strait sees frequent fog, averaging five to seven days per month in July and August. September and October are usually clear.

7.1.1.1 Northwesterly and Westerly Flow Pattern

Northerly to northwesterly flow is generated with the passage of low-pressure systems that develop over the Beaufort Sea and track eastward across the southern sections of the Canadian Arctic Archipelago. As northwest winds blow through Dolphin and Union Strait, they tend to strengthen due to channelling, with higher winds often experienced under such conditions in Stapylton Bay and South Bay.

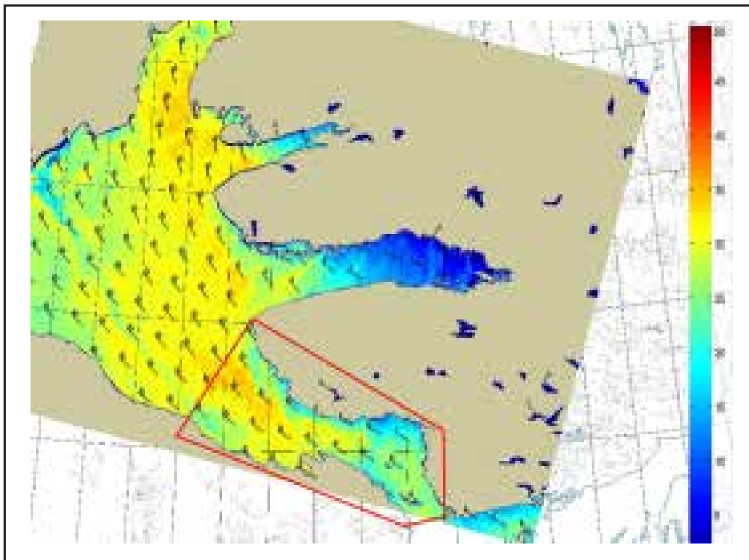


Figure 5: RADARSAT derived winds from September 6, 2014 at 14:28 UTC.

RADARSAT image from September 6, 2014, at 14:28 UTC (Dolphin and Union Strait is bounded by the red rectangle). Channelling in the strait is evident, with the strongest wind speeds occurring over its western portions.

While channelling enhances winds, the complex topography and coastline provide a variety of different wind effects felt in other areas. For instance, the topography of Simpson Bay's northern shore offers some protection from strong north and northwest winds while the southern shore experiences stronger north to northwest winds.

Figure 6: Image showing strong Northwest winds blowing into Stapylton Bay and Souths Bay.

Wind distribution over Dolphin and Union Strait and Simpson Bay in a northwesterly flow.

The length of the black arrows indicates the comparative strength of the wind in the different parts of the strait.

Northwesterly flow is also generated in the western sectors of storms that develop north of the Beaufort Sea and move southeastward. These low-pressure systems, combined with the building of high-pressure systems over western Alaska, create strong northwesterly flow south of the Banks and Victoria islands.

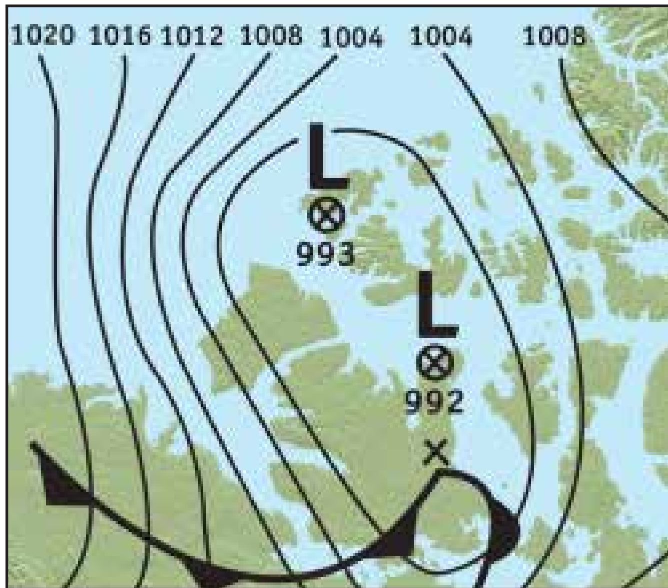


Figure 7: Surface analysis from August 14, 2004 at 18:00 UTC.

An intense low-pressure system generated gale-force northwest winds in Dolphin and Union Strait, with a ship near Lambert Island reporting northwesterly winds of 40 to 45 kt on August 14 and 15, 2004. Channelling, cornering, coastal convergence, and gap-wind effects (as indicated by the synoptic flow) were also likely contributors to the strong winds.

With this pattern, strong northwest winds are usually observed in Dolphin and Union Strait and can sometimes become stronger than expected from the synoptic pattern. Northwest winds are predominant during the summer.

The Lambert and Camping islands, at the narrowest point on Dolphin and Union Strait, can be used by mariners as crossing points between the mainland and Victoria Island (Austin Bay/Lady Franklin Point); however, the area could be exposed to channelling, coastal convergence, and cornering effects with northwest winds.

Figure 8: Image of Coronation Gulf.

7.1.1.2 Southerly Flow Pattern

A strong southerly flow is often generated ahead of storms that redevelop over the Mackenzie Valley and then move northeastward.

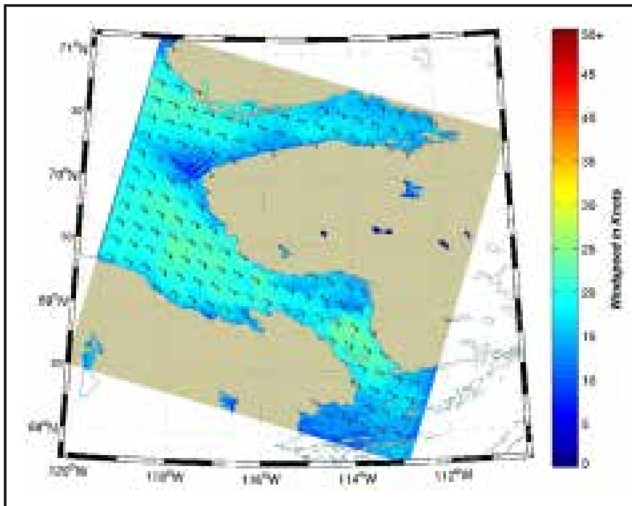


Figure 9: RADARSAT derived winds from September 4, 2013 at 14:32 UTC.

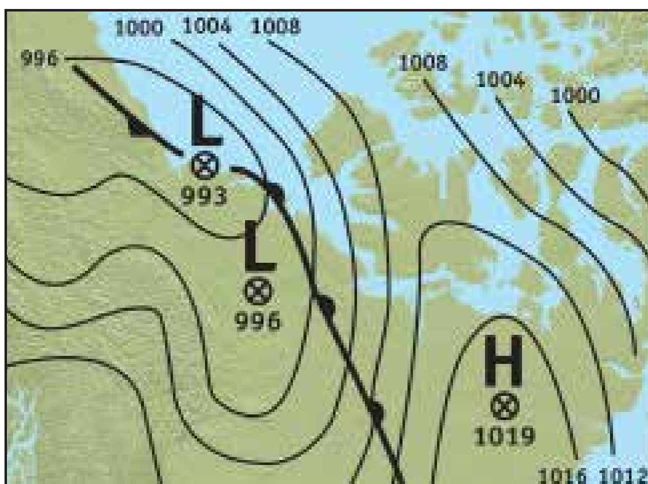


Figure 10: Surface analysis from September 4, 2013 at 12:00 UTC.

RADARSAT image (above) and surface analysis (below) showing a strong southerly flow generated ahead of a low on September 4, 2013. South winds changed to southeast and become stronger as they entered Dolphin and Union Strait, then weakened over Simpson Bay, where the channel widens. They strengthened again further westward, where the strait narrows.

Mariners can find shelter from strong southeast winds on the downwind side of the Liston, Harkness, and Sutton islands and in the northern parts of Simpson Bay. Stapylton Bay offers relief from east and southeast winds, while Bernard Harbour offers protection from winds of all directions. Fog is frequent in Bernard Harbour.

7.1.2 Currents, Shoals, and Ice Conditions

7.1.2.1 Currents

Dolphin and Union Strait is the narrowest point on the channel through which waters flow from the Beaufort Sea eastward. Following a period of strong northwesterly winds, the southeast current is reported to reverse for a few days.

> **Mariners' Tips:**
> With the narrowing of any large body of water, there is always the possibility of increased currents and other anomalies.

A strong southwestward current can be expected with the easterly tidal stream at the entrance to Austin Bay. Persistent, strong onshore flow may raise surf on the beach of Lady Franklin Point and cause ice congestion.

7.1.2.2 Shoals

- **Cape Bexley:** Shoals near the cape, combined with frequent strong northwest and east/southeast winds, can generate steep, large waves in this sector of the strait.
- **Harkness, Sutton, and Liston Islands:** Shoaling occurs to the north and northeast of these islands.
- **Lambert Channel:** There are many reefs and shoals on the northeastern side of the channel. The sea breaks on some of them, generating strong tidal rips.
- **Lady Franklin Point:** There is extensive shoal southwest of the point.
- **Cache Point Channel:** An extensive shoal area lies on the western side of the channel.
- **Read Island:** There are many shoals north of the island.

7.1.2.3 Ice Conditions

In Dolphin and Union Strait, the ice usually begins to loosen in early July, and open water can be found in most of the strait by the latter half of the month. If northwest winds are persistent, they can cause a considerable concentration of ice toward the southeastern, narrower end of the strait, where the presence of islands and shoals restricts ice movement. Although patches of ice may be present throughout the summer and ice usually reaches its minimum in the last weeks of August, the strait is rarely, if ever, entirely ice free.

Northwest winds can force ice into the strait that will only break up and dissipate when the winds become southeasterly. In September, quite variable conditions have been reported, with some years almost completely ice free and others experiencing heavy ice concentration. Along the shore, freeze-up generally begins in early September, although, in favorable years, the strait has been navigable through most of the month and even into October. By the middle of November, it is frozen solid.

In Simpson Bay, break-up usually occurs around the middle of July and freeze-up in October. After break up, the tides carry drift ice back and forth for about a week before it is gradually carried out to sea.

7.2 Bathurst Marine Region

Located on the southern coast of Coronation Gulf, Bathurst Inlet is a deep inlet studded with numerous islands. The uniform northwest-southeast orientation of its topographic features tends to channel the prevailing winds along its length, and there are places where the wind blows in only one direction or the other. Summer weather in the south part of the inlet is relatively mild, with temperatures generally deteriorating toward its northern end, where the cooling effect of the gulf is more significant. Although the region lies at sea level, it is protected the length of the inlet from the cooling influence of the Arctic Sea. Dry west winds blowing down from the uplands have a warming influence.

Figure 11: Local effects for the Bathurst Marine Region.

7.2.1 Winds and Weather

Figure 12: June, July, and August average winds, based on RADARSAT imagery.

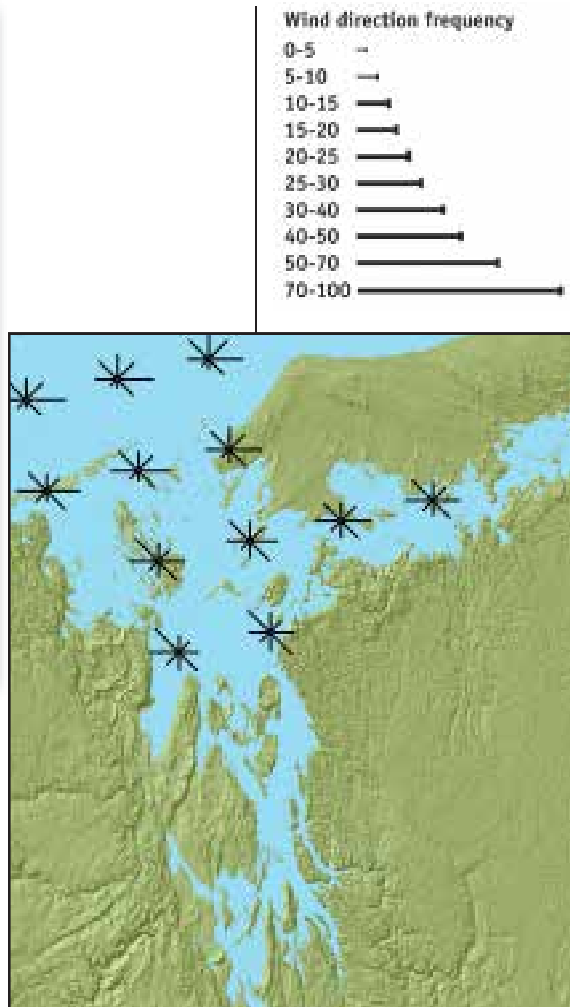


Figure 13: September, October, and November average winds, based on RADARSAT imagery.

7.2.1.1 Northerly and Northeasterly Flow Pattern

This flow is generated over Bathurst Inlet in behind lows that are moving eastward and southeastward from the Beaufort Sea. Stronger north winds are most evident in this marine area, where Coronation Gulf narrows into the Bathurst Inlet, while the Coronation Gulf area can be relatively calm. Light north or northeast winds can increase significantly in strength due to channelling, especially after the passage of a cold front.

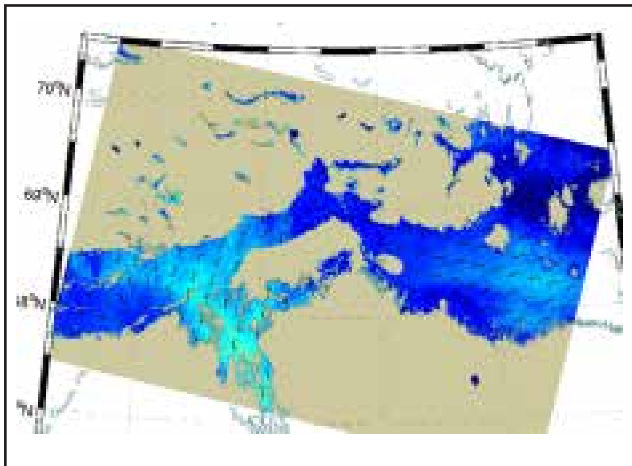


Figure 14: RADARSAT derived winds from September 16, 2013 at 13:42 UTC.

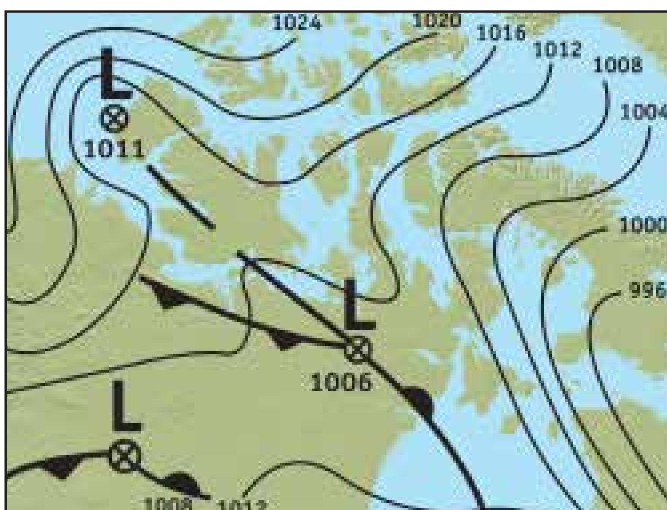


Figure 15: Surface analysis from September 16, 2013 at 06:00 UTC.

RADARSAT image (above) and surface analysis (below) from September 16, 2013, at 13:42 UTC, showing a northerly flow over Bathurst Inlet.

Wind distribution over Bathurst Inlet in a northeasterly flow. The length of the black arrows indicates the comparative wind speed in the various areas depicted.

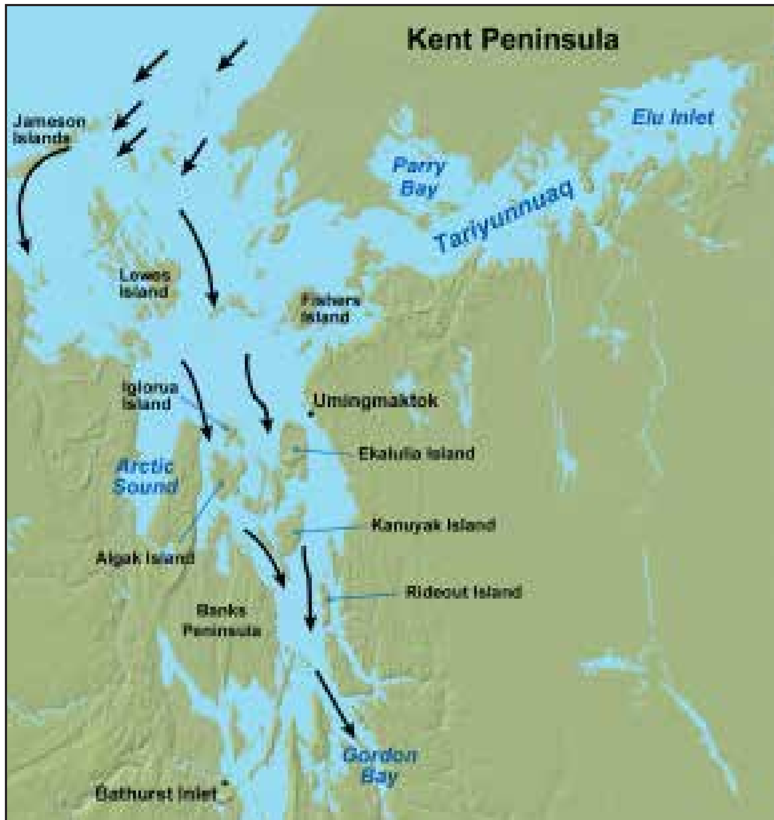


Figure 16: Image depicting Northerly winds being channeled and funneled between islands and along the channel.

North winds of almost 15 kt were observed at Bathurst Inlet weather station when the synoptic flow was relatively weak and were almost 10 kt stronger in the inlet's narrow channels and between its numerous islands.

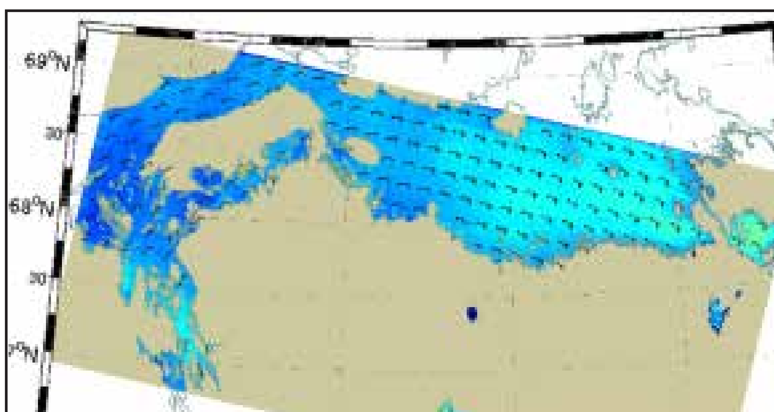


Figure 17: RADARSAT image from October 7, 2013 at 13:30 UTC, indicating strengthened winds in the Arctic Sound between Banks Peninsula and Rideout Island and, further south, in Gordon Bay.

7.2.1.2 Southerly and Southeasterly Flow Pattern

South winds are also quite common and can be as strong as northerlies, depending on the weather pattern. Southerly flow develops over the Bathurst Inlet ahead of two types of low-pressure systems: one, when a storm tracks from the Beaufort Sea southeastward and the other, when it tracks from the Great Slave Lake area northeastward.

Detention Harbour is well protected from all winds due to its geographical location and terrain. Little or no fog is reported in the Bathurst Inlet Marine Region during the summer season.

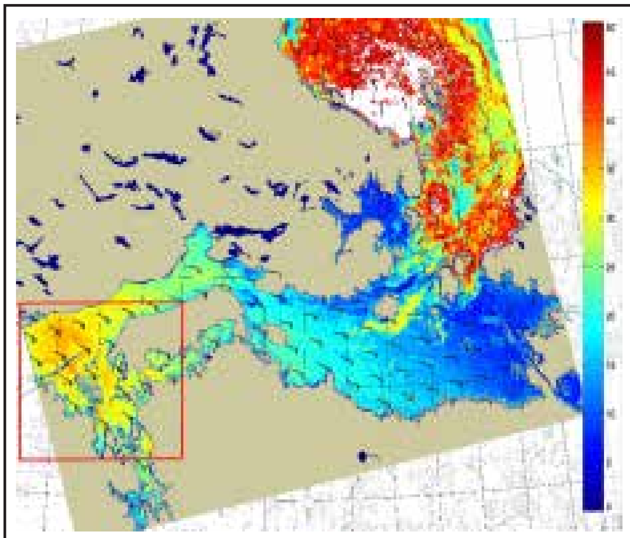


Figure 18: RADARSAT image taken late October 1, 2014 at 00.22 UTC.

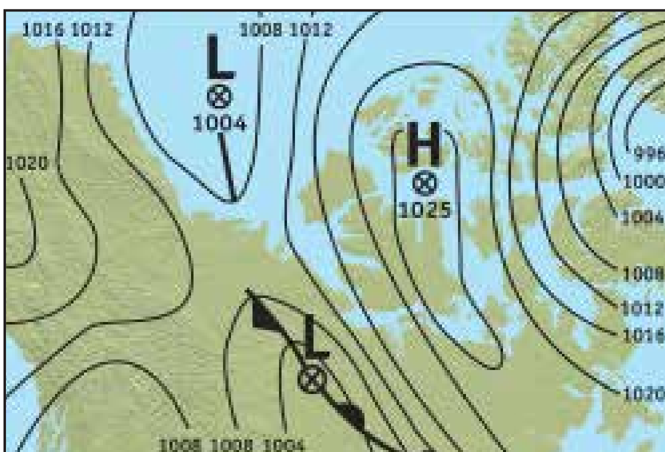


Figure 19: Surface analysis from September 30, 2014 at 18.00 UTC.

RADARSAT image (above) from October 1, 2014 and surface analysis (below) from September 30, 2014, showing the two types of low-pressure systems occurring at the same time and combining with a high-pressure ridge over the High Arctic to generate a strong southeasterly flow over Bathurst Inlet. South winds were nearly twice as strong over the coast of Victoria Island (west of Kent Peninsula, near Cape Peel West), and reached nearly gale force over northern and central parts of the inlet. Most likely, these bands of stronger winds were influenced by the effects of channelling and coastal convergence.

7.2.2 Waves, Tides, Shoals, and Ice Conditions

7.2.2.1 Waves

The geographic location of Bathurst Inlet and its numerous islands severely restricts the fetch available for wave development. During prolonged and strong northwest wind events, the sea surface likely begins to slope upward, to the south. The degree to which the elevation of the sea surface rises above the astronomical high tide will also be larger in the southern parts of the inlet. Storm surges are accompanied by larger waves, with north or strong south winds capable of changing the wind setup at the port of the inlet.

7.2.2.2 Tides

The tidal range in the inlet is small. Outflow from the rivers moves northward, into Coronation Gulf, with some of the narrowest channels seeing a flow of up to 5 kt.

7.2.2.3 Shoals

There are shoals southwest of Walrus Island and at the southwestern corner of Arctic Sound.

7.2.2.4 Ice Conditions

In Bathurst Inlet, ice breaks up on the larger rivers in the first or second week in June. Open water appears outside the mouth of the inlet shortly afterward and gradually begins to expand, particularly in the south. By the end of June, all areas south of North Quadyuk Island, the inner part of Gordon Bay, and the south end of the Arctic Sound are usually open. Further north, the ice remains longer but is generally gone by about the third or fourth week of July. Some years, ice can be found in early August in the northern part of the inlet and in Daniel Moore Bay. Southern Bathurst Inlet begins to develop an ice cover toward the end of October. In the north, where the currents are strong and the water has greater salinity, open water will remain longer—sometimes until December. The narrows between the North and South Quadyuk islands, for example, may not freeze at all some years.

Sunrise over calm and dangerous waters. Photo courtesy of Nicolas Peissel.

7.3 Coronation and Dease Marine Regions

Coronation Gulf lies between Victoria Island and mainland Nunavut. Prevailing winds over the open waters of the gulf are typically from the west/northwest and east. Dease Strait is adjacent to Coronation Gulf, between Kent Peninsula and Victoria Island.

The community of Kugluktuk. Credit: Tessa Macintosh

The community of Kugluktuk is located at the mouth of the Coppermine River, on the shores of Coronation Gulf. To the west, the terrain is fairly flat for several kilometres; to the southwest, however, the hills surrounding the river valley rise to more than 90 m and, to the southeast, the terrain reaches more than 150 m in some places.

The community of Cambridge Bay is located on the southeast coast of Victoria Island at the northern end of the bay of the same name.

The community of Cambridge Bay. Credit: Fritz Mueller

7.3.1 Winds and Weather

Northwest, west, and east winds are the most frequent in this region, while south winds are the least. The strongest winds are westerly and northwesterly, generated by storms coming from the Beaufort Sea and the western reaches of the High Arctic. Sea breezes occur during the warmer months. While Kent Peninsula serves as a wind break by shielding particular areas in different wind directions, it can also cause the channelling of east and west winds in Dease Strait. Especially strong, gusty winds can be expected after the passage of a cold front.

This is the warmest route in the Arctic, with the mean temperature for both July and August being 7 to 10°C. Relatively extreme high temperatures of over 25°C occur on the mainland coast and of over 20°C on the islands. The drop in temperature during September and October is more rapid in the eastern than the western portion of the route. While the mean temperature for August is close to 7°C throughout the region, it varies in September from 2°C in the west to -1°C in the east; in October, it varies from -7 to -12°C. During the navigation season, precipitation averages 30 mm. Snow is rare in July and August, while rain rarely occurs in October. In September, the probabilities for rain and snow are about equal.

Figure 20: Local effects for the Coronation Gulf area.

Figure 21: June, July, and August average winds, based on RADARSAT imagery.

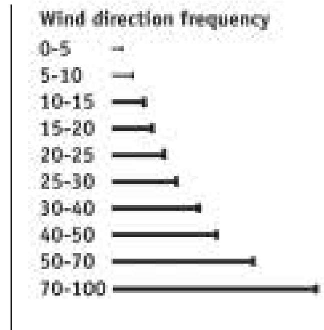


Figure 22: September, October, and November average winds, based on RADARSAT imagery.

Figure 23: Local effects for the Dease Strait area.

Figure 24: June, July, and August average winds, based on RADARSAT imagery.

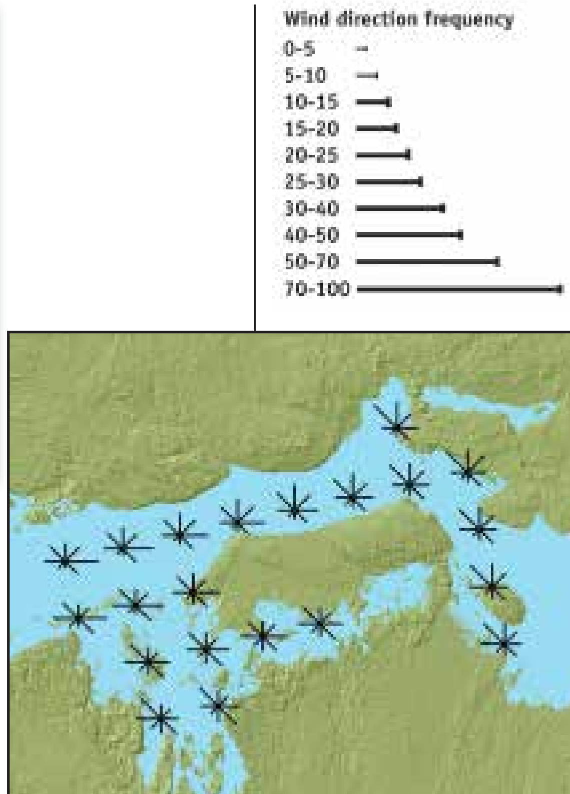


Figure 25: September, October, and November average winds, based on RADARSAT imagery.

7.3.1.1 Northerly and Northwesterly Flow Pattern

In Coronation Gulf and Dease Strait, this flow is generated behind low-pressure systems that move in from the Beaufort Sea/High Arctic or Great Slave Lake areas. Strong northwest to west winds develop on the western side of these storms, especially when a high-pressure system is pushing in from the west or southwest. Byron Bay may offer some shelter as these winds channel through Dease Strait.

Significant Event: September 4, 2014

According to the diary of the *Arctic Tern* expedition, a morning forecast of winds NW 20 kt had the ship headed for the Richardson Islands via the north side of Dease Strait. After about 12 hours, however, the wind backed straight into its nose and increased to 30 kt. With few good anchorages available, the expedition backtracked 27 km to Byron Bay, where it waited some 30 hours for more favorable winds. With reports the next morning of light northerlies developing to 25 kt later in the day, the ship was bounding toward Lady Franklin Point at 7 to 8 kt, with no fetch, when the wind once again gradually backed to the west. With another anchorage needed and nearly 300 km to go to reach Dolphin Strait, to the northwest, the foul current and daily run of NW winds were, in diarist's own words, "not going to be fun".

Figure 26: Image depicting winds across Coronation Gulf and Dease Strait on September 4, 2014.

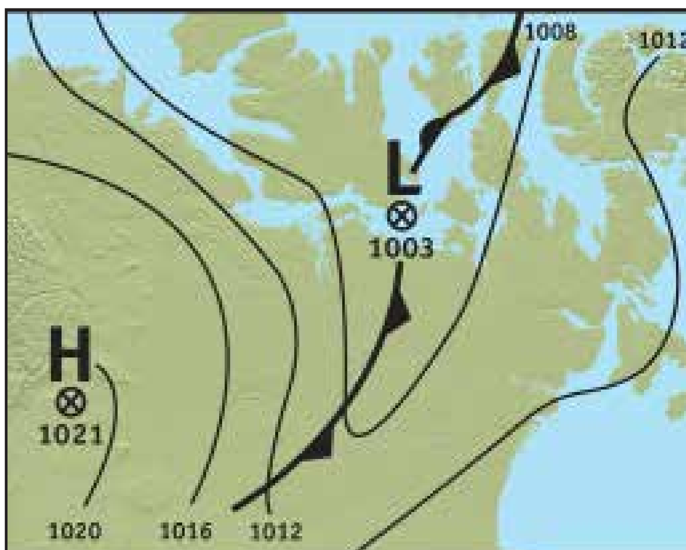


Figure 27: Surface analysis from September 5, 2014 at 00:00 UTC.

Strong west winds (nearly 30 percent stronger than expected) in Dease Strait after the passage of a cold front on September 4-5, 2014, were most likely caused by channelling. Cape Peel West, near Byron Bay, reported speeds of nearly 20 kt and the Arctic Tern, 30 kt.

Mariners' Tips:
Mariners are advised to watch for strong west-to-northwest winds during the ice-free fall season—in particular, when strong pressure rises following a low-pressure trough or the passage of a cold front.

7.3.1.2 Northeasterly and Easterly Flow Pattern

Figure 28: Image depicting the funnelling effect on northeasterly winds between the Jameson Islands and the mainland.

This flow is generated over Coronation Gulf in the northern sectors of storms rotating over the southeastern arctic. This type of system combined with strong high pressure system pushing from the western parts of High Arctic can generate strong east to northeast winds over the Coronation Gulf.

Significant Event: September 15, 2007

On its way to Bathurst Inlet, the CCGS *Sir W. Laurier* encountered near gale-force northeast winds of 25 kt, 2.7-m swells, and fog between the Jameson Islands and the mainland, although the pressure system suggested wind speeds of only 20 kt over Coronation Gulf. The winds were more than 25 percent stronger than those reported in Cambridge Bay (19 kt), which was also under the same pressure gradient.

Figure 29: Image depicting winds across Coronation Gulf and Dease Strait on September 15, 2007.

Significant differences in wind speed were encountered by the CCGS Sir W. Laurier and nearby locations, such as Kugluktuk and Cambridge Bay.

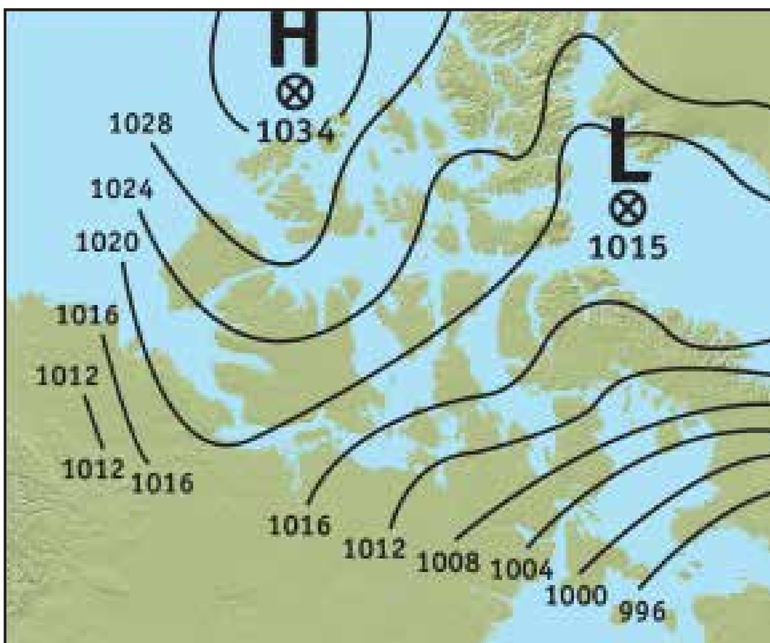


Figure 30: Surface analysis from September 15, 2007.

7.3.1.3 Southerly and Southeasterly Flow Pattern

This flow is generated ahead of lows coming from the Beaufort Sea or Great Slave Lake areas—the same as is experienced for Bathurst Inlet. Southeast winds slowly back to the east and accelerate over Coronation Gulf, which stretches east to west.

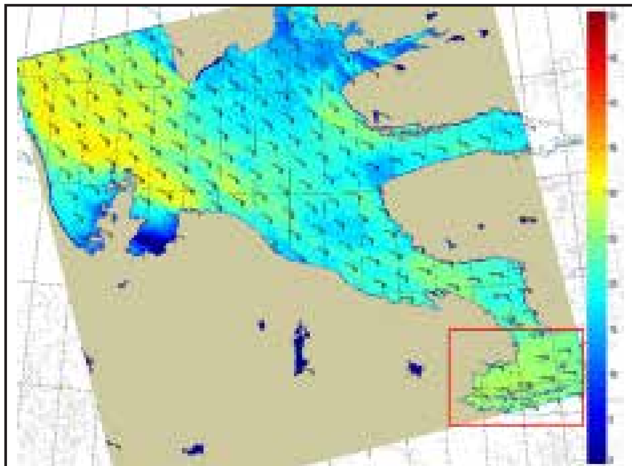


Figure 31: RADARSAT derived winds from September 29, 2014 at 01:29 UTC.

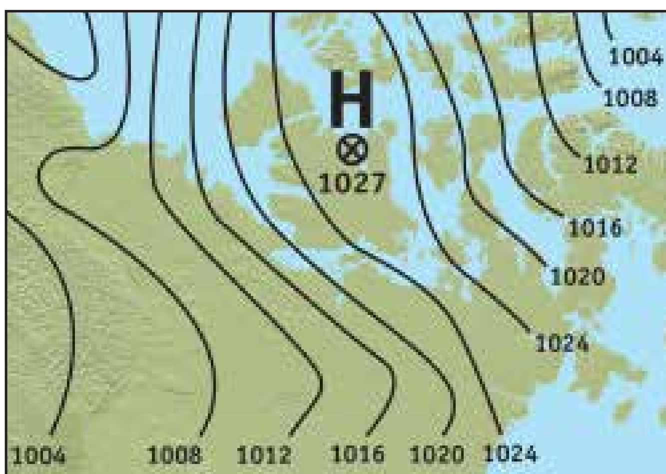


Figure 32: Surface analysis from September 29, 2014 at 00:00 UTC.

RADARSAT image (above) and surface analysis (below) showing a southeasterly flow on September 29, 2014. Easterly winds were reported at Kugluktuk at nearly 20 kt, at the Cape Peel West weather station in Dease Strait at just over 15 kt, and in the western parts of Coronation Gulf at 25 kt or higher.

Complex topography causes local effects, such as funneling in northerly or southerly flows, at Inman Harbor.

Figure 33: Local effects for Inman Harbour and Grays Bay.

7.3.1.4 Kugluktuk

Kugluktuk is located near major storm tracks. The valley and hills in the area have a major influence on the prevailing winds in the vicinity of the community, which are considerably different from those experienced over the open water in nearby straits. This should be taken into consideration when local weather information is used for marine purposes.

Prevailing easterly winds in the summer result from storms located over the mainland area south of Coronation Gulf. In the fall, the winds not only strengthen but also become predominantly southwesterly and persist through the colder months. The stronger, gustier winds tend to come from the northwest—especially in fall and winter—following the lows that move eastward from the Beaufort Sea. Strong northwest winds also occur when storms from the Foxe Basin area track westward and a high-pressure system is positioned to the west of Coronation Gulf. In summer, northeast winds are often the result of a sea-breeze effect.

Freezing precipitation in the form of freezing rain or freezing drizzle is relatively uncommon in the area, occurring (if at all) in May and October, when the seasons are transitioning.

Localized fog, often associated with northeasterly winds, can sometimes occur in the early morning hours during the summer, although it is less common in July than in June or August. The same winds—which can come in the form of a sea breeze, in summer—can also bring stratus clouds inland during the summer and fall. Fair weather is most likely to come with southwest winds.

7.3.1.5 Cambridge Bay

The wide range of prevailing winds at Cambridge Bay is influenced by the diversity of the storms tracks that impact the Central Arctic. During the marine season, the winds may be affected by lows moving northeast from the vicinity of Great Bear Lake and Great Slave Lake, moving southeast through the Arctic Archipelago, or tracking west and northwest from Hudson Bay and Foxe Basin. In the fall, some storms also come from the Gulf of Alaska and track northeastward over the Beaufort Sea and around the Banks and Victoria islands.

Storms tracking into the Foxe Basin area can put it in a squeeze between a high-pressure system to the west and low-pressure areas to the east—a situation that often produces strong north-to-northwest winds. Strong, gusty north-to-northeast winds in the Cambridge Bay area are often associated with storms that develop over the southern Mackenzie Valley or Great Slave Lake areas in summer. The strongest winds tend to come from the northwest during the colder months; however, during the fall, they can approach from various directions.

In July and August, temperatures remain largely above freezing, with 20 to 25 mm of precipitation typically falling each month, as well as in September. Thundershowers are rare north of the mainland but do occur from July to early August and sometime linger into early September.

By October, precipitation falls mainly in the form of snow, which can occur in any month of the year. Freezing precipitation in the form of freezing rain or freezing drizzle is relatively uncommon in the Cambridge Bay area. If it does occur, it is usually when the seasons are transitioning, in late May to early June or in early October.

Low cloud, fog, or a combination of the two are persistent in the area from spring to fall. Fog is most likely to appear in the early morning hours in the summer, June being the foggiest month. Overcast conditions are most likely to occur in September, with northwesterly flows bringing low cloud across the area in both summer and fall. In the summer, when the winds are light, low cloud and fog blowing in from the open water penetrate only a few kilometers inland.

7.3.2 Waves, Tides, Currents, Shoals, and Ice Conditions

Significant Event: August 22-24, 2013

The *SV Empiricus*, a 50-foot sailboat (Arctic Expedition 2013), while anchored and taking shelter in Johansen Bay, experienced west to northwest winds of 40 kt, 1 to 2 m waves, and heavy fog. On the same day, the Cape Peel weather station—located on the same shore of Victoria Island but 150 km to the east—reported the same winds at 44 kt.

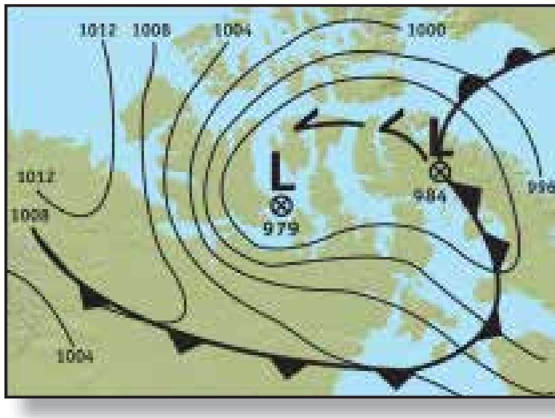


Figure 34: Surface analysis from August 24, 2013 at 06:00 UTC.

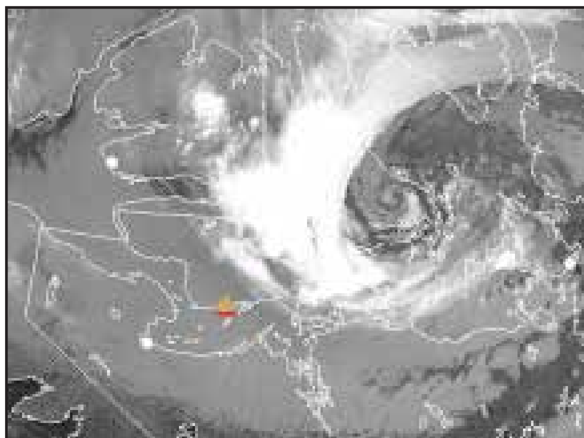


Figure 35: Satellite image from August 24, 2013, 04 UTC, the sailboat icon indicating the position of the SV Empiricus in Johansen Bay.

Surface analysis from August 24, 2013, at 06 UTC, showing a storm that originated over the High Arctic Archipelago and moved southeastward, producing very strong northwesterly and westerly flows over many regions of Kitikmeot.

7.3.2.1 Waves and Tides

- **Kugluktuk:** The tidal variation is less than 0.5 m. Local water levels are affected more by winds than tides, with a strong northwest wind of a few days' duration capable of increasing water levels by as much as 1.2 m.
- **Johansen Bay:** A tidal stream of 3 kt is observed across the bay.
- **Grays Bay:** The bay is protected from large waves by Hepburn Island.
- **Dease Strait:** Tides are affected by strong winds.
- **Cambridge Bay:** The inner bay that forms the harbour is oriented northwest to southeast, thereby protecting the community from outer-bay waves, storm surges, and mobile ice. With strong northwest winds, waves of up to 2 m have been reported. The tidal range is small, with a maximum recorded tide of 1.4 m.

7.3.2.2 Currents

- **Coppermine River (western Coronation Gulf):** Outflow from the river may create east- or west-going currents of up to 2 kt, depending on recent prevailing winds.
- **Coronation Gulf and Dease Strait:** Currents are from the east.
- **Edinburgh Channel:** There is a strong east current in the vicinity of the channel.
- **Byron Bay:** The Lauchlan River flows into this shallow bay, allegedly creating a 3-kt current early in the meltwater season.

7.3.2.3 Shoals

- **Coronation Gulf:** This shallow basin, which averages less than 100 m in depth, has progressive shoaling toward the shoreline.
- **Kugluktuk:** There is a large shoal just west of the town site, some 150 m offshore.
- **Berens Islands:** Large shoals can be found to the north.
- **Wilbank Bay:** Shoals exist in front of the bay.
- **Lauchlan River:** There are shoals near the mouth of the river.
- **Wellington Bay:** Shoals can be found in the northern parts of the bay.
- **Cape Enterprise:** There is shoal water to the south-southwest of the cape.
- **Cape Alexander:** There is a shoal north of the cape.
- **Melville Sound:** Shoals are found at the entrance to the sound, north of Cape Croker.
- **Expeditor Cove:** Shoal waters exist on the southeastern side of the bay.

7.3.2.4 Ice Conditions

Coronation Gulf and Dease Strait are areas of fast ice in winter, as several chains of islets prevent any ice motion. In the gulf, ice cover is complete for about nine months of the year and is predominantly land-fast. Many of the channels and straits are ice-choked throughout the summer.

Break-up is a matter of the ice melting in situ, with only the freshwater runoff from the Coppermine River to assist. The flow of the river causes the ice in front of the same-named settlement to break up by mid-June, while ice several kilometres offshore remains solid, thus limiting navigation.

The effect of the river, and the minor influence of a small polynya off Cape Kruesentern, results in break-up developing from west to east in late June or early July. The water in the vicinity of the entrance to Dolphin and Union Strait clears first, due to the strong current. The smoothness of the ice in the gulf results in extensive puddling, so once it begins to clear, the rest of the pack disappears quickly. August and September are essentially ice-free.

Coronation Gulf and Dease Strait are usually closed to navigation from November through June and, sometimes, through most of July. Toward the end of September or the first week in

October, new ice begins to form on the gulf, especially in sheltered bays. Bathurst Inlet and the waters along both sides of the gulf are generally frozen solid by the end of October. By November, the gulf is firmly covered, although some open patches may still exist at its centre and at the entrance to Dolphin and Union Strait, which does not consolidate until well into December.

In Dease Strait, the ice loosens along the coast of Kent Peninsula in June and, by late July or early August, there is open water with varying amounts of floating ice in the central section from Victoria Island to the mainland and along the south shore into Bathurst Inlet. At Cambridge Bay, the average date of first appearance of breaks and the complete clearance of ice are June 13 and July 25, respectively—although an ice barrier often extends between Long Point, Cape Colborne, and the Finlayson Islands, hindering sea transportation to and from the bay until late July or early August.

By the latter part of August and early September, the strait is usually clear, although ice from Queen Maud Gulf frequently invades its eastern end during the summer, depending on the winds and the timing of break-up in the gulf. Similarly, polar pack from Cape Bathurst and Cape Kellett has periodically penetrated the western gulf.

Ice begins to form along the south coast of Dease Strait and in Cambridge Bay and the northeastern section of Wellington Bay in mid- to late-September, with Cambridge Bay experiencing complete coverage by October 16. By November, the entire strait is usually frozen solid, except for a tongue of heavy but unconsolidated pack ice that may persist in mid-channel from the entrance of Queen Maud Gulf to the vicinity of Wellington Bay until early December.

Getting to shore for supplies. Photo courtesy of Nicolas Peissel.

7.4 Maud and St. Roch Marine Regions

The Queen Maud Gulf lies between the northern coast of the mainland and the southeastern corner of Victoria Island. At its western end lies Cambridge Bay, which leads to Dease Strait. To its east lies Simpson Strait and, to its north, Victoria Strait.

The community of Gjoa Haven is located on the southeast coast of King William Island, near the southern tip of Neumayer Peninsula. The surrounding terrain is very flat, so the winds in the area follow the prevailing weather pattern.

Photo of the community of Gjoa Haven. Credit: Michel Thibert

Taloyoak is located at the northeast end of Spence Bay on the Boothia Isthmus at the southern tip of the Boothia Peninsula.

Photo of the community of Talyoak. Photo courtesy of Karmen Loyek.

7.4.1 Winds and Weather

The frequency of storms moving directly through this area increases to the east of Victoria Island. These storms originate from the southwest and, to a lesser extent, the northwest and southeast. The most common gales that occur in the Maud Marine region during the navigation period come from the northwest. These winds are generated by the same storms that affect areas to the west of the region.

A severe mirage effect (caused by a strong arctic marine inversion) occurs in the eastern part of Queen Maud Gulf when ice is present, making it difficult to take visual bearings.

Northwest winds are also the most common in Simpson Strait, reaching velocities of over 20 kt due to the channelling effect.

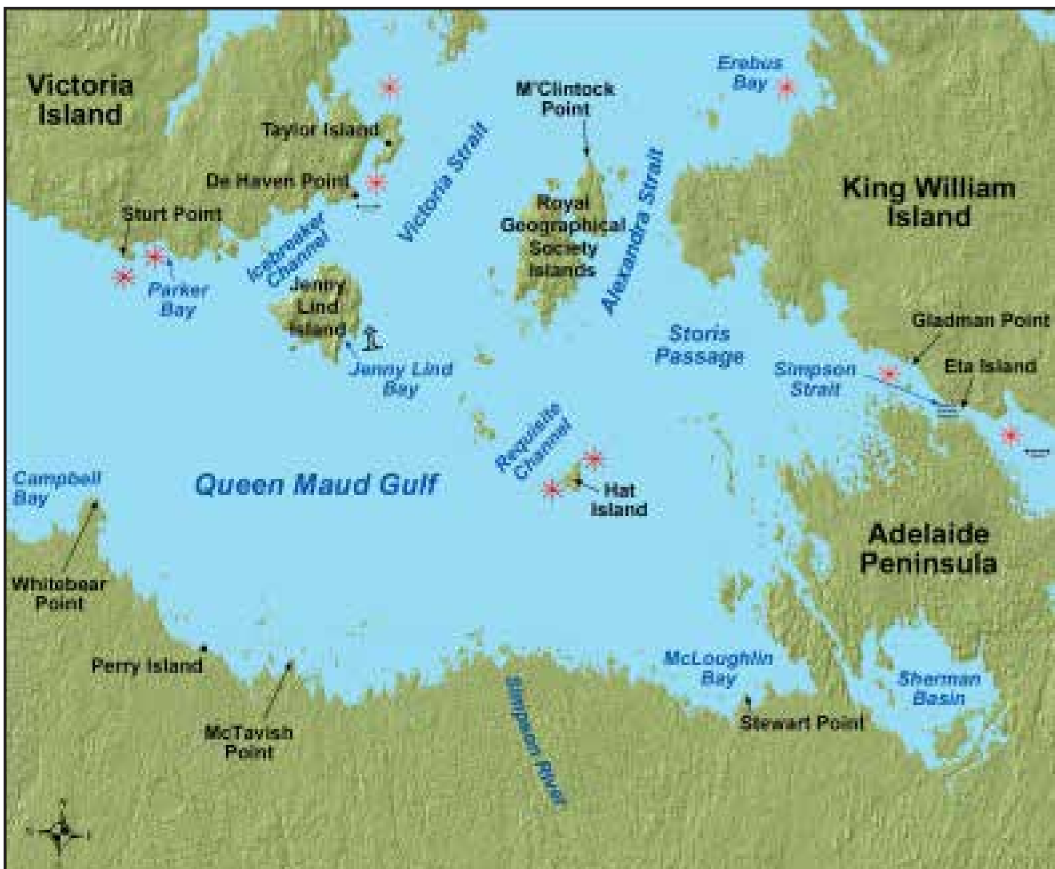


Figure 36: Local effects for the Maud Marine Region.

Figure 37: June, July, and August average winds, based on RADARSAT imagery.

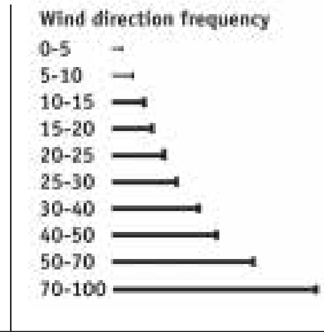


Figure 38: September, October, and November average winds, based on RADARSAT imagery.

Sunset over High Arctic IMHO. Photo courtesy of Nicolas Peissel.

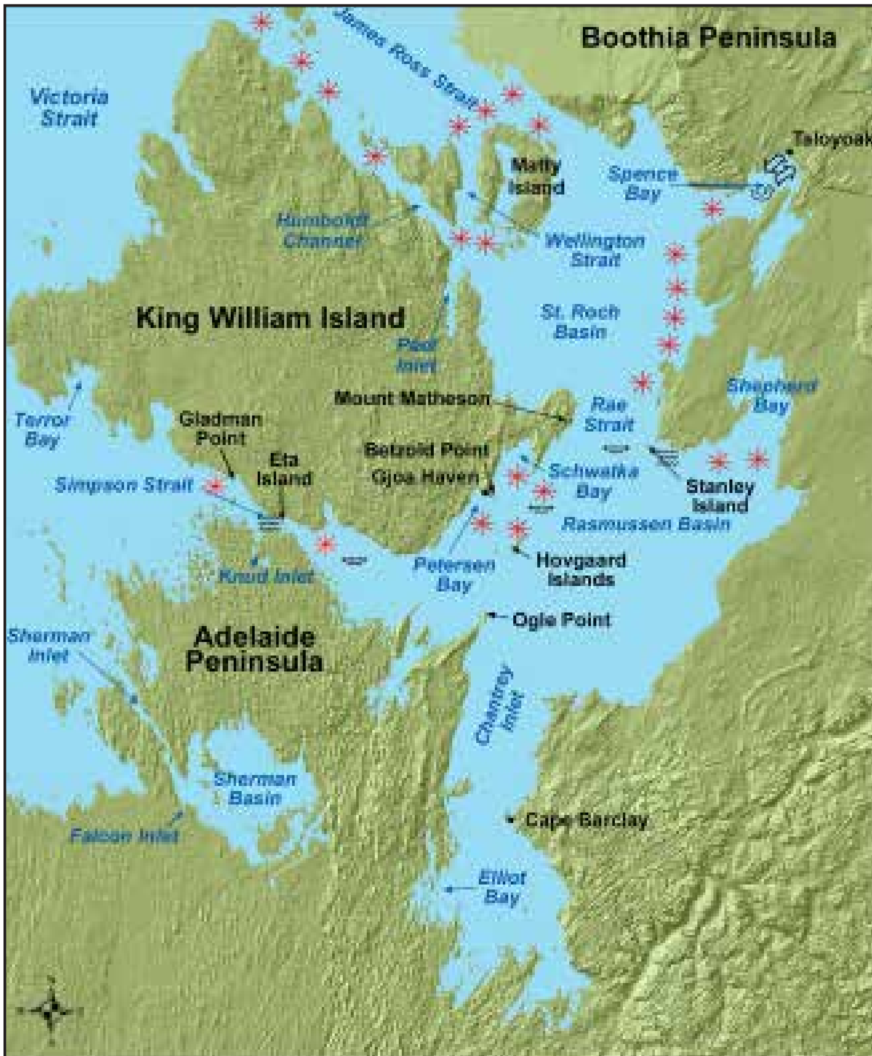


Figure 39: Local effects for the St. Roch Marine Region.

Figure 40: June, July, and August average winds, based on RADARSAT imagery.

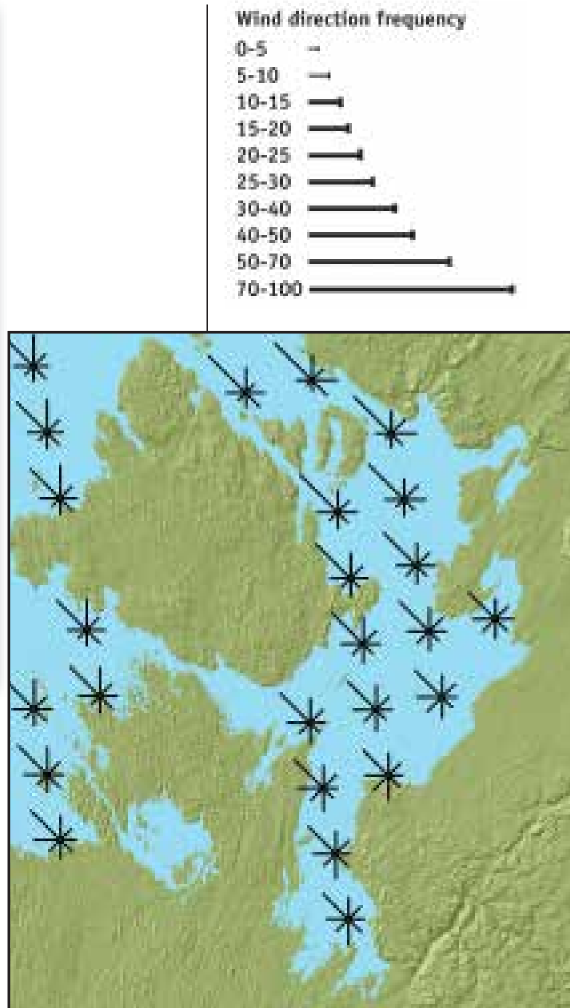


Figure 41: September, October, and November average winds, based on RADARSAT imagery.

Figure 42: Local effects for Jenny Lind Island and area.

Figure 43: June, July, and August average winds, based on RADARSAT imagery.

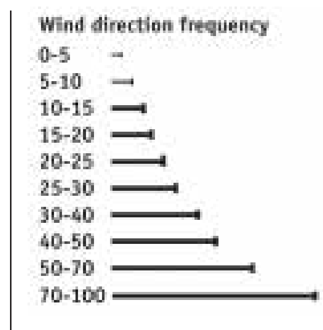


Figure 44: September, October, and November average winds, based on RADARSAT imagery.

7.4.1.1 Gjoa Haven

Caught between frequent storms in the vicinity of Foxe Basin and a ridge of high pressure located over the Beaufort Sea, the community of Gjoa Haven is frequently subjected to strong north-to-northwest winds. It is also affected by storms approaching from the west to southwest or tracking east, across the Arctic Islands.

The relatively flat terrain around the community results in few surprises with regard to wind direction, with summer winds common from the southwest, northeast, and northwest. Northwest winds are the most prevalent wind direction in summer and increase in frequency and intensity during the fall, when southwesterly winds die off and northeasterly winds also become stronger.

Freezing drizzle is patchy but common during the transition seasons of spring and fall, occurring mainly in the morning to early afternoon from September through October. Fog can occur in any wind direction during the summer, with June the most common month. In the fall, fog tends to occur with light, southwest winds.

When the winds are stronger than 20 kt, precipitation is usually associated with south to southwest or northeast winds, and there is a 20 to 55 percent chance of snow.

7.4.1.2 Taloyoak

The strongest winds experienced in Taloyoak tend to be northwesterlies; however, northeasterlies can be just as strong due to channelling in Spence Bay—which is oriented northeast to southwest. The community experiences these northerly flows as a result of its being affected by storms in the Davis Strait-Baffin Bay and Foxe Basin areas. Southerly winds also occur frequently, associated with low-pressure systems originating in the Mackenzie-Beaufort Sea area.

Patchy, freezing drizzle tends to occur in May and October. It has a fairly strong directional preference, especially when the winds are stronger than 20 kt, and is mostly associated with southwest winds approaching from the open water. In the summer, rain is also more likely to occur when winds are from the southwest at over 20 kt. When there is fog over Spence Bay, it is also often observed over Taloyoak.

7.4.1.3 Jenny Lind Island

Over the waters west of Jenny Lind Island, the prevailing winds are northwest, although strong east-to-southeast winds also occur, especially in the fall. The terrain and numerous inlets, islands, and narrow channels in the area have a significant influence on the local winds.

Jenny Lind Bay offers relief from all the winds except those from the south and southeast, due to its shape and location. Winds from these two directions most likely funnel when blowing over the bay and could fill the harbour with ice. Strong west winds can increase the maximum tidal range in the bay. Fog conditions are extremely bad in the area due to the close proximity of coastal ice.

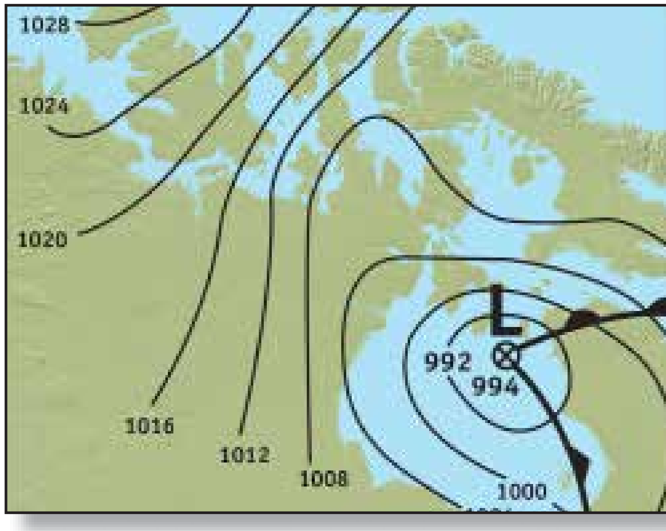


Figure 45: Surface analysis from August 27, 2007 at 18:00 UTC.

Example of a quasi-stationary low over Hudson Bay that generated a strong northerly flow over the Queen Maud and St. Roch areas on August 27, 2007. Cambridge Bay reported the strongest northerly winds at 20 kt, with Gjoa Haven reporting speeds of less than 15 kt.

Significant Event: August 27, 2007

"Our nighttime drift became a wallow. By morning, 30-knot winds propelled very lumpy 9-foot swells with frothy whitecaps rolling off their tops. Strong wind and a course heading diagonal to the swells seemed to heel the ship some five degrees. By the time we set the anchor for the night in Jenny Lind Bay, on the east side of Jenny Lind Island (near the confluence of Victoria Strait and Queen Maud Gulf), the temperature had tripled to +3°C (one degree warmer than the sea), and the wind remained steady at 25 knots – producing a wind chill. Fortunately, the bay afforded shelter from the rolling sea. Extensive fog." - from the journal of the Arctic Patrol 2007 aboard the CCGS *Sir Wilfrid Laurier*.

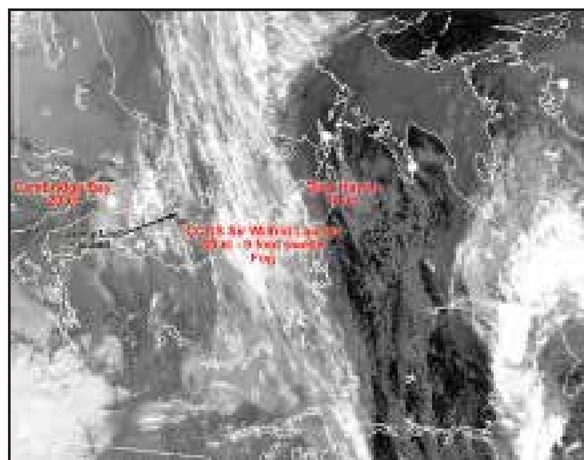


Figure 46: Satellite image taken on August 27, 2007 at 17:41 UTC with location of CCGS Sir Wilfrid Laurier icebreaker indicated (in Jenny Lind Bay).

7.4.2 Tides, Currents, Shoals, and Ice Conditions

7.4.2.1 Tides

- **Jenny Lind Bay:** Strong west winds can increase the maximum range of the tide in the bay.

- **Simpson Strait:** A large number of islands cause back eddies, return flows, and tidal rips in the area. The tidal streams appear to set roughly along the axis of the strait. Strong rips occur in the narrowest part of the strait, southeast of Eta Island. An opposing tidal stream has been reported west and east of Parker Bay during the same, incoming tide.

- **Gjoa Haven:** Tidal effects are negligible because of the low tidal range and coastal topography. The mean tidal range is 0.25 m or less.

- **James Ross Strait:** Tidal rips extend across the northwestern end of the strait.

- **Stanley Island:** There are strong tidal rips near the island.

Did You Know?
The skeletons of a number of members of Franklin's last expedition (1845) were found in Starvation Cove, near the south entrance of Simpson Strait.

7.4.2.2 Currents

- **De Haven Point:** There is a strong southward current off the point.

- **Simpson Strait:** The strait experiences strong currents.

- **Hovgaard Islands:** Strong northward currents are reported north of the islands.

- **Rae Strait:** Southward currents exist in the approach to the strait.

7.4.2.3 Shoals

- **Queen Maud Gulf:** This shallow basin averages less than 100 m in depth, with shoaling increasing progressively toward shore.

- **Sturt Point:** There is a shoal south of the point.

- **Hat Island:** Shoals are found around the island.

- **Simpson Strait:** There are abundant shoals in the strait.

- **St. Roch Basin:** There are many shoals in the basin.

- **Betzold Point and Schwatka Bay:** Shoals are located to the north of the point and on the inner shores of the bay.

- **Storis Passage:** Many shallow areas are found in the passage.

- **Parker Bay:** There is a shoal in the middle of the bay.
- **James Ross Strait:** Shoals are found in many parts of the strait.
- **Rae Strait:** The strait contains many shoals.

7.4.2.4 Ice Conditions

During the first half of September, all of Queen Maud Gulf is mostly open, with only a few large patches of ice remaining in its southeastern portion and, some years, two tongues of ice protruding southwestward from the entrances to Victoria Strait. Some years, navigation can be difficult throughout the summer, and strong northerly or southerly winds can pack drifting ice against the lee shores of the gulf.

The ice in this sector is the most difficult on the coastal route east of Cape Parry, likely because a gentle drift of cold water through Victoria Strait results in somewhat thicker floes and a later break-up. Intrusions of old ice from M'Clintock Channel can also occur during the navigation season. Usually, the maze of islands, islets, and shoals between Victoria Island and King William Island prevents any large-scale transport, so the invading ice comes in strips and patches. Puddling begins in mid-June and becomes extensive before break-up begins in early August. Clearing progresses steadily from Dease Strait and Simpson Strait; however, it is not until the last week of August that the ice pack is reduced to scattered patches. By then, the ice in Victoria Strait is mostly mobile, and northerly winds may carry it into the gulf if the channels to the north have cleared less than usual. Southerly and southeasterly winds can also fill the harbour in Jenny Lind Bay with ice, with nearby Parker Bay a good option for shelter. Freeze-up begins in mid-September and spreads quickly over the area due to the low water temperatures. A smooth, solid layer of fast ice usually forms by mid-October and increases steadily in thickness through the winter months.

In the St. Roch region, break-up begins in James Ross Strait and Victoria Strait. Little ice motion develops, as light winds are predominant in most seasons. If a persistent flow develops, however, the pack may be driven to one side of the channel, crushing any rotten ice in the process and creating extensive leads on the windward side. Like Coronation Gulf, the waterway from Simpson Strait to James Ross Strait is confined by numerous shoals and islets, which restrict ice motion. While the narrow entrances to the straits prevent any significant intrusions of ice from adjoining areas, they also cause congestion—as happens in James Ross Strait during northwesterly blows.

Puddling begins in mid-June and is extensive by the time break-up develops in late July. Simpson Strait, Rae Strait, and the narrows east of Matty Island clear during the second half of July, and complete melting progresses rapidly through the remainder of the pack by mid-August. The ice usually reaches its minimum by late August or early September, when patches may still remain in Shepherds Bay and along the southeast coast of King William Island. With northerly winds, heavy polar ice may, at any time, be driven down from the north into these waters. The ice concentration increases towards the latter part of September, and the sheltered bays are frozen solid by the end of the month. As is normal, the time of freeze-up and consolidation is variable, since the ice cycle is highly influenced by annual variations in weather.

Did You Know?
On September 1, 2014, a large search by a Canadian team found two items on Hat Island in the Queen Maud Gulf, near Nunavut's King William. Less than a week later, the expedition located the wreck of the HMS *Erebus*, Franklin's flagship, in the eastern portion of Queen Maud Gulf, west of O'Reilly Island.

7.5 Boothia and Committee Marine Region

The Boothia and Committee Marine Regions include some of the most unnavigable and uncharted waters in the Arctic. The community of Kugaaruk is located on the Simpson Peninsula, on the eastern coast of Pelly Bay, south of the Gulf of Boothia—nestled in the coastal mountains that lie between the bay and a wide expanse of tundra.

7.5.1 Winds and Weather

North winds can be quite strong over the Boothia and Committee regions—including Pelly Bay and Kugaaruk—depending largely on the pressure pattern and on the geographical position and configuration of the bodies of water in the area. Winds from the north to northwest and south to southeast are affected by channelling when they blow over the Gulf of Boothia and Committee Bay. The most frequent winds in the area are north to northwest, while the strongest most often come from the north to northwest or south to southeast.

The winds at Pelly Bay are influenced by the hills to the southeast and northwest, which often deflect the air flow and cause a funneling effect, resulting in strong and frequent southwest and northeast winds. Southwest winds are often stronger than expected and produce strong gusts—and are more frequent in the summer and less frequent in the fall. Strong northwest and south to southeast winds rarely occur, as they are blocked by the hills in the area. Kugaaruk's location makes it susceptible to the effects of storms from Davis Strait and Baffin Bay, as well as passing low-pressure centres to both its north and south.

Figure 47: Local effects for the Boothia Marine Region.

Figure 48: June, July, and August average winds, based on RADARSAT imagery.

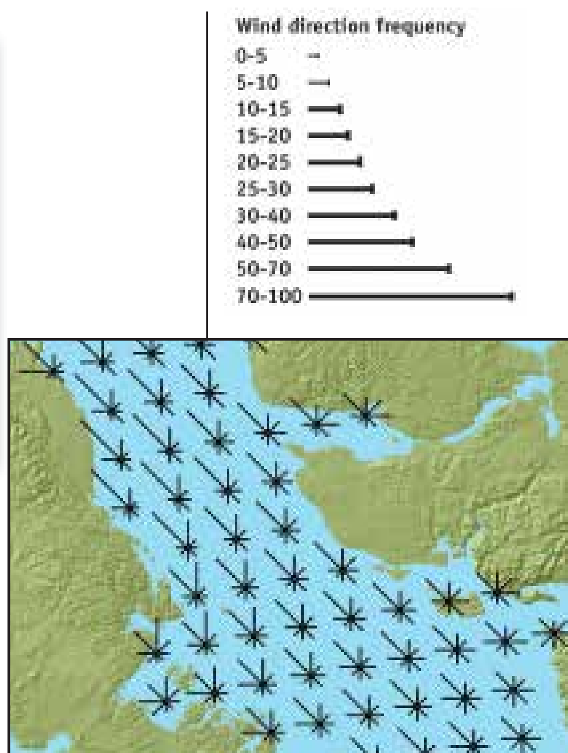


Figure 49: September, October, and November average winds, based on RADARSAT imagery.

Figure 50: Local effects for the Committee Marine Region.

Figure 51: June, July, and August average winds, based on RADARSAT imagery.

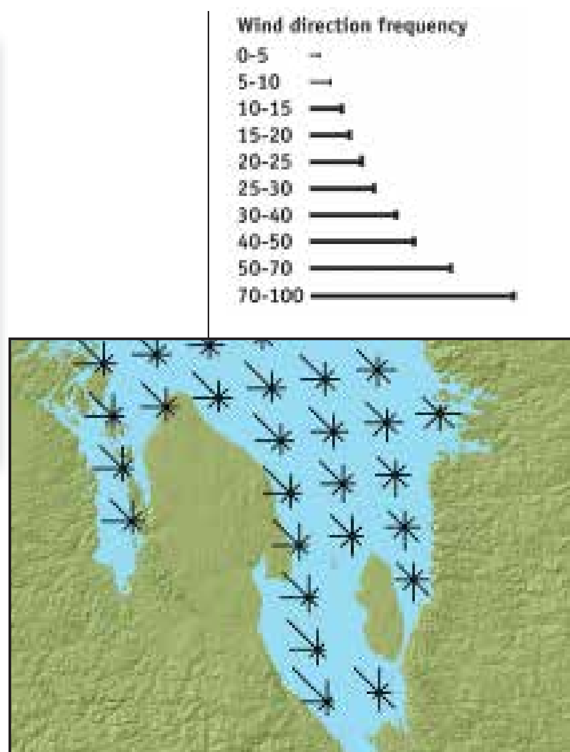


Figure 52: September, October, and November average winds, based on RADARSAT imagery.

Significant Event: July 23-27, 2012

After taking shelter in Kugaaruk for five nights to wait for the fierce winds to die down, the team of kayakers on the Agguanittuq arctic expedition returned to the icy waters of Pelly Bay and attempted to head north along the west shore. Paddling in the vicinity of Cape Chapman proved impossible, and the kayaks had to be threaded and pulled around a puzzle of ice blocks. Two days later, higher tides made escape feasible, and the explorers finally rounded the tip of the Simpson Peninsula via a narrow strip of open water between the sea ice and the barren tundra to enter the Gulf of Boothia.

Figure 53: Image depicting Kugaaruk and Cape Chapman, on Committee Bay.

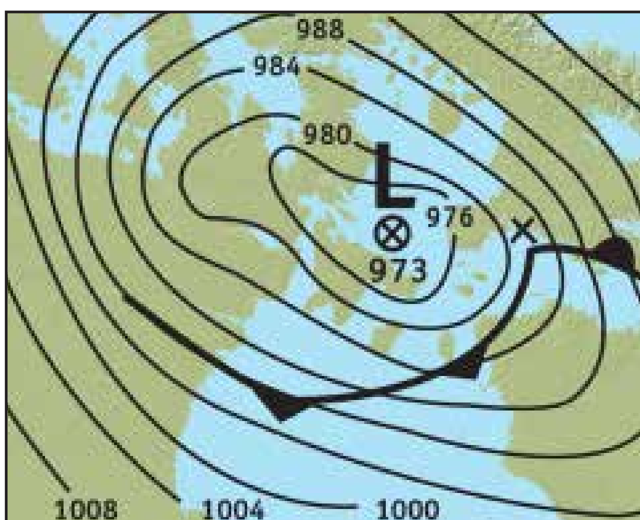


Figure 54: Surface analysis from July 24, 2012 at 06:00 UTC.

Surface analysis taken on July 24, 2012, when a low that approached from the west and moved towards Baffin Island generated north winds of 30 kt in Kugaaruk airport overnight.

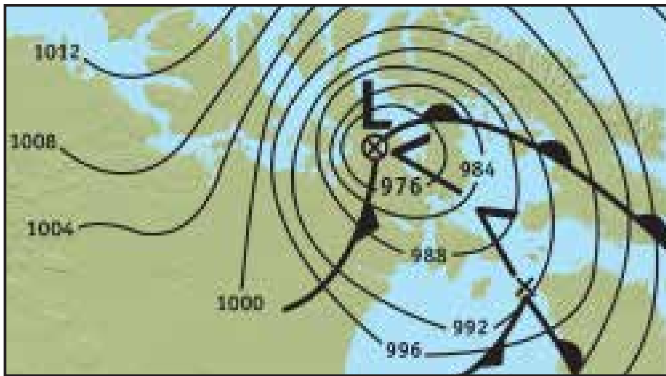


Figure 55: Surface analysis from September 28, 2011 at 00:00 UTC.

Figure 56: Image depicting the location of the CCGS Terry Fox (CGTF) icebreaker when it encountered northerly gales.

Surface analysis from September 28, 2011, showing a low-pressure system (the centre of which was located near the northwestern shore of Melville Peninsula) that approached the Gulf of Boothia from the southwest, generating a strong northerly flow in its northwest and west quadrants. The flow generated gale-force winds over the gulf, with the CCGS Terry Fox (CGTF) icebreaker reporting speeds of 34 kt.

Patchy, freezing drizzle may be encountered in low cloud in the spring and late fall. Low clouds and fog associated with onshore flow are very common at Kugaaruk in late spring and summer because of the abundance of nearby moisture. When they are stronger than 20 kt, south to southwest winds bring fog to the area 25 to 40 percent of the time.

Convective cloud is more common during the summer; however, thundershowers are rare.

The persistence of high concentrations of multi-year ice in the Committee Bay area in most summers—combined with a prevailing onshore flow from the bay to the rugged, coastal terrain of western Melville Peninsula—is reflected in the high frequency of low cloud and fog in July.

7.5.2 Shoals, Tides, and Ice Conditions

7.5.2.1 Shoals

- **Thom Bay:** Shoals are found in the bay.
- **Pelly Bay:** Most of the western part of the bay is fronted by shoals.
- **Cape Chapman and Cape Anderson:** Shoal waters exist between the two capes.
- **Simpson Peninsula:** Most of the eastern coast of the peninsula has shoal waters.

7.5.2.2 Tides

- **Login Bay:** Tides run strongly in the approach to the bay.

7.5.2.3 Ice Conditions

The prevailing winds in the Gulf of Boothia tend to come from the north to northwest or south to southeast as a result of the funneling effect. The most significant leads open up between the coast and the pack ice as a result of north to northwest flows. Sections of the coast that run parallel to the prevailing winds have shear zones but smaller shore leads. Sections of the coast that run perpendicular to these winds tend to have larger shore leads when the winds come from offshore.

During August and September, the ice is generally pressed against the western shore of Prince Regent Inlet, while the eastern shore is comparatively ice free; however, the opposite may sometimes occur, likely due to the prevailing wind. Over Committee Bay, ice conditions are such that there is no definable open season for navigation. While aerial reconnaissance has shown a limited amount of open water in July and August, the bay is heavily encumbered by ice floes throughout the summer season, making marine travel virtually impossible. While Pelly Bay is virtually ice free in August, the onset of prevailing north winds in September can drive heavy pack ice into the bay.

ARCTIC REGIONAL GUIDE PART 4: HIGH ARCTIC

8. High Arctic Islands and Northern Baffin Bay Marine Region

This section provides information on local weather, wind, sea state, and ice conditions for the following marine regions in the High Arctic Islands and Northern Baffin Bay: West Baffin and Clarence, Jones, Lancaster, Barrow, Regent, Peel, Larsen, Admiralty, Navy Board, and Pond.

Figure 1: Marine regions in the High Arctic and Northern Baffin Bay.

Figure 2: Main waterways of the High Arctic and Northern Baffin Bay areas.

The winds and weather in this region are influenced primarily by low-pressure centres moving into Baffin Bay from the south and into the Arctic Archipelago from the west and northwest. High-pressure centres that develop over the region usually move slowly and do not follow any well-defined track.

It is common for storms situated well south of the Arctic to be steered northeastward in the polar jet stream and become trapped in the North. Summer storms that move into the High Arctic Islands sometimes originate in the Prairies or over the Arctic mainland. While conditions north of the Arctic mainland are less favourable for their development, storms still do form in the area—in particular, over the southern islands and Arctic Ocean. In the fall, storms that develop over eastern Canada often impact the Baffin Bay area. While northwesterly and southeasterly wind directions dominate over this region, conditions in its narrow channels are highly affected by local topography.

The waters in the High Arctic are extremely dangerous, due to the presence of icebergs and pack ice, which are often driven by the wind into navigation areas. Chunks of old ice are of particular danger to small boats, as they tend to float beneath the surface of the water and are as hard as rock.

8.1 West Baffin and Clarence Marine Regions

The West Baffin and Clarence marine regions cover the northern parts of Baffin Bay, with northern sections of the Clarence region bordering Smith Sound.

Figure 3: Local effects for Clarence Marine Region.

Mariners' Tips:
A good place to seek shelter from icebergs is behind islands or in shallow bays.

Mariners' Tips:
Most of the coastlines in this part of the Arctic feature high-relief topography, so winds are often affected by channelling and gap-wind effects.

Figure 4: RADARSAT-derived wind roses for June, July, and August for Clarence.

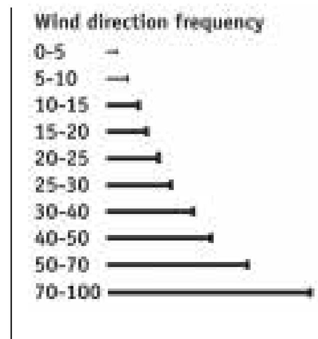


Figure 5: RADARSAT-derived wind roses for September, October, and November for Clarence.

Did You Know?
A fata morgana, or mirage, is commonly observed in the polar regions, especially in calm weather in the spring and fall, over large sheets of ice that have a uniformly low temperature.

In 1818, Sir John Ross was on track to find the infamous Northwest Passage when his ship reached Lancaster Sound and he saw what he thought was a mountainous land mass dead ahead. He named the range, which was actually a mirage, the Croker Mountains, and changed directions, missing his intended target.

Figure 6: Local effects for the West Baffin Marine Region.

8.1.1 Winds and Weather

On the northeastern side of Baffin Bay—near Greenland's Cape Alexander, Thule, and Cape York—calm weather prevails throughout the year. In the summer, the strongest and most common winds are south to southeast on the east side of the bay (near the coast of Greenland). Northwest to north winds prevail over the central and western parts of the bay. Storms may occur in all seasons, most approaching from the southeast or south.

Katabatic winds often develop along the southeast coast of Ellesmere Island, the outflow accelerating as gravity draws glacially cooled air down its steep slopes. Some fiords act as "wind-acceleration zones" in which flows are funnelled to extremely high speeds, especially when joined by katabatic winds. Outflows blowing over the ice-covered surface can reach gale force, causing strong, gusty conditions near coastal areas of the Arctic and Greenland. Katabatic winds in the Clarence region have been observed in Lady Ann Strait, between Cape Fitz Roy and Raper Point.

From July to September, precipitation in Baffin Bay falls as either rain or snow, with snow more common. Rain is rare by October. Total monthly precipitation in July and August ranges from only 30 to 40 mm on the Canadian side and even less on the Greenland side. In September, the average monthly snowfall along the shores of Baffin Island varies from 30 cm in the north to 15 cm in the south. In October, the average is about 40 cm. The northern coast of Baffin Island and the coast of Bylot Island receive appreciable amounts of precipitation in autumn, while Lancaster Sound is open and the prevailing winds have a northerly component.

During July and August, fog is present for an average of 5 to 10 days per month along the Baffin coast, most likely due to the onshore, southeast flow. The Greenland coast sees fog less than one day a month, likely because its prevailing flow is offshore. Dense fog often forms along the edges of the ice during mid-summer. Ideal conditions for its formation are light to moderate winds from the south to east—especially if they are accompanied by precipitation. Good visibility is common with winds from the north and northwest, except when they are accompanied by snow squalls.

Figure 7: RADARSAT-derived wind roses for June, July, and August for West Baffin.

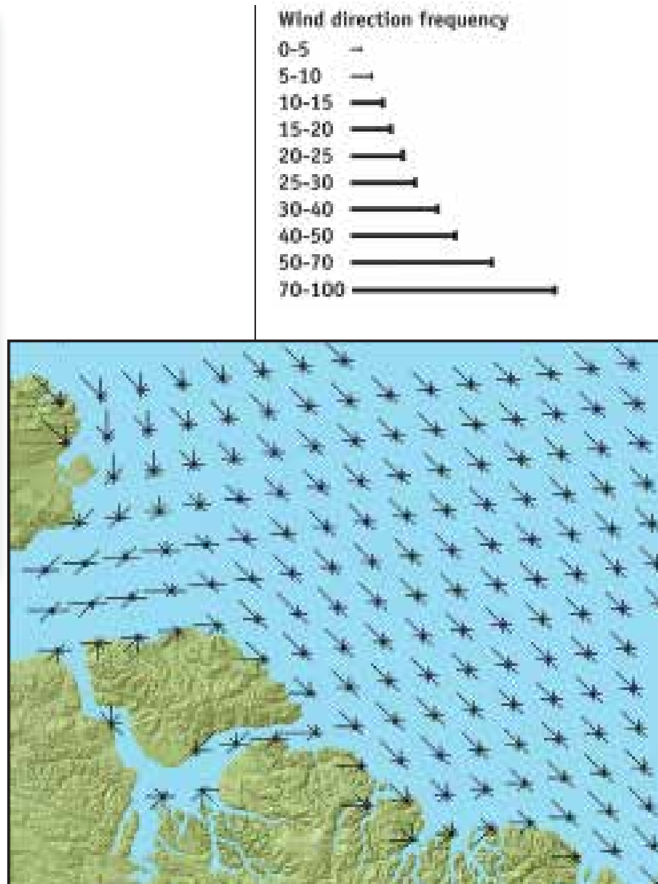


Figure 8: RADARSAT-derived wind roses for September, October, and November for West Baffin.

8.1.1.1 Northerly, Northeasterly, and Northwesterly Flow Pattern

These flows can be generated in the northern Baffin Bay and Clarence areas by low-pressure systems moving in from the south along the west coast of Greenland, southeastward from the Arctic Ocean, or northeastward from the Great Slave Lake area or the Prairies. Strong north winds develop behind or over the western parts of these storms.

Figure 9: Major storm tracks in the Northern Baffin Bay and Clarence areas in the summer. (Source: David B. Fissel, Mar Martínez de Saavedra Álvarez, and Randy C. Kerr, ASL Environmental Sciences Inc., Feb. 2012) .

North or northeast winds are channeled through Nares Strait and Smith Sound, where gap winds may increase them to gale or even hurricane force. A pressure difference of 25 mb between the Lincoln Sea (high-pressure) and northern Baffin Bay (low-pressure) has been reported to generate northeast outflow winds of 70 kt out of Smith Sound. These winds can blow strong for many kilometres through the Clarence region. A band of moderate to gale-force winds usually develops along the southeast coast of Ellesmere Island and extends further south to the West Baffin region in a northerly or northeasterly flow.

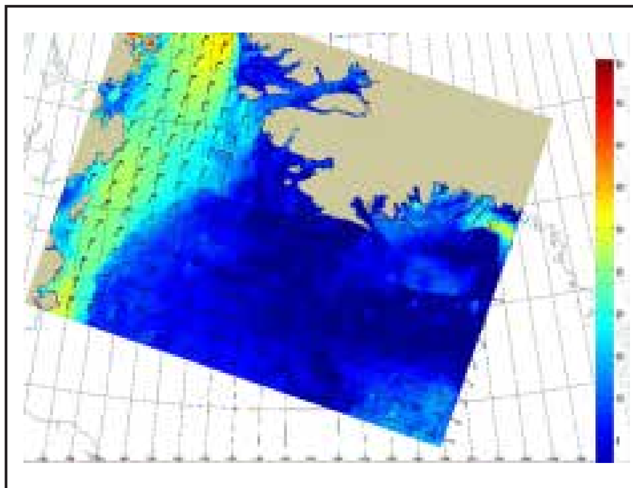


Figure 10: RADARSAT image showing strong outflow winds from Smith Sound and bands of strong winds near the western coastline of the Clarence region.

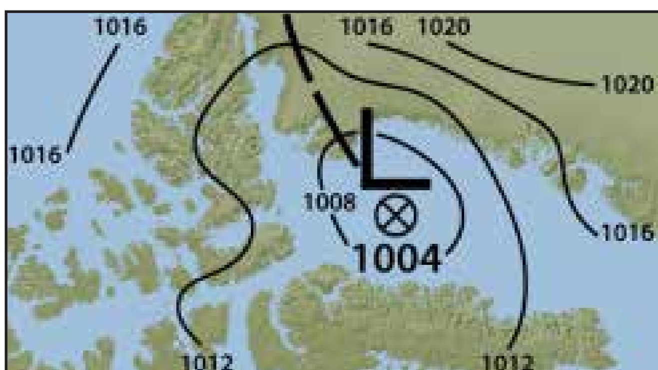


Figure 11: Surface analysis showing that weak low-pressure systems over Baffin Bay can generate moderate to strong north winds along the coastline in the Clarence and West Baffin regions.

A northerly flow often generates strong to moderate winds southwest of Coburg Island in Lady Ann Strait due to channelling, with an area of lighter winds often evident south of the island. Good shelter from north winds can also be found in Glacier Strait, in the shadow of the Manson Ice Field.

The Devon and Sydkap ice caps also play a significant role in the development of the wind field in Jones and Lancaster sounds and the western parts of the Clarence and West Baffin regions. The former, located on the eastern side of Devon Island and nearly 2 km in elevation, sees calm conditions in its downwind shadow in a northerly flow. The area south of the Sydkap Ice Cap also sees lighter north winds.

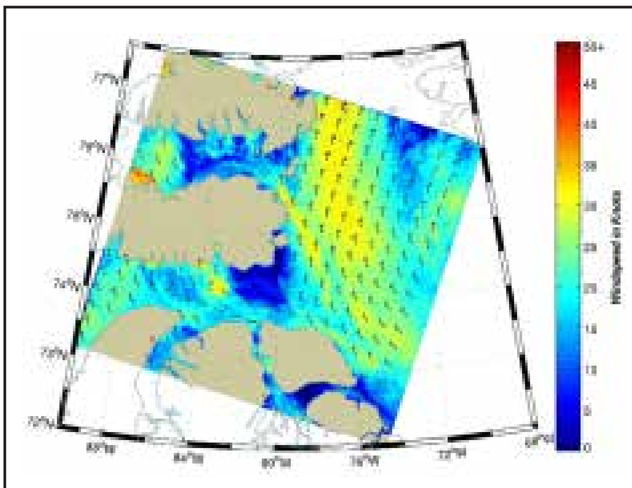


Figure 12: RADARSAT image from September 12, 2013, at 12:00 UTC showing the wind shadows that occur downwind of the ice caps.

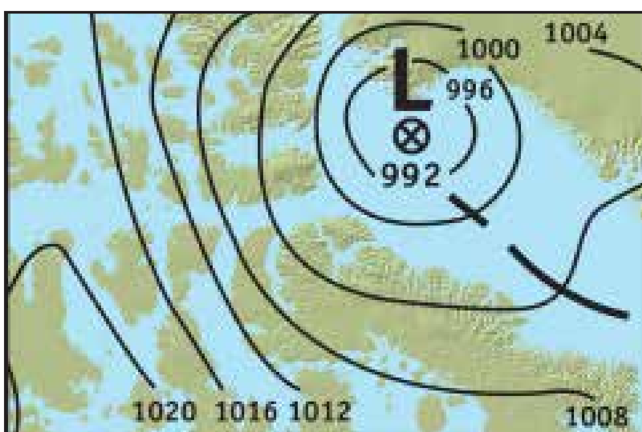


Figure 13: Surface analysis from September 12, 2013, at 06 UTC demonstrating the flow that results in the wind shadows downstream of the ice caps.

8.1.1.2 Easterly and Southeasterly Flow Pattern

Easterly and southeasterly flows tend to be generated ahead of low-pressure storms moving into Baffin Bay. The strongest south winds develop over the western coast of Greenland due to cornering. Sometimes, when southeast winds enter Lancaster Sound, they corner around Cape Liverpool and Cape Fanshawe (Bylot Island). Bands of moderate winds can be generated in the northwestern sections of the West Baffin region, due to a cornering effect, even without the presence of a storm in the area. Shelter from southeast winds can be found along the coast of Maud Bight, just west of Cape Liverpool.

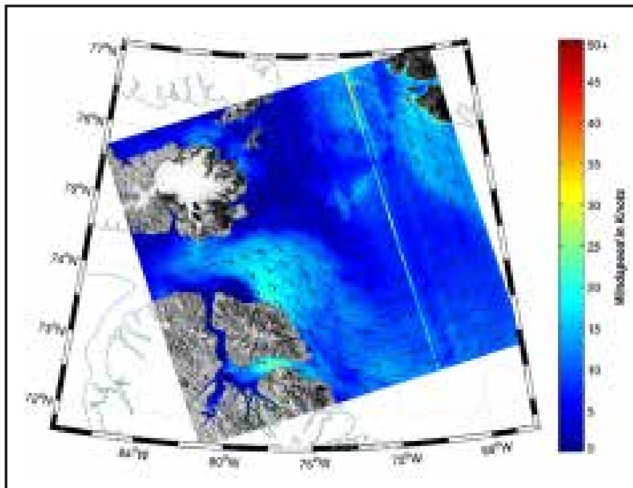


Figure 14: RADARSAT image from August 19, 2012, showing bands of moderate winds in the northwestern sections of the West Baffin region in the absence of any storm.

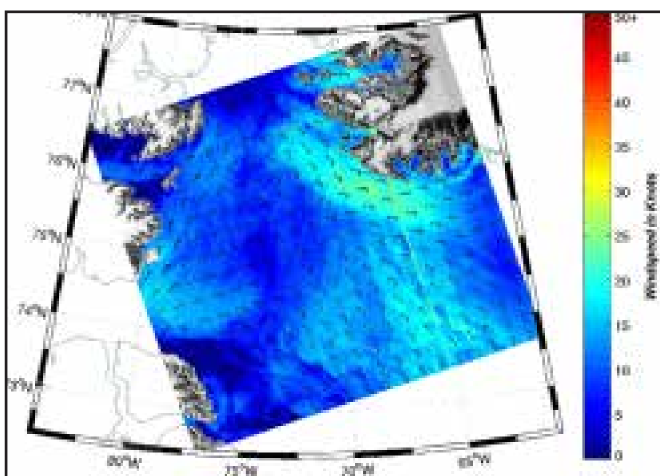


Figure 15: RADARSAT image showing the cornering of southeast winds (as often occurs when a low is entering Baffin Bay) along the tip of Greenland (Cape York) on September 22, 2012.

Cliffs along the coast of Coburg Island range from 100 to 300 m in height. Flows from the southeast and east split and corner around the island, creating a strong band of winds around its southern tip and an area of lighter winds on its downwind side.

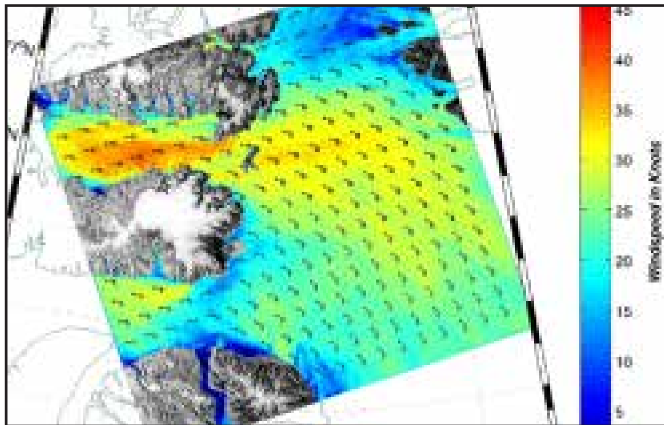


Figure 16: RADARSAT image showing a band of strong winds around the southern tip of Coburg Island in a southeasterly and easterly flow.

8.1.1.3 Westerly and Northwesterly Flow Pattern

Figure 17: Winds in a westerly flow, based on RADARSAT images taken from 2012 to 2015. The length of the arrows indicates the relative wind speed in each area.

This flow is associated with low-pressure centres moving into Baffin Bay and the Arctic Archipelago from the west and northwest. Strong west winds occur behind such systems and accelerate through Jones and Lancaster sounds—continuing to blow strong into northwestern parts of the West Baffin region due to channelling and gap-wind effects. Glaciers averaging 1500 m in height and pierced by high mountain peaks diminish the strength of westerly winds on the downwind side of Bylot Island.

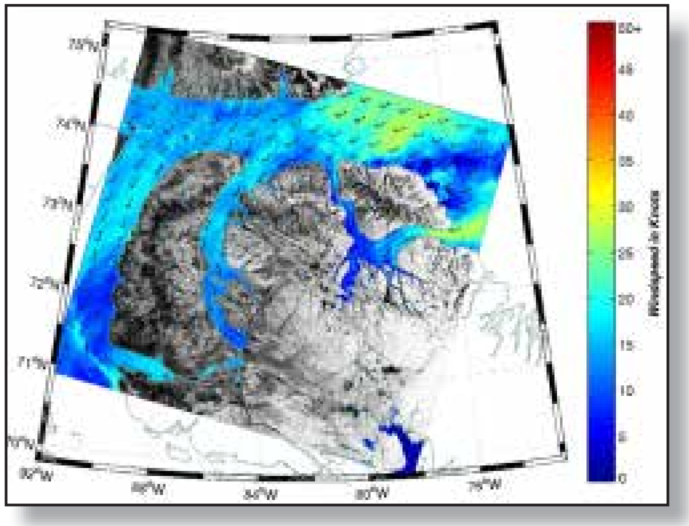


Figure 18: RADARSAT image showing strong westerly winds in Lancaster and Eclipse Sounds on August 17, 2012, at 12:21 UTC.

Channelling and gap winds also occur with a westerly flow at the eastern exit of Eclipse Sound (which separates Bylot and Baffin islands). Strong west outflows also come out of Coutts Inlet and then split around Nova Zembla Island, their speed sometimes reinforced by katabatic winds.

Significant Event: October 14, 2015

Two tug boats navigating in Coutts Inlet, just south of Nova Zembla Island, reported winds blowing at 65 to 70 kt—most likely due to the channelling of katabatic winds from a glacier in the northern arm of the inlet.

A cornering effect can be experienced with a westerly flow around Coburg Island. Strong winds are observed at the east entrance to Jones Sound, on the upwind side of the island, due to channelling and cornering. Gap-wind effects can double the speed of winds blowing out of Jones and Lancaster sounds, even on a calm day. Shelter can be found on the downwind sides of Coburg Island, the Manson Ice Field, and the Devon Ice Cap in such conditions.

Mariner's Tips:

The bow of the boat should always face the exit of the anchorage. Set up multiple anchors and shorelines to ensure stability and protect the vessel from katabatic winds and waves.

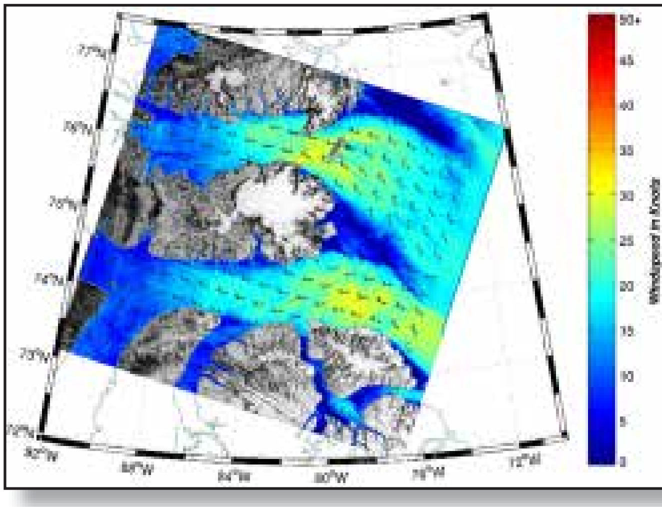


Figure 19: RADARSAT image from September 3, 2012, at 12:25 UTC showing the Coburg Island effect and strong, channelling outflow winds from Jones and Lancaster sounds.

On August 16, 2013, gale warnings were in effect for Clarence, Jones, Lancaster, and West Baffin regions. While the arctic icebreaker Amundsen reported light winds in the shelter of the Manson Icefield, Cape Liverpool (on Bylot Island) saw gale-force west winds of 37 kt.

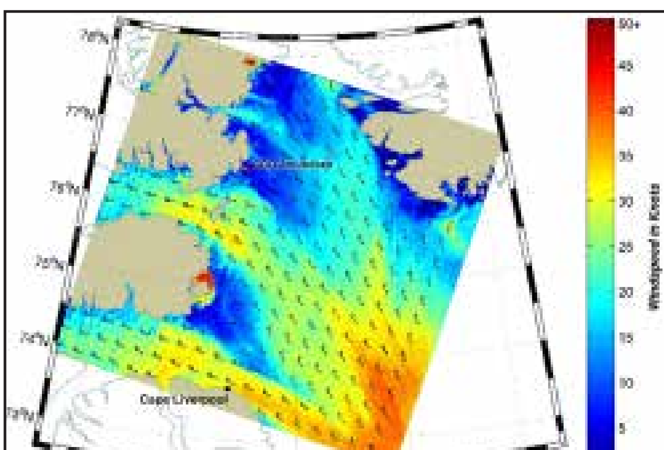


Figure 20: RADARSAT image from August 16, 2013, showing wind conditions in Baffin Bay and the location of the arctic ice breaker Amundsen.

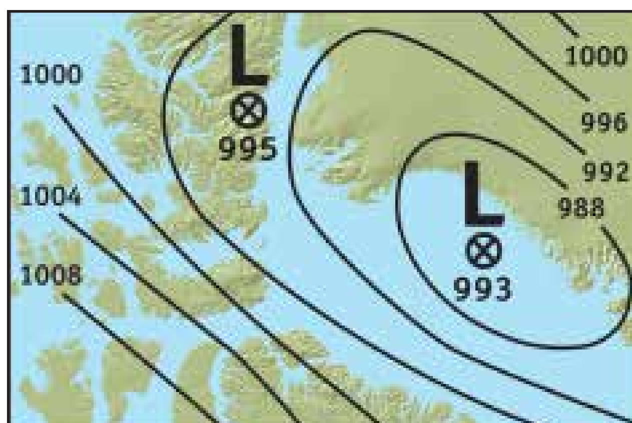


Figure 21: Surface analysis showing pressure systems on August 16, 2013, at 18:00 UTC.

In clear weather, the high point of Cape Alexander (in northeastern Baffin Bay) is nearly always covered with clouds. A strong breeze, sometimes reaching gale force, can blow offshore near the cape.

8.1.2 Waves, Tides and Currents, Shoals, and Ice and Icebergs

8.1.2.1 Waves

Fairly significant waves can be generated in Baffin Bay from July through October, although reduced fetch caused by the presence of ice restricts their size, as does the fact that storms tend to weaken or dissipate in the area.

Significant Event: September 10, 2013

The freighter Mitiq was in transit from Baffin Bay to Grise Fiord when it encountered northerly to northwesterly gales caused by a storm that had moved in from the Labrador Sea. Winds were reported at 45 kt, with waves reaching up to 5 m in height as the blow intensified.

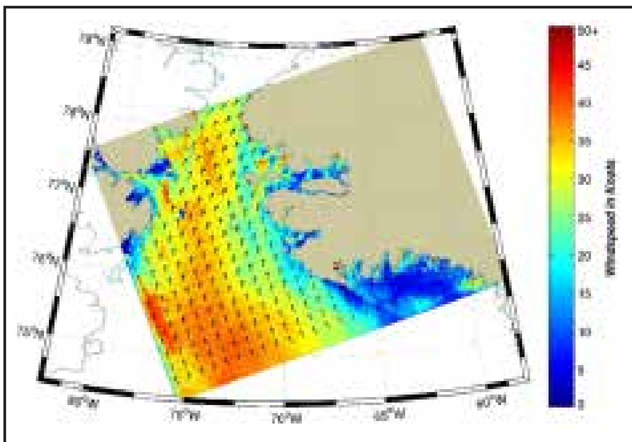


Figure 22: RADARSAT image from September 10, 2013, at 21:32 UTC, showing widespread area of gale activity in the Clarence Marine Region.

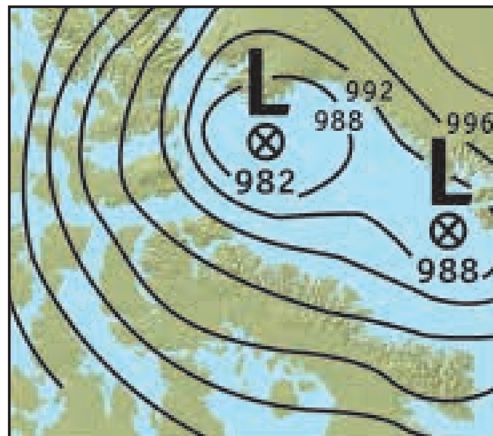


Figure 23: Surface analysis from September 10, 2013, at 12 UTC, showing deep, low-pressure systems with strong northwesterly flow in the Clarence Marine Region.

8.1.2.2 Tides and Currents

In Baffin Bay, the average tidal progression is northward along the west coast of Greenland, across northern Baffin Bay, and then southward along the coast of Baffin Island. Maximum tidal heights occur in the northern part of the bay, where they can reach up to 2.7 m.

Winds and tides are the main driving force behind the current in Baffin Bay. Prevailing southerlies near the west coast of Greenland and northerlies near the east coast of Baffin Island, combined with the rotation of the earth, result in the transfer of water northward toward Greenland (warm current), then westward toward Baffin Island, and, finally, southward along the coast of the island to the Labrador Sea (cold current).

After it leaves Lancaster Sound, the Baffin Bay current turns southeast to flow past Bylot Island but frequently becomes detached from the coast at Cape Liverpool. As a result, the area east of Bylot sees frequent eddies and northerly counter-flows. In particular, anticyclonic eddies up to 20-km wide are often found between the coast and a band of southerly flow 30 to 50 km offshore. South of Pond Inlet, the current becomes relatively linear, with a core speed occasionally reaching 1 kt. Strong northeast outflow winds from Nares Strait enhance the tidal current, which reaches 2 to 3 kt in the strait.

8.1.2.3 Shoals

There are shoals northeast of Nova Zembla Island, north and northeast of Philpots Island, and south of Coburg Island.

8.1.2.4 Ice and Icebergs

Over the past 30 years, the average break-up date in the deep waters of central portions of northeastern Baffin Bay occurred during the week of July 16 or later. Further to the north and the west, ice begins to break up in June, in association with the expansion of the North Water Polynya. To the east, nearer the western coastline of Greenland and toward Davis Strait, break-up has even occurred prior to June.

Old ice of significant thickness (6 to 15 m) is a problem in many areas in the Arctic, including northern Baffin Bay and the entrance to Lancaster Sound, both of which are free of ice well into October.

Figure 24: Satellite image showing the size and location of the middle ice-pack between Baffin Island and Greenland, which typically does not clear until August.

Freeze-up in Baffin Bay is a lengthy process that begins in mid-September in its northwestern sections. The growing ice-cover spreads down the coast of Baffin Island in October, solidifying mainly in bays and inlets, while offshore ice forms in the approaches to Smith, Jones, and Lancaster sounds.

The majority of icebergs are calved in Baffin Bay by the glaciers on the west coast of Greenland and Ellesmere Island. Those from Greenland glaciers can drift northward, cross northern Baffin Bay, and then proceed southward along the coast of Baffin Island—some moving into Lancaster Sound.

Navigation northward along the east coast of Baffin Island is made extremely difficult, especially in early summer, by the vast stream of ice that is borne southward by the Canadian current from Baffin Bay. By late summer, ice along the southeastern coast of Baffin Island consists chiefly of the occasional iceberg and small patches of drifting ice; however, even in August, large fields of heavy drifting ice may be encountered off its northern coast.

8.2 The Jones Marine Region

Jones Sound is located between Devon Island and the southern end of Ellesmere Island. At its northwestern end, it is linked by several channels to Norwegian Bay; at its eastern end, it opens through Glacier Strait and Lady Ann Strait into Baffin Bay (the Clarence Marine Region).

Figure 25: Local effects for the Jones Marine Region.

8.2.1 Winds and Weather

Jones Sound has similar wind patterns to those of Lancaster and Barrow sounds due to similarities in their location, shape, and coastal topography. These patterns can be complex and are affected not only by the dominant pressure system but also by local effects. Winds from the northeast to southeast or northwest to southwest generate strong east and west winds through the sounds. In straits and inlets, the prevailing direction is usually along the channel, nearly parallel to the shore, with speeds increasing as the channels narrow.

Local katabatic winds may occur where dense, cold air over a glacier flows seaward, increasing in velocity when it overflows a precipitous coastline—although such winds are becoming less common due to glacial retreat. Katabatic winds has been observed in

Glacier Strait, along the southeastern coast of Ellesmere Island (associated with the Manson Icefield), in South Cape Fiord (associated with the Sydkap Glacier), Lady Ann Strait between Belcher Point and Cape Caledon (associated with the Belcher Glacier).

Although Jones Sound does not lie directly on any of the mean storm tracks, its wind and weather are influenced by low-pressure centers moving into Baffin Bay from the south and the Arctic Archipelago from the west. Centres of high pressure that develop over the region usually move slowly and do not follow any well-defined track.

Figure 26: RADARSAT-derived wind roses for June, July, and August for the Jones Marine Region.

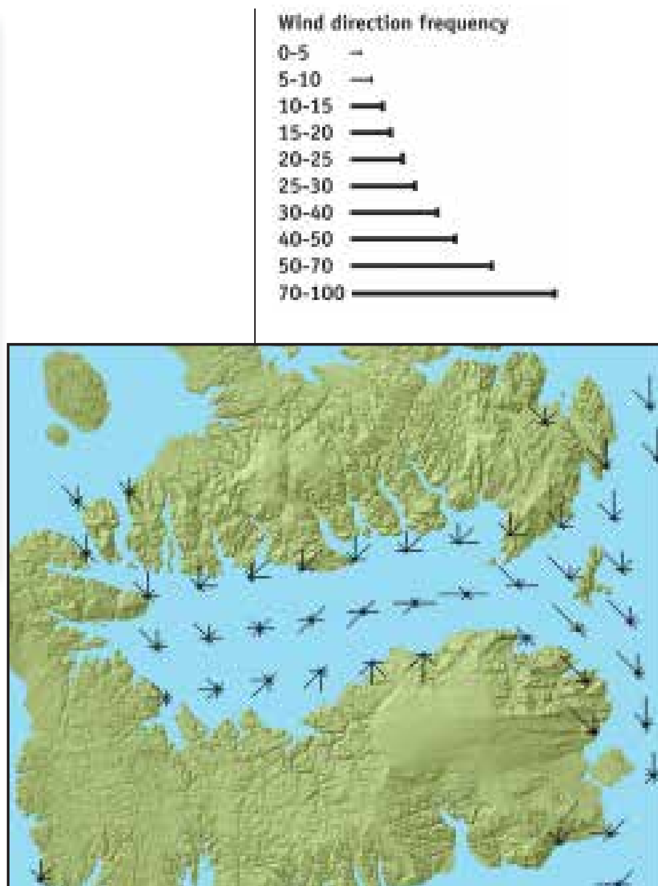


Figure 27: RADARSAT-derived wind roses for September, October, and November for the Jones Marine Region.

July is the warmest month, with a mean temperature along the shores of about 5°C. The highest temperature likely to occur over land is about 16°C in July, 13°C in August, and 5°C in September. For the same three months, the lowest is near -7°C. In July and August, precipitation falls in the form of rain on most days; however, by September, it is almost always snow.

8.2.1.1 Northerly Flow Pattern

A northerly flow over Jones Sound can affect the local winds in many ways. The glaciers of the Manson Icefield and Sydkap Ice Cap create areas of light winds on their lee sides in moderate or strong north winds. All fiords on the southern coast of Ellesmere Island can experience channelling when there is a northerly or northwesterly wind pattern in the area (often when there is a low in Baffin Bay). North winds are strong and frequent in Craig Harbour and Hell Gate as a result.

Station observations at Grise Fiord do not necessarily represent what is happening offshore, as outflow winds are frequently channeled between the high terrain on either side of the straits. This effect can actually double the wind speed along the straits and out 5 to 15 km into Jones Sound. Cardigan Strait, Hell Gate, and Fram Sound are particularly prone to these strong outflow winds.

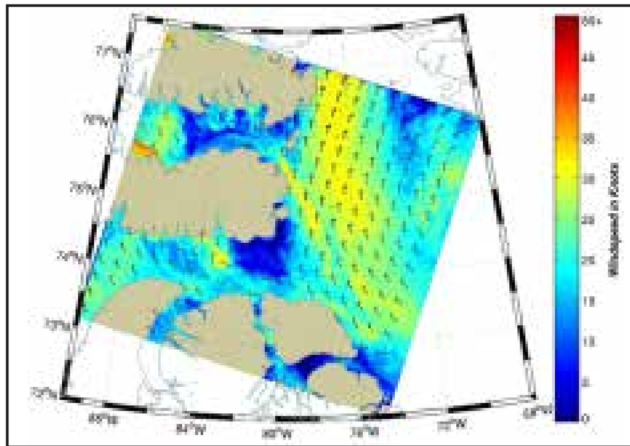


Figure 28: RADARSAT image from September 12, 2013, showing moderate to strong northerly fiord outflow winds in Jones Sound.

Figure 29: Winds in a northerly flow, based on multiple RADARSAT images. The length of the arrows indicates the relative wind speed in each area.

8.2.1.2 Westerly and Northwesterly Flow Pattern

This flow pattern is generated by the same systems that are at work in the West Baffin and Clarence Marine Region. West winds can be channeled to gale force within Jones Sound, with even a weak flow capable of generating strong to moderate winds over eastern parts of the sound. These channelling winds are often reinforced by gap winds. As a result, stronger outflow winds exit into northern Baffin Bay.

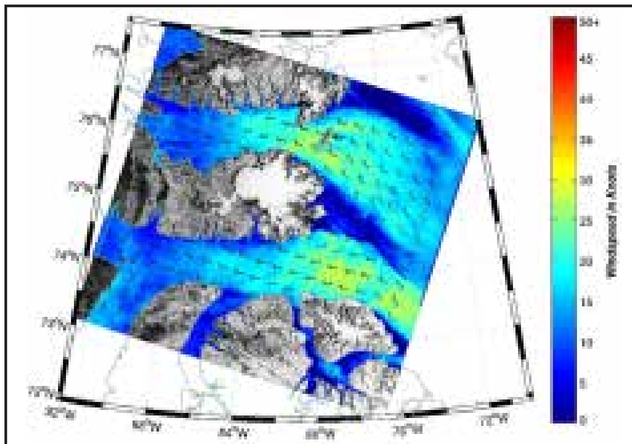


Figure 30: RADARSAT images from September 3, 2012, when a weak westerly flow generated strong winds over the eastern parts of Jones Sound.

8.2.1.3 Easterly and Southeasterly Flow Pattern

This flow pattern is generated by the same systems as those in the West Baffin and Clarence Marine Regions. East winds corner around King Edward Point and Smith Island, generating a band of strong winds in the northern parts of the east entrance to Jones Sound.

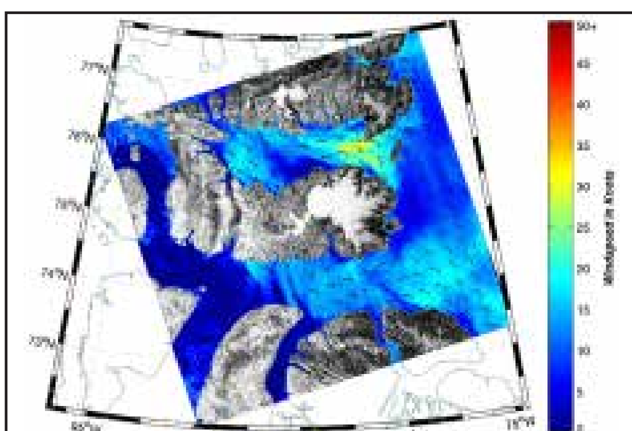


Figure 31: RADARSAT image from September 16, 2012, at 22:43 UTC, showing weak easterly flow that developed over the eastern sections of Ellesmere Island on September 16, 2012, generating light east winds in Baffin Bay that became moderate to strong in Jones Sound due to channelling and cornering effects.

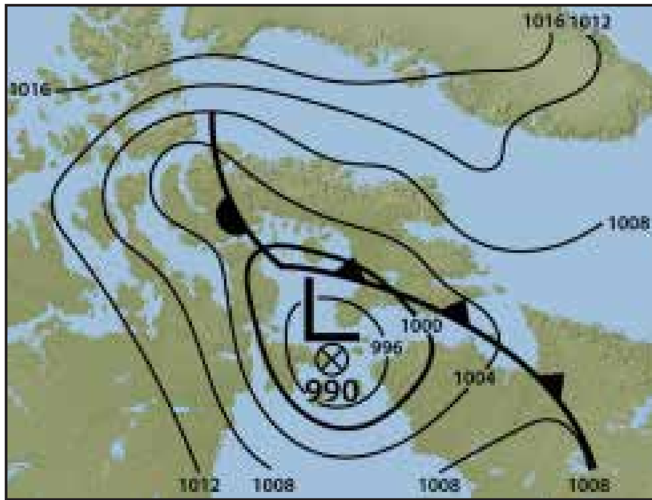


Figure 32: Surface analysis showing weak easterly flow that developed over the eastern sections of Elsmere Island on September 17, 2012, at 18:00 UTC, generating strong to gale-force winds in Jones Sound due to the channelling effect.

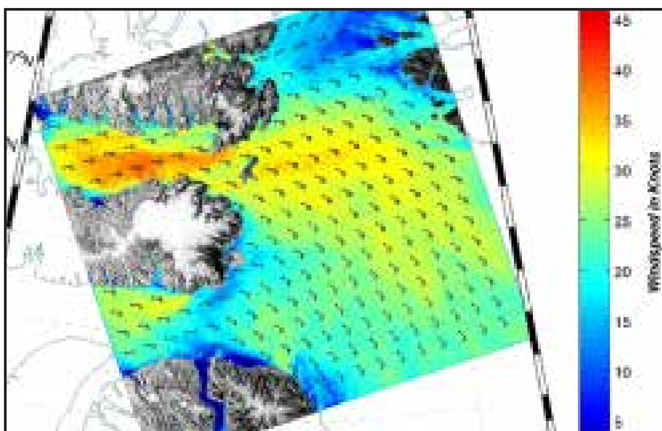


Figure 33: RADARSAT image from September 17, 2012, at 22:14 UTC when the low-pressure system intensified and moved further north. Strong easterly flow developed over Ellesmere Island, strengthening to gale force due to the channelling effect in Jones Sound. Stronger winds were observed over the narrower, eastern part of the sound.

8.2.1.4 Grise Fiord

Grise Fiord is the northernmost settlement in Canada. It is located on the south coast of Ellesmere Island in the bottom of a fiord on Jones Sound, between two plateaus that rise more than 600 m above sea level.

Community of Grise Fiord. Photo courtesy of the Government of Nunavut.

Wind speeds and directions over Grise Fiord can be quite different than those over Jones Sound, with local winds often strong, erratic, and unpredictable. Strong winds are mostly from the southeast to northeast, with a strong preference from the east, where Jones Sound opens into Baffin Bay.

The southern Ellesmere Island area near Baffin Bay is considered a graveyard for storms moving north along the east coast of North America, which frequently move into the area and often remain stalled there for several days. These storms generally produce a north to northeast wind flow over the region. At Grise Fiord, this pattern can create a strong wind event in the fiord.

East and Northeast Winds

East and northeast winds are the strongest and most dangerous encountered in Grise Fiord. They descend into the area from the higher terrain north of the hamlet.

Southeast Winds

Southeast winds are the second-most dangerous winds in the area and often occur in conjunction or following easterlies. They can be intermittent but gusty.

North and Northwest Winds

North downslope winds are the third most significant source of strong winds in Grise Fiord. According to local sources, drainage and fiord winds from the northwest do not directly affect the town site.

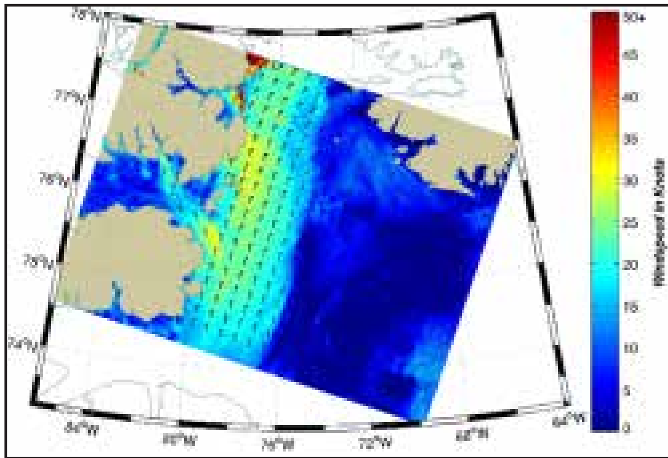


Figure 34: RADARSAT image from September 9, 2013.

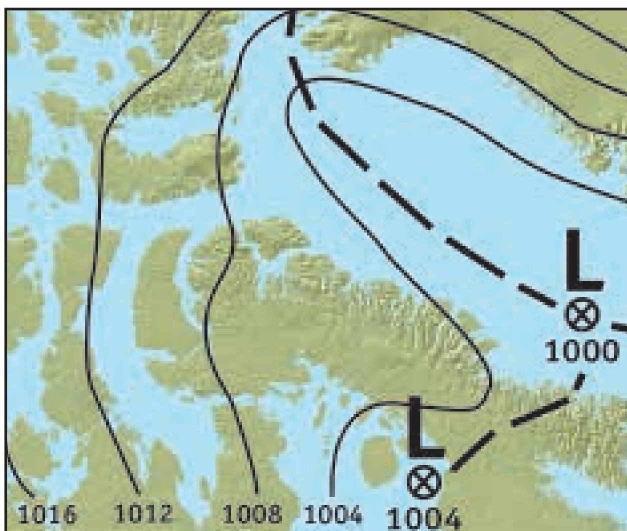


Figure 35: Surface analysis from September 9, 2013.

RADARSAT image (above) and surface analysis (below) from September 9, 2013, showing north winds created by an elongated trough of low pressure generating northeasterly flow over eastern parts of Ellesmere Island and a moderate to strong outflow from Starnes Fiord. The same flow generated northerly gusts of 51 kt at Grise Fiord the next day, when the low had deepened to 978 mb, with northerly winds descending from the higher terrain north of the town.

During the summer, low cloud and fog are common across ice-covered waterways and open water. Onshore winds readily bring these conditions inland, and Grise Fiord is affected when southeasterly flows arrive from Jones Sound. The presence of high terrain across its entire northern quadrant protects the community from such intrusions from the north.

8.2.2 Tides and Currents, Shoals, and Ice Conditions

8.2.2.1 Tides and Currents

- **Hell Gate and Cardigan Strait:** Strong northerly outflow winds enhance tidal currents in these areas. With strong northerly winds, outgoing tidal currents can reach speeds of 6 kt in Hell Gate and 4 to 5 kt in Cardigan Strait. Southward-flowing tides strengthen when they combine with an outgoing tidal stream over 3 kt, while incoming tides (which flow northward) are usually weak.
- **Craig Harbour:** Strong tidal streams has been observed.
- **Grise Fiord:** Tidal currents flow toward the northwest with the incoming tide and southeast with the outgoing tide.
- **Jones Sound:** Strong currents can occur in the western part of the sound.

8.2.2.2 Shoals

Shoals can be hazardous in Brae Bay, at the entrance to Thomas Lee Inlet, near the coast around Anstead Point, and at the entrance to Starness Fiord.

8.2.2.3 Ice Conditions

The eastern extremities of Jones Sound are the first to break up and become ice-free. By early June, Lady Ann Strait is normally ice-free as far west as the solid ice pack that extends from Coburg Island to Devon Island. By mid-June, this ice-free area expands into the eastern entrance of the sound, although Glacier Strait is still usually covered with fast ice. By mid-July, this ice-free zone has extended a bit further into the sound, while the open water at its western end has expanded considerably. Only small amounts of ice flow into Baffin Bay through its eastern entrance, as most melts or evaporates in situ.

The central part of Jones Sound remains solid until the middle of August, but is normally ice-free by September. In extreme years, however, it can support up to four tenths of ice, and the ice cover on the inlets in Ellesmere Island and Devon Island can remain unbroken. Old ice flowing southward from Nares Strait may also temporarily congest the eastern entrance of the sound, and icebergs and heavy floes from Baffin Bay can fill Glacier and Lady Ann straits—the former sometimes being blocked for most of the summer.

Navigation in Jones Sound is usually feasible from mid-August until mid-October. If conditions are adverse, the north shore of the sound usually offers easier passage, as the heaviest concentration of local ice and ice pack draining from Norwegian Bay moves eastward, along the coast of Devon Island.

Young ice may begin to form as early as late August but does not usually start until mid-September. By the end of October, the sound has a high concentration of ice, most of which is young and can still be navigated by ships. By mid-November, final freeze-up has prevented any further ice movement.

8.3 Lancaster Marine Region

This region includes Lancaster Sound, which is bounded to the north by the coast of Devon Island and to the south by Bylot and Baffin islands. The sound is the eastern entrance to the Northwest Passage, linking Baffin Bay with Barrow Strait and Viscount Melville Sound.

Figure 36: Local effects for the Lancaster Marine Region.

8.3.1 Winds and Weather

Lancaster Sound experiences similar winds and weather systems as northern Baffin Bay and Jones Sound. Because the sound stretches from west to east, the most significant effects are channelling and gap winds from northwesterly-westerly and easterly-southeasterly flows.

Southeast winds are predominant at the eastern end of Lancaster Sound from June through August, while northwesterlies are prevalent the remainder of the year. Precipitation along the exposed coasts of Ellesmere, Coburg, and Devon islands is heavy compared to most other Arctic Islands (> 300 mm annually)—due, partly, to storm activity and the abrupt lift of onshore winds flowing up the rugged coastal slopes and partly to the presence of the North Water Polynya.

Lancaster Sound's location in the northern sector of the Arctic Islands means that it is frequently affected by cyclonic activity originating in Davis Strait. Many of the systems formed in the strait stagnate and die in the sound.

Katabatic winds occur in Burnett Inlet, between Cape Warrender and Cape Sherard, and in Croker Bay.

Figure 37: Black arrows indicating the location of katabatic winds in the Lancaster Sound area.

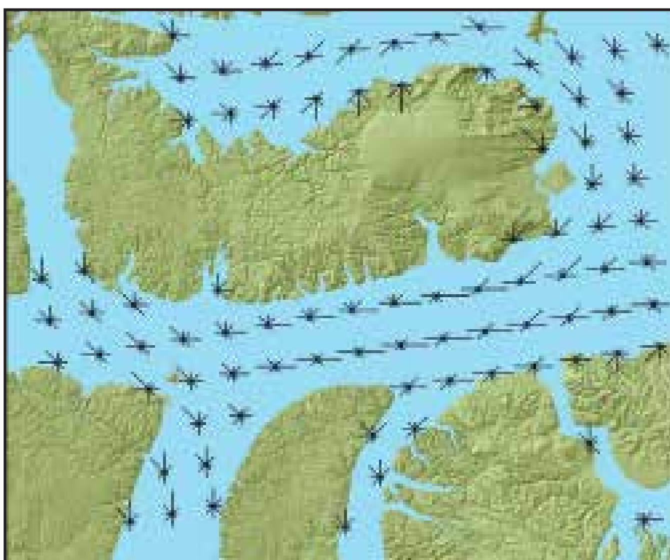


Figure 38: RADARSAT-derived wind roses for June, July, and August for the Lancaster Marine Region.

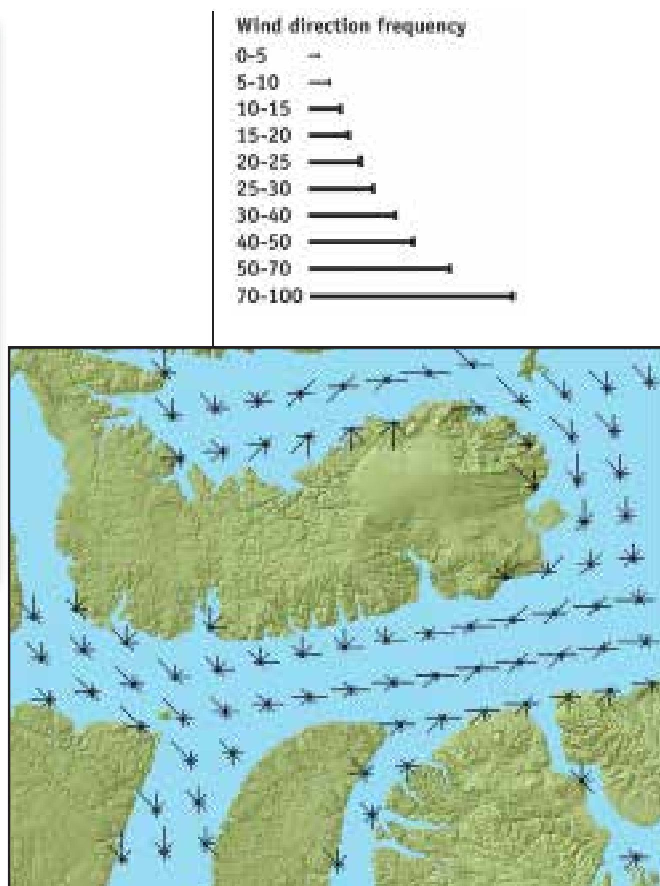


Figure 39: RADARSAT-derived wind roses for September, October, and November for the Lancaster Marine Region.

8.3.1.1 Easterly and Southeasterly Flow Pattern

Channelling occurs in Lancaster Sound with easterly or southeasterly flows and, on occasion, even with northeasterly winds. Easterly winds can easily reach gale force, with even a weak low-pressure system. With east winds, a cornering effect also occurs west and southwest of Cape Warrender and Cape Sherard, off the southeastern tip of Devon Island.

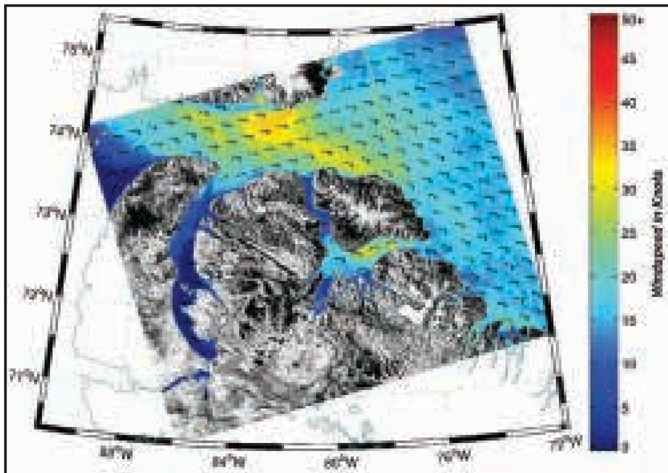


Figure 40: RADARSAT image from September 18, 2012, at 22:31 UTC, showing cornering effect in Lancaster Sound, west of Cape Warrender. As the southeasterly flow entered the sound, the wind change to easterly. Gale-force winds likely developed in the area southwest of Cape Warrender due to cornering.

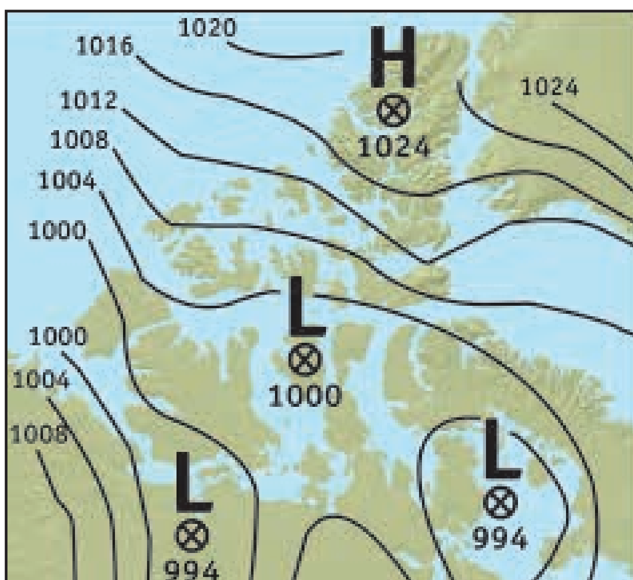


Figure 41: Surface analysis showing easterly flow in Lancaster Sound on September 18, 2012.

Coastal convergence is noticeable along the southern coast of Devon Island in a southeasterly flow. With this flow, a cornering effect also occurs near Fellfoot Point, intensifying moderate southeasterly winds to near gale force or gale force.

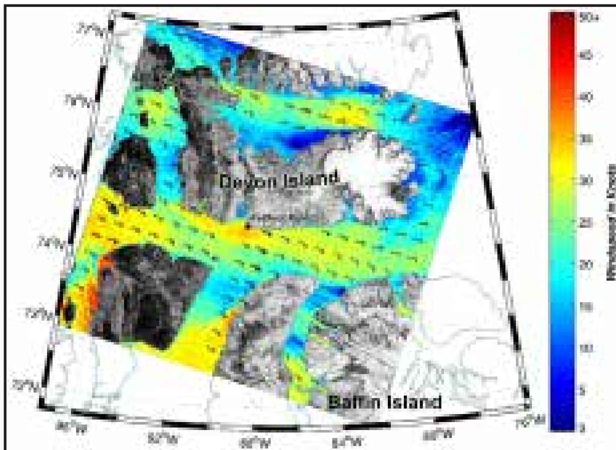


Figure 42: RADARSAT image from September 22, 2011, showing coastal convergence and cornering effects in a southeasterly flow.

A strong easterly airflow impinging on Brodeur Peninsula “piles up” and slows down as it feels the effects of the steep-walled terrain (which rises from 300 to 550 m). This causes a wall of lighter winds to extend out on either side of the peninsula. A short distance downstream, the winds increase again as they get swept up in the prevailing easterly flow. When winds are not as strong, they split around the peninsula and hug the coastline, instead. If the easterly flow has a southerly component, the wall does not occur and the change in wind speed is less pronounced; however, a northerly component to the winds could make this effect even stronger. A similar effect can be experienced downwind of Prince Leopold Island.

Getting wet in Lancaster Sound. Photo courtesy of Nicolas Peissel.

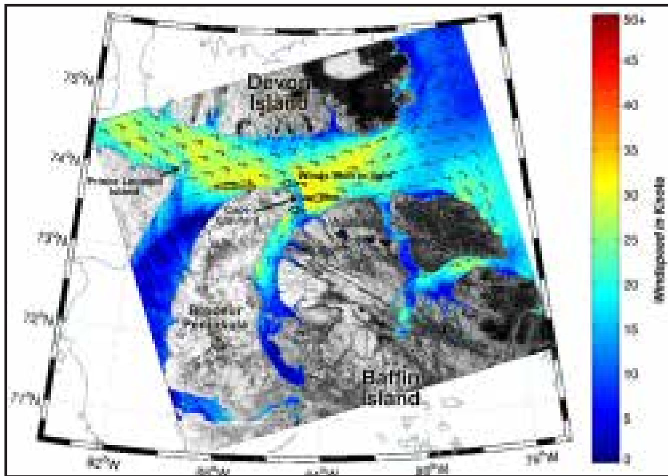


Figure 43: RADARSAT image from August 22, 2011, at 22:47 UTC, showing areas of lighter winds near Cape Crauford and Prince Leopold Island in a strong easterly flow.

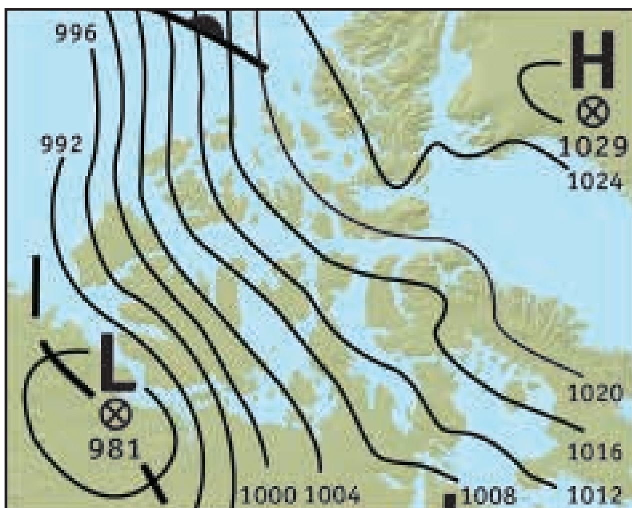


Figure 44: Surface analysis from August 22, 2011, showing the surface pattern that generates areas of lighter winds near Cape Crauford and Prince Leopold Island in a strong easterly flow.

8.3.1.2 Westerly Flow Pattern

West winds experience channelling and gap-wind effects over Lancaster Sound, with even light westerly or northwesterly flows capable of generating strong to gale-force winds, especially over eastern parts of the sound and near its entrance.

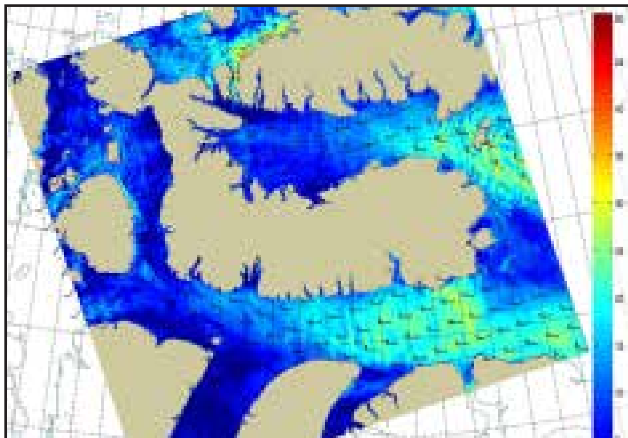


Figure 45: RADARSAT image from August 23, 2014.

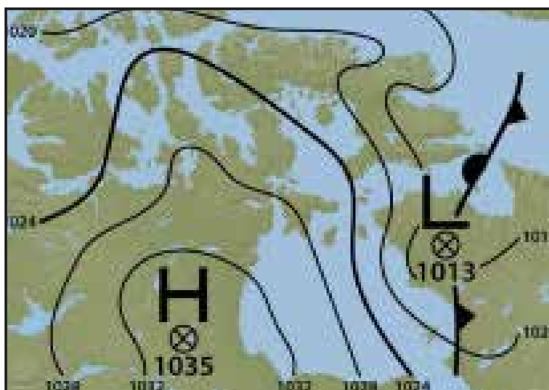


Figure 46: Surface analysis from August 23, 2014.

RADARSAT image (above) and surface analysis (below) from August 23, 2014, taken during a substantial wind increase (moderate to strong) over the eastern sections of Lancaster Sound in a westerly flow—although the pressure pattern does not support strong wind generation.

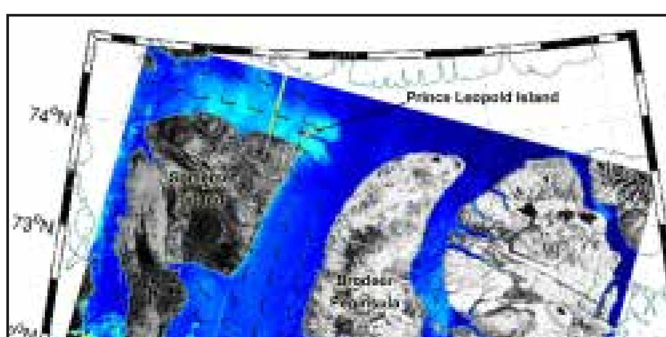


Figure 47: RADARSAT image from July 31, 2011, at 12:40 UTC, showing west winds cornering around Prince Leopold Island. Mariners can find shelter from such winds on the lee side of the island.

8.3.1.3 Northerly and Northwesterly Flow Pattern

North and northwest winds channel as they blow over Lancaster Sound. When they reach the terrain on the southern coastline, the winds take on a more westerly component than they do in the northern sections of the sound. This flow also results in bands of strong, fiord-outflow winds in the northern sections of the sound that can extend as far as 10 to 20 km out over the waters of the sound. The larger fiords of Devon Island reportedly generate even stronger winds; however, light winds in the downwind shadow of the Devon Ice Cap offer good shelter during such events.

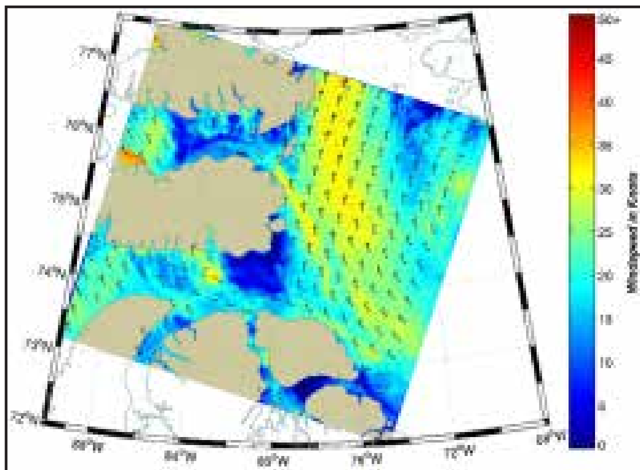


Figure 48: RADARSAT image from September 12, 2013.

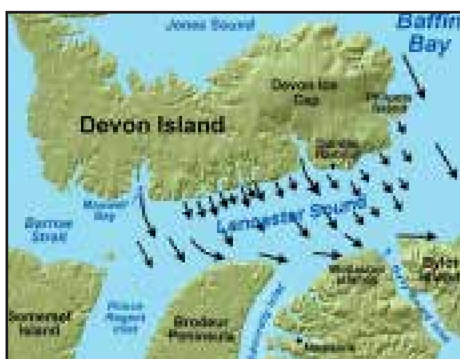


Figure 49: Compilation map created from multiple images showing an area of light winds on the downwind side of the Devon Ice Cap during northerly or northwesterly events. The length of the arrows indicates the relative wind speed in each area.

8.3.2 Waves, Tides and Currents, Shoals, Ice and Icebergs

8.3.2.1 Waves

East and west winds channelling through Lancaster Sound are the main driving force behind wave development. Due to the shape of the sound, the longest fetch occurs when winds are blowing from the west or east; however, seas are highest when the winds are easterly. The biggest waves develop when a fetch of up to 900 km extends across Baffin Bay and the eastern end of Lancaster Sound is not blocked by pack ice. Fetches for westerlies are usually shortened by ice moving south from Wellington Channel into Barrow Strait. The largest fetches occur in late August and early September, when open water is at its maximum.

8.3.2.2 Tides and Currents

Real tides in Lancaster Sound are primarily semi-diurnal. The extreme tidal range at Dundas Harbour is 3.4 m, while the mean tidal elevation in some parts of the sound is approximately 1.7 m. Tidal currents near Cape Crauford (at the tip of Brodeur Peninsula) have been measured at speeds of up to 0.8 kt.

A cold surface current (slightly over 2 kt) from the Arctic Ocean flows eastward from Barrow Strait along the southern shore of Lancaster Sound. A relatively warm westward surface current enters Lancaster Sound from Baffin Bay along the northern shore. This intrusive current occasionally carries icebergs from Baffin Bay into the sound, where they eventually sweep back along its southern shore. Surface currents are likely to align with sustained east or west winds due to the confining effect of the shorelines in the sound.

8.3.2.3 Shoals

Shoals can be found along the coast east of Cape Charles York, northwest of Cape Crauford, and southeast of Cape William Herschel, in Maxwell Bay.

8.3.2.4 Ice and Icebergs

Lancaster Sound is mainly influenced by first-year sea ice, which usually begins clearing in July. It is still subject to intrusions of floes from adjacent waterways, however, with multi-year floes and icebergs sometimes posing a hazard to ships.

Break-up starts in its eastern sections first and continues, in some years, into early August in its western sections. Water currents create complex ice trajectories in the area, and numerous eddies near the entrance of the sound steer local ice floes in circles. Freeze-up typically happens during the first two weeks of October, starting in the western part of the sound, although the area may continue to be navigable until the end of October during a light ice season.

Baffin Bay receives its water in approximately equal quantities from the southeast (western Greenland) and the northwest (Lancaster, Jones, and Smith sounds). As such, icebergs can be drawn into the sound from the west or northwest coasts of Greenland or the glaciers of Devon and Ellesmere islands. They drift westward with the current along the northern side of the sound as far as 90th meridian, cross the sound southward, and then turn to drift eastward along its southern coast.

8.4 Barrow Marine Region

West of Lancaster Sound, Barrow Strait stretches 270 km westward to Viscount Melville Sound. A shipping waterway and important link in the Northwest Passage, the strait separates Cornwallis and Devon islands to the north from Prince of Wales, Somerset, and Prince Leopold islands to the south.

Did You Know?

The waters of Barrow Strait are a special place for large, migrating pods of beluga whales.

Figure 50: Local effects for the Barrow Marine Region.

8.4.1 Winds and Weather

This marine region is influenced mainly by weather systems that originate over the Arctic Ocean and move eastward or southeastward. Those moving northward over Baffin Bay have a similar impact on weather conditions as they do in Lancaster Sound. With respect to temperature, however, Barrow is slightly colder in July and August and considerably colder in September than Lancaster.

Figure 51: RADARSAT-derived wind roses for June, July, and August for the Barrow Marine Region.

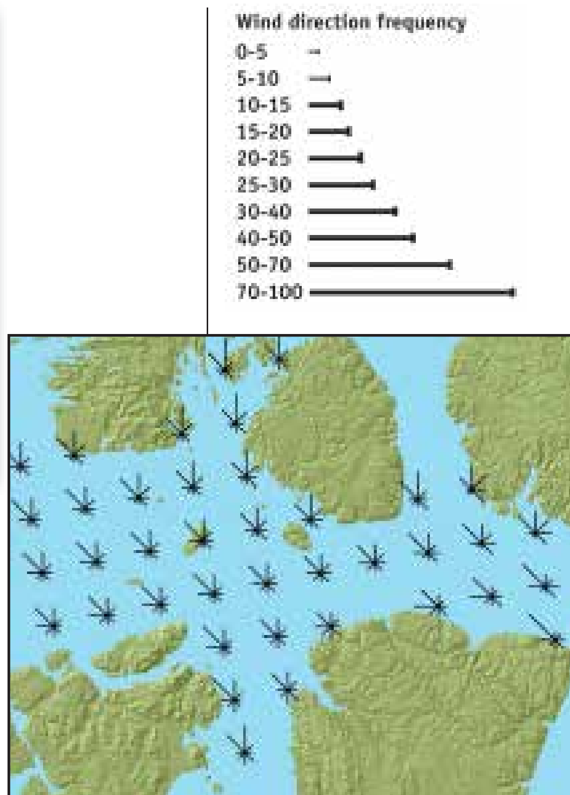


Figure 52: RADARSAT-derived wind roses for October, November, and December for the Barrow Marine Region.

8.4.1.1 Northeasterly Flow Pattern

Northeast winds can blow moderate to strong over Barrow Strait for a couple of days straight, even in a weak synoptic flow. Light northeasterlies can result in pumping winds, while light northwesterlies have been known to shift suddenly to strong northeasterlies. A northeast flow over Cornwallis Island will result in the intensification of the winds in areas downwind.

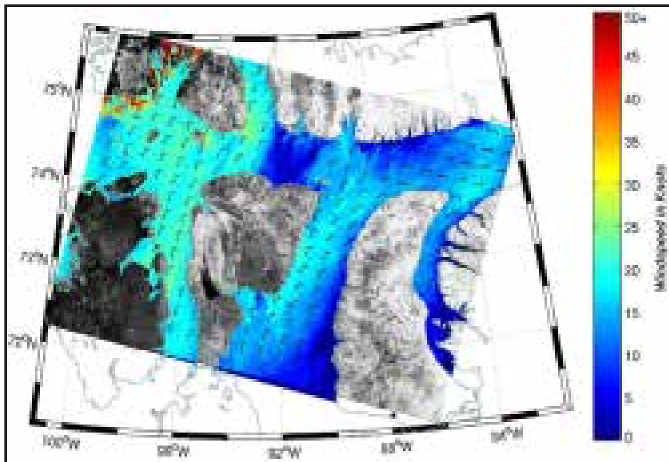


Figure 53: RADARSAT image from September 18, 2010.

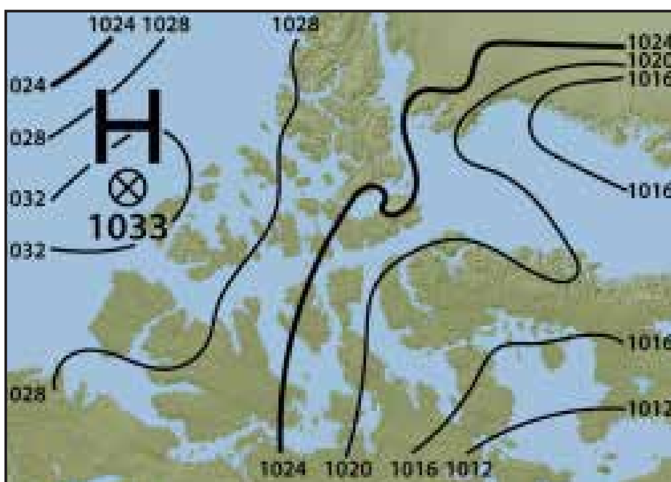


Figure 54: Surface analysis from September 18, 2010.

RADARSAT image (above) and surface analysis (below) from September 18, 2010, when strong to moderate northeast winds in Resolute diminished at times and then strengthened again.

8.4.1.2 Northerly and Northwesterly Flow Pattern

This flow is generated primarily by systems that have stalled over northern Baffin Bay. Prevailing winds from the northwest during the summer result in considerable amounts of ice impinging on the shores of Northern Somerset Island. Shelter from strong north and northwest winds can be found at Beechey Island in Erebus and Terror Bay, although drifting ice can make navigation in the area hazardous.

Did You Know?

Beechey Island is where Franklin's ill-fated expedition spent its last winter in 1845 before disappearing—sparking numerous expeditions that completed the mapping of Canada's northern archipelago. Roald Amundsen also stopped at the island during the first complete transit of the Northwest Passage, almost 60 years later.

Figure 55: Satellite image from August 15, 2013.

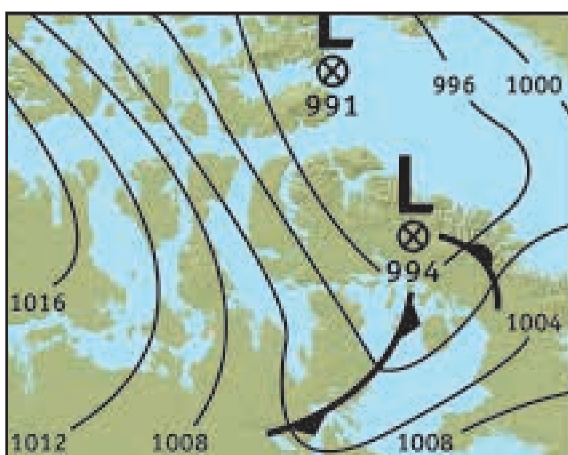


Figure 56: Surface analysis from August 15, 2013.

Satellite image (above) and surface analysis (below) from August 15, 2013, at 18 UTC during a northerly/northwesterly flow. Resolute reported northwest winds as strong as 25 kt, gusting to 37 kt, as well as snow and rain.

Mariners' Tips:
Ripples on satellite imagery are an indicator of very strong winds aloft, which can reach the surface in unstable atmospheric conditions, often after the passage of a cold front.

8.4.1.3 Easterly and Southeasterly Flow Pattern

Winds in this flow pattern often channel through Barrow Strait in the same as they do through Lancaster Sound. East winds split around the southeastern tip of Cornwallis Island and Griffith and Lowther Island, creating a wall of light winds, and then pick up speed again further from the islands. The downwind sides of Prince Leopold Island and Lowther and Griffith Island can offer protection from strong east winds.

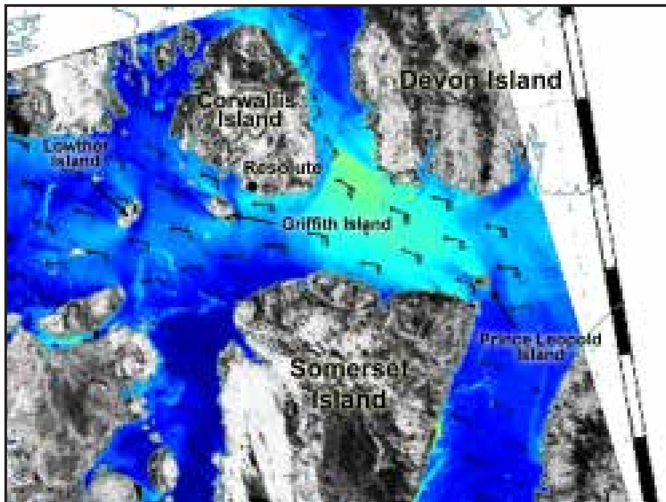


Figure 57: RADARSAT image from August 5, 2012.

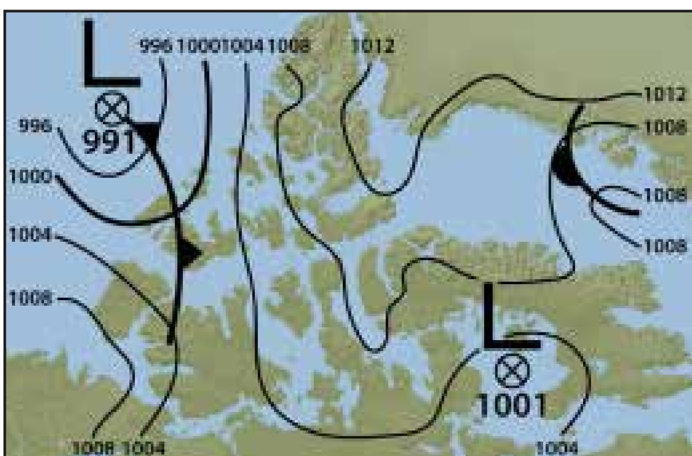


Figure 58: Surface analysis from August 5, 2012.

RADARSAT image (above) and surface analysis (below) from August 5, 2012. Strong east winds channeled through Lancaster Sound and Barrow Strait—especially between Somerset and Devon islands. The synoptic pattern did not suggest strong winds in the area. The winds split around Cornwallis Island and veered around its eastern coast toward Resolute Bay, where east to southeast winds over 20 kt were reported.

Figure 59: Compilation created from multiple images showing winds in an easterly flow pattern and the protection offered on the downwind side of Griffith, Lowther, and Prince Leopold Islands. The length of the arrows indicates the relative wind speed in each area.

8.4.1.4 Resolute

Resolute is a small Inuit hamlet on Cornwallis Island. Known in Inuktitut as the "place with no dawn" because of its long winter nights. It also sees no sunsets during the summer months.

Community of Resolute, Nunavut. Photo courtesy of the Government of Nunavut.

Resolute Bay is affected by a wide variety of storm tracks and, as a result, can experience strong winds from all directions except west to southwest. Southwest winds are transitory, as winds back from the northwest when a low-pressure system approaches from the west and the ridge moves off. Local winds are influenced by the wide, east-west alignment of

Barrow Strait to the south and the winding channels and irregular land masses to the north. Sea breezes occur in July and August.

During the summer, Resolute is vulnerable to onshore flows that draw clouds across the low terrain. Northwest, west, and southwest winds bring low cloud and fog to the area that can persist for days in stagnant weather patterns. Although stronger winds sometimes help to disperse the fog, it returns as soon as they subside. In the fall, the colder temperatures, more stable weather, and frozen waters make such conditions much less likely.

South winds tend to have the highest link to cloudy skies and precipitation. When air temperatures are below freezing and upwind waters are open, freezing drizzle or freezing fog can occur at Resolute. Depending on the moisture content of the air, hoarfrost can also develop with freezing fog.

Mariners' Tips:
In a strong northerly to northeasterly flow, Resolute tends to report stronger winds than those experienced by ships in the Barrow Strait.

Northeast, North, and Northwest Winds
Winds from the northwest though the north to northeast are the result of storms that move north through Davis Strait into Baffin Bay, where they often stall and dissipate. Strong winds can occur with these systems, the strongest usually coming from the northeast. Northwest winds tend to be stronger when they are bringing cold air across Resolute Bay. Long periods of strong northeast winds are punctuated by brief lulls in which the wind speed decreases dramatically and the direction often backs to west to northwest. This often occurs when storms approach Resolute Bay from the south to west.

East and Southeast Winds
Winds from the east and southeast occur when storms approach Resolute Bay from the west. They are more common than winds from other directions and can be very strong and persistent when these storms stall over Hudson Bay or Foxe Basin.

Significant Event: September 21-23, 2011
Strong east winds of nearly 25 kt began developing in Resolute on the afternoon of September 21. They reached gale force at 37 kt by the next day and remained strong until the afternoon of September 23. The Canadian Coast Guard icebreaker *Henry Larsen*, positioned in Resolute Bay at the time, reported easterlies at 36 to 44 kt on the same two days.

8.4.2 Waves, Tides and Currents, Shoals, and Ice and Icebergs

8.4.2.1 Tides and Currents

The tides in this marine region are semi-diurnal and diminish in height as they move through Lancaster Sound (nearly 2 m) to Barrow Strait (less than 0.5 m). A weak westward current occurs on the northern side of Barrow Strait and a strong eastward one on its southern side. A tidal current of 3 kt has been reported between Limestone Island and Somerset Island and south of Sight Point, at the entrance to Resolute Bay.

8.4.2.2 Shoals

Shoals are found in Union Bay (northwest of Beechey Island), at the entrances to Irvine Bay and Cunningham Inlet, northeast of Gourdeau Point (on Lowther Island), and north and northeast of Young Island.

8.4.2.3 Ice and Icebergs

Ice freeze-up in the strait usually occurs during the first two weeks of October, with the eastern sections freezing first. The ice begins to break up in July in the eastern end of the strait and continues until about the middle of August in its western end, leaving the navigation season from about mid-August to mid-September. Even during this short period, the bay may be partly filled with scattered pack ice and growlers, which move in and out with the tidal currents. Ice is often grounded on the shoals and shallow waters at the entrances to the strait, affording some protection for ships, even from southerly winds. In general, northeast winds keep the bay comparatively free of ice, while southeast winds may make it untenable.

Icebergs rarely drift as far as the east coast of Cornwallis Island.

Did You Know?

Scientists can now predict the date when Canada's legendary and deadly Northwest Passage will freeze based on the salinity of the water in late summer. An underwater observatory, located 40 m below the surface of Barrow Strait, sends measurements of temperature and salinity by underwater cable to a station 8 km away, where it is transmitted by satellite to meteorologists in Dartmouth, Nova Scotia.

8.5 Regent Marine Region

Prince Regent Inlet is a body of water that lies between Somerset Island and Brodeur Peninsula (Baffin Island). These waters were not used by mariners until the discovery of Bellot Strait, which is known as one of the most dangerous channels in the Northwest Passage for its strong tidal currents.

Figure 60: Local effects for the Regent Marine Region.

8.5.1 Winds and Weather

The same weather systems affect this marine region as the Lancaster and Barrow regions.

Figure 61: RADARSAT-derived wind rose for June, July, and August for the Regent Marine Region.

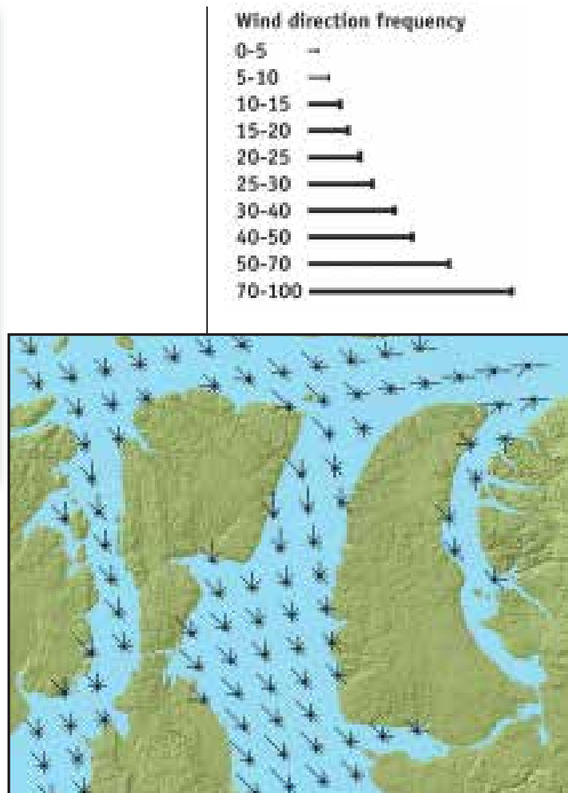


Figure 62: RADARSAT-derived wind rose for September, October, and November for the Regent Marine Region.

8.5.1.1 Northerly, Northeasterly and Northwesterly Flow Pattern

The Regent Marine Region can experience channelling in any flow that has a primarily northerly component due to the configuration of Prince Regent Inlet. The strongest effect occurs in the northern part of the inlet, which is also the narrowest.

Northwesterly flow is most common over these areas when a low-pressure system is moving eastward and a high from the Beaufort Sea is pushing in from the west. In this flow, northwest winds prevail in southern parts of the area and then, further north, gradually veer from northwest to north or northeast. The northeast winds strengthen from light to moderate, even in a very weak synoptic flow. Very strong north winds have been reported to blow from Rodd Bay across the isthmus into Port Leopold Bay.

8.5.1.2 Easterly and Southeasterly Flow Pattern

Easterly flows split around the tip of Somerset Island (Cape Clarence) and Prince Leopold Island and become northeasterly in Prince Regent Inlet. These winds tend to corner around Fury Point if they have a more easterly component.

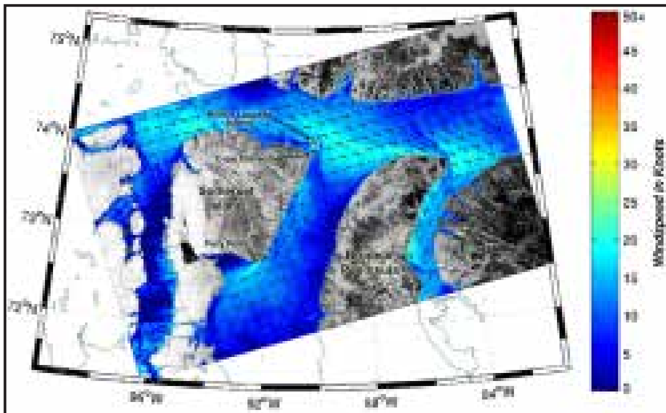


Figure 63: RADARSAT image from August 22, 2012.

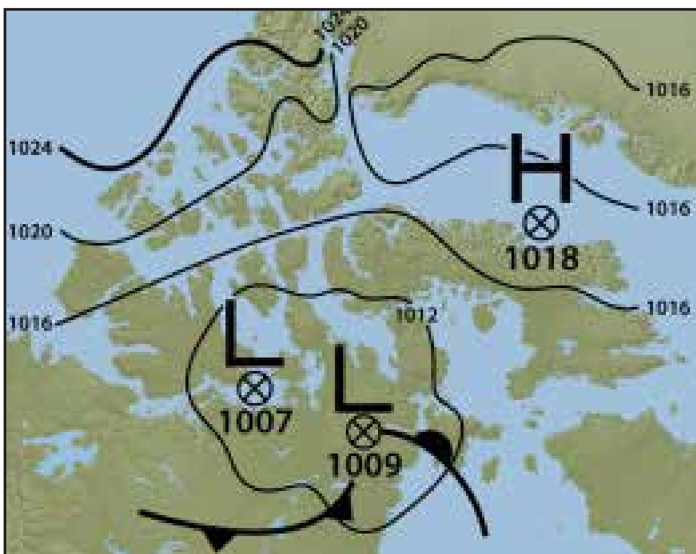


Figure 64: Surface analysis from August 23, 2012, 00 UTC.

RADARSAT image (above) and surface analysis (below) from August 22 and 23, 2012, respectively. An easterly airflow split around Somerset Island and then shifted direction and cornered around Fury Point. The synoptic flow at the time was relatively weak.

Downslope effects and lee waves occur along the northwestern coast of Brodeur Peninsula with a strong southeasterly flow, while a narrow band of gale-force winds can occur just off its western coast. When the southeast flow is weak, the downslope effect is not as pronounced. In strong southeasterlies, mariners are advised to sail away from the peninsula, as winds can be 5 to 10 kt lighter further to the west.

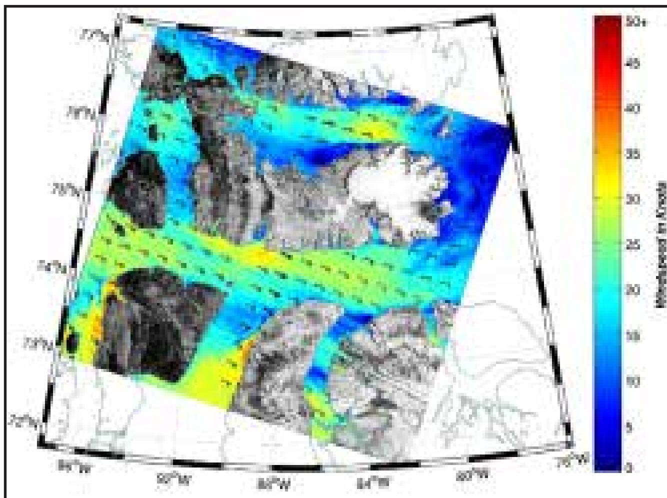


Figure 65: RADARSAT image from September 22, 2011, at 12:46 UTC, showing downslope winds and lee waves off the western coast of Brodeur Peninsula.

8.5.1.3 Westerly Flow Pattern

Funneling and gap winds have been reported in Bellot Strait with this flow pattern when there is a ridge over Victoria Island and a trough over northwestern Baffin Bay.

8.5.2 Waves, Tides and Currents, and Ice and Icebergs

8.5.2.1 Waves

Strong winds and waves can drive boats into the tall, coastal cliffs in this area.

8.5.2.2 Tides and Currents

A branch of the eastward-flowing current in Lancaster Sound sets south-southwest into Prince Regent Inlet and then southeast into the Gulf of Boothia. Part of this branch recurves in Prince Regent Inlet, and sets north-northeast along its eastern side.

While Bellot Strait is the shortest route to the Northwest Passage, it is renowned for being dangerous and unpredictable. The tidal current in the strait runs at a brisk 8 kt and carries with it any free-moving ice it has grabbed from either entrance. Since it flows in either direction and is highly irregular, the amount of drifting ice that might be encountered at any point along the route is impossible to determine. Calculation of the tide is essential before committing to the passage.

In the vicinity of Magpie Rock, the currents are highly variable, with eastward currents at 8 kt reported on the north side of the channel at the same time as equally strong westward currents were reported on the south side.

8.5.2.3 Ice and Icebergs

The pattern and extent of ice break-up in Prince Regent Inlet depends on the winds. In average years, northeast winds open up the eastern side of the inlet in July, while north winds drive the ice-edge south in August, leaving the inlet relatively ice-free by the end of the month. Southeast winds can bring old ice from the Gulf of Boothia into the inlet in August and September, pressing it up against the western shore; the reverse occurs when the prevailing winds are from the opposite direction. The inlet usually becomes ice covered during the first two weeks of October.

West winds in Bellot Strait are strong and not favorable for crossing, as they drive large quantities of ice into the channel. Easterlies are favorable for crossings, because they clear ice blockage at the exit in the narrow western end of the strait. The strait is often filled with small icebergs, which pose a navigational hazard to ships.

Managing the ice floes in the High Arctic. Photo courtesy of Nicolas Peissel.

8.6 Peel Marine Region

The Peel Marine Region is part of the main route through the Northwest Passage, and includes Peel Sound and Franklin Strait. Peel Sound lies between two islands: Somerset, to the east, and Prince of Wales, to the west. To the north, it opens into Parry Channel, while its southern end merges with Franklin Strait.

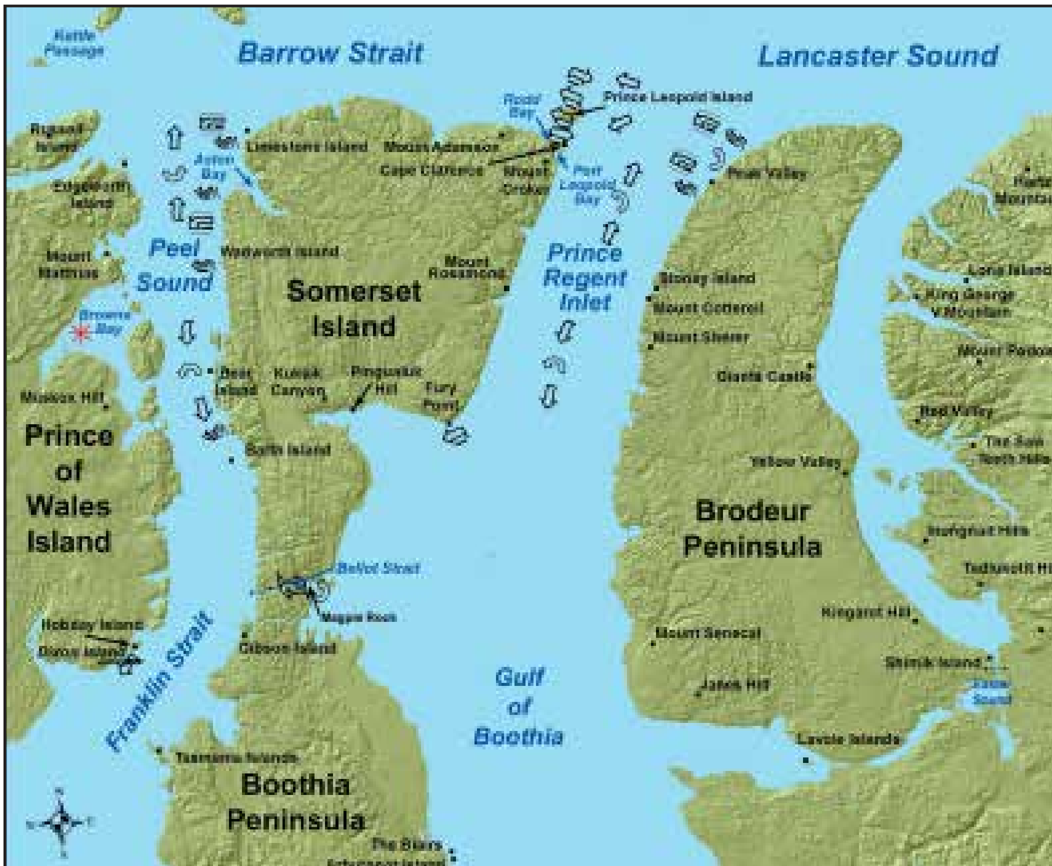


Figure 66: Local effects for the Peel Marine Region.

8.6.1 Winds and Weather

Peel Sound and Franklin Strait are affected by the same weather systems as the Barrow, Lancaster, and Regent marine regions. Ships travelling westward through the Northwest Passage often go to Resolute and then southward to Peel Sound to avoid problems navigating in Bellot Strait. Peel Sound can be blocked with ice by northwest or west winds and cleared by east, southeast, or northeast winds. Most often, the heaviest ice blockage occurs in the area of Bellot Strait, where the channel is narrower. Small boats are often trapped in the ice on the strait and must be rescued by a Canadian Coast Guard icebreaker.

8.6.1.1 Westerly and Northwesterly Flow Pattern

A northwesterly and westerly flow can generate strong winds (including gales) in Peel Sound and Franklin Strait. Willis Bay, on the eastern shore of Prince of Wales Island, can offer some shelter from wind and ice in such conditions. In gale-force winds from this direction, small boats are advised to head to the western side of the sound and strait, as those on the eastern side risk being crushed or trapped by wind-driven ice.

Significant Event: August 23-25, 2013

An intense low-pressure system that developed over northern Victoria Island and was moving northeastward across the Arctic Archipelago produced gale-force northwest winds and large waves over Franklin Strait from August 23-25. The yacht *Traversay 3* became trapped by the wind and ice after passing Bellot Strait. The nearest weather station at Fort Ross reported wind speeds of nearly 30 kt on August 25.

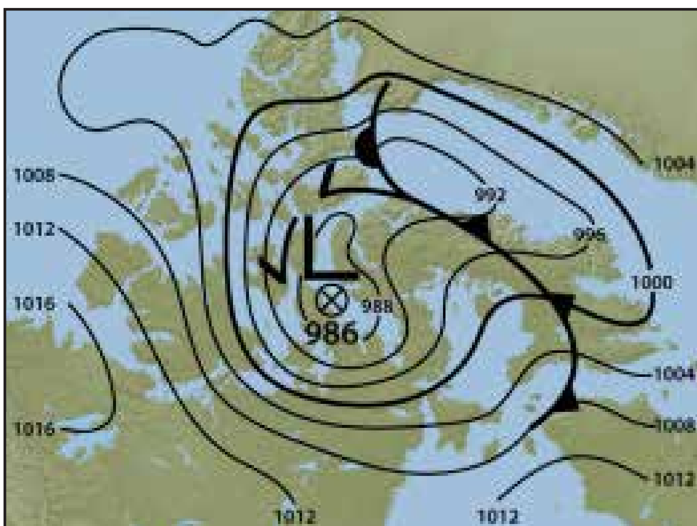


Figure 67: Surface analysis from August 24, 2013, showing pressure systems in Franklin Strait and surrounding area.

8.6.1.2 Easterly and Southeasterly Flow Pattern

An intense easterly or southeasterly flow can generate downslope winds and lee waves along the eastern coast of Peel Sound due to its relatively high, steep terrain. These winds can reach gale-force strength, especially over the northeast coast of the sound (including Aston Bay). The west coast of the sound is the best route to take in order to avoid such conditions.

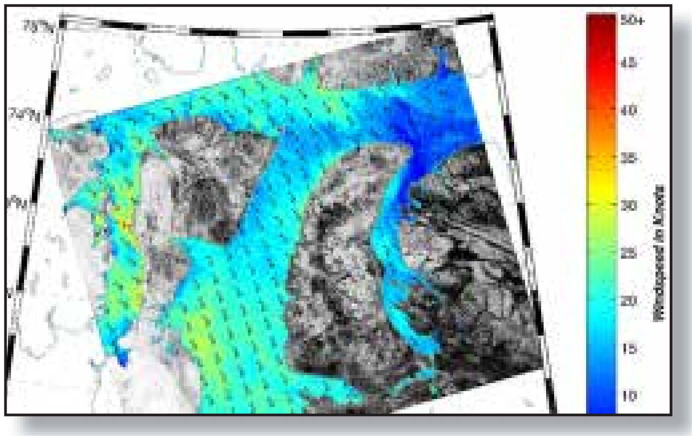


Figure 68: RADARSAT image from September 21, 2011, at 23:12 UTC, showing pre-development of downslope winds over the eastern coast of Peel Sound. The winds began to blow strong on September 22, 2011, and increased to gale force as the flow strengthened.

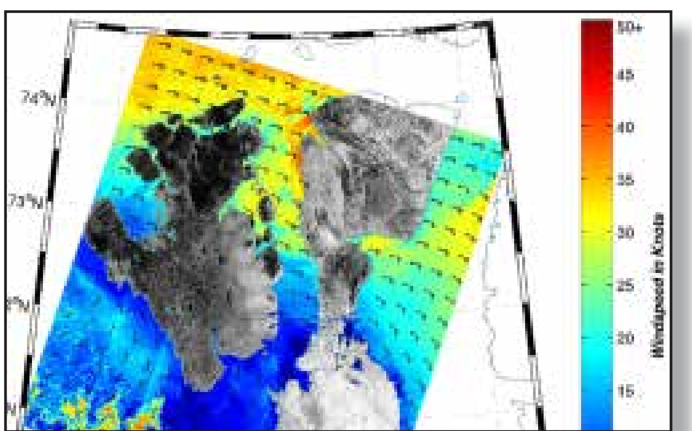


Figure 69: RADARSAT image from September 22, 2011, at 17:32 UTC, showing the development of downslope winds over the eastern coast of Peel Sound. The winds began to blow strong on September 22, 2011, and increased to gale force as the flow strengthened.

8.6.2 Currents, Shoals, and Ice Conditions

8.6.2.1 Currents

A southward current about 0.25 kt has been reported within Peel Sound setting to on the west side and a northward current of the same speed on the east side.

8.6.2.2 Shoals

There are shoals in Browne Bay, between Hobday Island and the coast, and between Hobday Island and Dixon Island.

8.6.2.3 Ice Conditions

Break-up in the Peel Marine Region starts in early August, with clearance caused mainly by melting and drifting under strong wind conditions. Narrow channels like Peel Sound and Franklin Strait are often the last areas to clear of ice. Some years, they do not clear at all, making passage through them nearly impossible. Sometimes, heavy ice blocks the northern entrance to Peel Sound, leaving Bellot Strait the only practical route into the sound from the east.

Freeze-up begins in some parts of the region in mid-September, although the main ice formation starts at the start of October in Barrow Strait. By late October, the ice cover is usually consolidated over most of the area.

Cold Arctic Ocean. Photo courtesy of Nicolas Peissel.

8.7 Larsen Marine Region

The Larsen Marine Region (Larsen Sound and Victoria Strait) is an Arctic waterway in the Kitikmeot Region of Nunavut. It is located south of Prince of Wales Island, west of the Boothia Peninsula, north of King William Island, and east of Gateshead Island.

Figure 70: Local effects for the Larsen Marine Region.

8.7.1 Winds and Weather

Northwesterly gales occur in Victoria Strait and Larsen Sound during the summer months. Weld Harbour, south of the Tasmania Islands, offers good shelter from all winds.

Figure 71: RADARSAT-derived windroses for June, July, and August for the Larsen Marine Region.

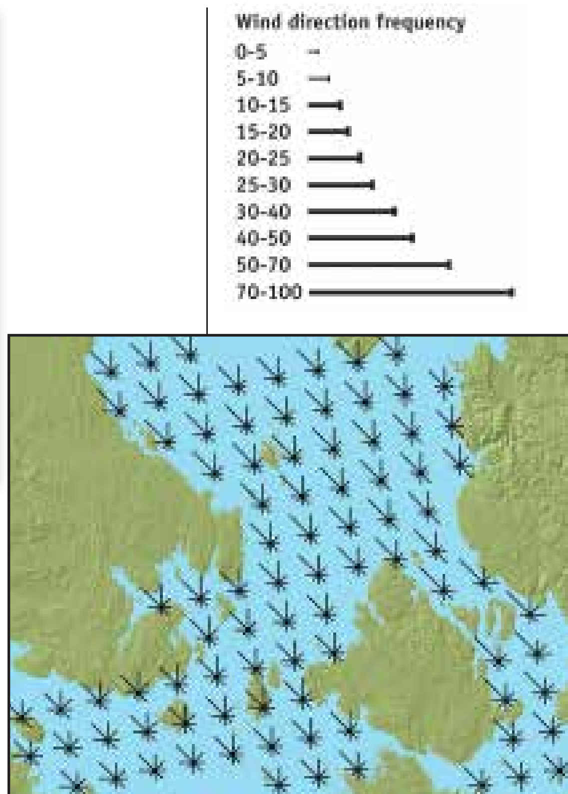


FIgure 72: RADARSAT-derived windroses for September, October, and November for the Larsen Marine Region.

8.7.2 Tides, Shoals, and Ice Conditions

8.7.2.1 Tides

Tidal rips are found to a depth of 40 m around the Tasmania Islands.

8.7.2.1 Shoals

Shoals are found around the Tasmania Islands, north of M'Clintock Point, in the northeastern part of Erebus Bay, north to northeast of De Haven Point, between Taylor and Admiralty Island, and outside the entrance to Pasley Bay.

8.7.2.3 Ice Conditions

Since the climate in Victoria Strait is somewhat milder than it is in the regions further north, the continual melting and eroding of old ice prevents excessive congestion. While substantial amounts of first-year ice form between the old floes, extensive clearing can occur in a good summer. Puddling begins in mid-June, but it is not until early August that significant break-up occurs. The process begins in Victoria and James Ross straits and spreads north into M'Clintock Channel. Little ice motion develops because light winds predominate in most seasons. If a persistent flow develops, however, the pack may be driven to one side of the channel, destroying any rotten ice and creating extensive leads on the windward side.

Easterly winds in late August or September can clear Larsen Sound and the west coast of Prince of Wales Island, while creating a belt of heavy old ice along the coast of Victoria Island. Subsequent freeze-up in mid- to late September forms large areas of first-year ice, which melts easily the following summer. Northwest winds bring ice from Larsen Sound into Victoria and James Ross straits, forcing any vessels in the area to wait late into the season before they can continue westward. Although the sea starts to refreeze in mid-October, northerly winds can close off the passage well before then by piling ice up against the coast.

Mariners' Tips:
Ice in these waters is usually confined to specific areas indicated on ice charts and can, therefore, be avoided. Navigating through pack ice in the dark is dangerous.

A sunny day of sailing. Photo courtesy of Nicolas Peissel.

8.8 Admiralty Marine Region

The Admiralty Marine Region includes Admiralty Inlet, a body of water that lies between the Brodeur and Borden peninsulas of Baffin Island. The narrow, crescent-shaped inlet has a few fiords along the coasts—one of them, Adams Sound, is home to the small community of Arctic Bay.

Figure 73: Local effects for the Admiralty Marine Region.

8.8.1 Winds and Weather

The shape of the inlet and its geographical position determine the local wind regime.

> **Did You Know?**
> Killer whales are often present along the west coast of Admiralty Inlet in the summer.

Figure 74: RADARSAT-derived wind rose for June, July, and August for the Admiralty Marine Region.

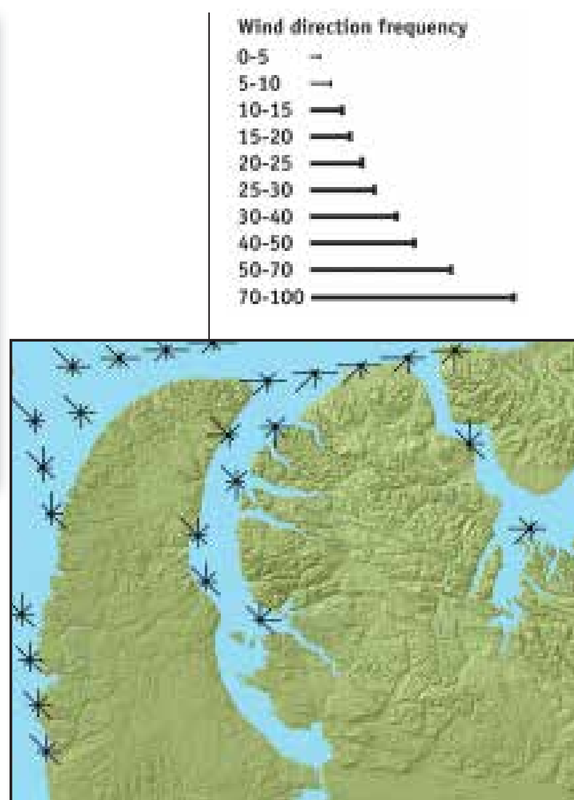


FIgure 75: RADARSAT-derived wind rose for September, October, and November for the Admiralty Marine Region.

8.8.1.1 Easterly Flow Pattern

Easterly flows in Lancaster Sound split around the northern end of Brodeur Peninsula, where part continues westward down Lancaster Sound and part heads south into Admiralty Inlet. Moderate to strong northeasterlies continue along the western side of the inlet, while its eastern coast can be totally calm.

8.8.1.2 Southeasterly Flow Pattern

A southeasterly flow is not favorable in Admiralty Inlet, because it blows across almost the entire body of water. Channelling occurs over the inlets and sounds on the eastern side of Admiralty Inlet. As a result of this effect, mariners in Strathcona and Adams sounds have reported much stronger winds in those areas than those experienced within Admiralty Inlet itself.

8.8.1.3 Northeasterly Flow Pattern

Northeast winds can accelerate to strong or near gale-force over the northern parts of Admiralty Inlet due to a channelling effect caused by its northeast-to-southwest configuration. Northeast winds can also create a barrier jet effect as they blow against the steep western coast in the northern part of the inlet. Shelter from strong northeasterlies can be found in any of the sounds along the eastern coast.

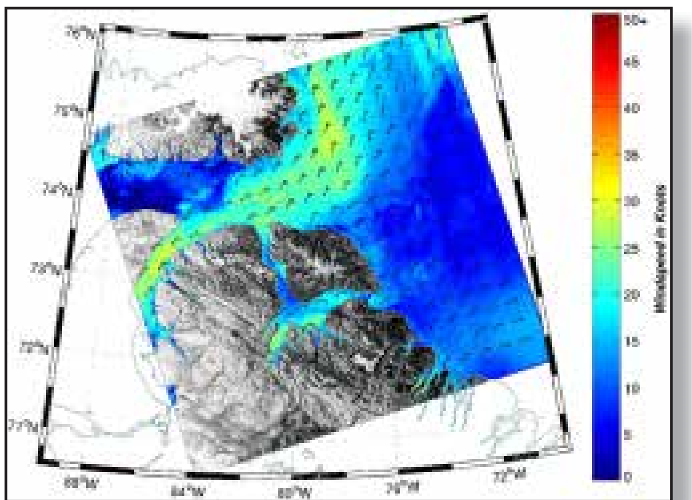


Figure 76: RADARSAT image from September 7, 2010, at 22:26 UTC, showing wind channelling and barrier jet development.

8.8.1.4 Northwesterly and Westerly Flow Pattern

Admiralty Inlet is not generally prone to northwest winds; however, a few local effects occur with this flow. They include cornering at the entrance to Admiralty Inlet (near Cape Crauford) and the potential for a narrow band of moderate, downslope winds to occur in a northwesterly flow along the western site of the inlet. Mariners exiting the inlet to enter Lancaster Sound should exercise caution, as they may experience a sharp shift from light to strong northwesterlies.

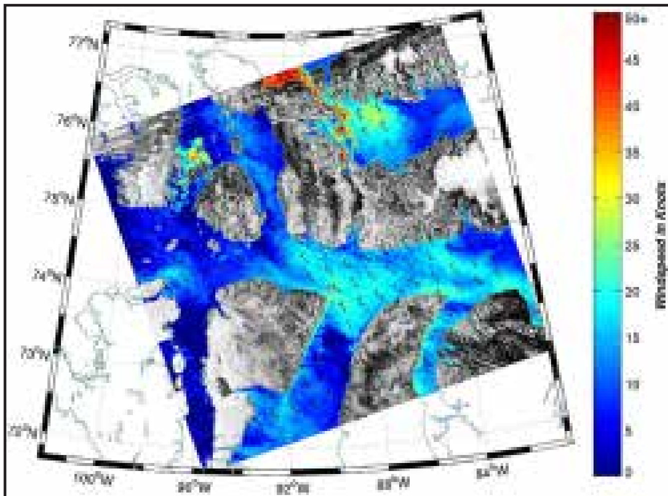


Figure 77: RADARSAT image from September 9, 2010, at 23:08 UTC, showing downslope-effect winds on the western side of Admiralty Inlet in a northwesterly flow.

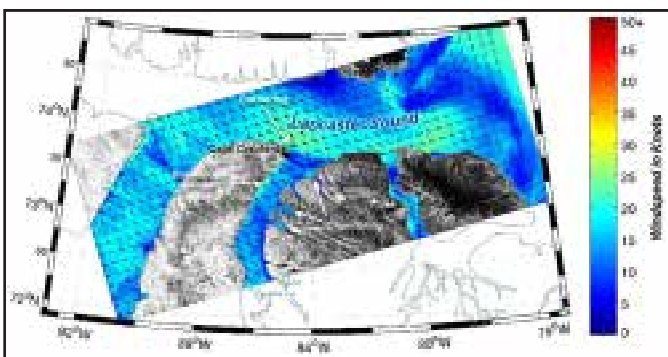


Figure 78: RADARSAT image from August 16, 2012, at 22:47 UTC, showing northwest winds channelling in the inlets and sounds over the eastern side of Admiralty Inlet.

8.8.1.5 Southwesterly and Southerly Flow Pattern

Like northeast winds, southwest winds accelerate over the northern part of Admiralty Inlet due to the channelling effect. The stronger winds occur at the northern entrance to the inlet and can extend out for many kilometres northeast into Lancaster Sound. South or southwest winds usually shift to westerly at the opening to Adams Sound and then shift back to their original direction at the entrance to Arctic Bay.

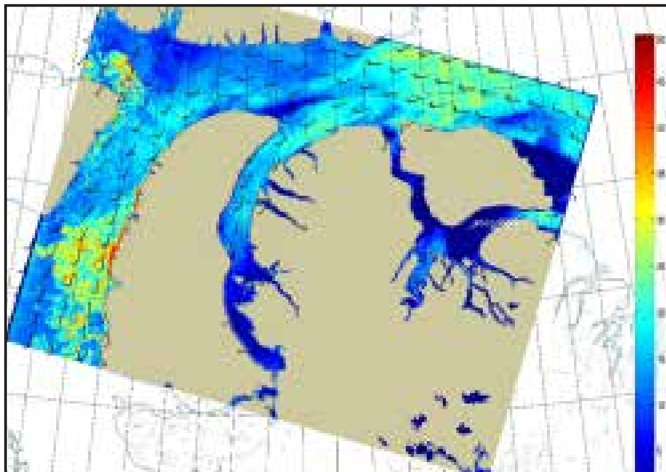
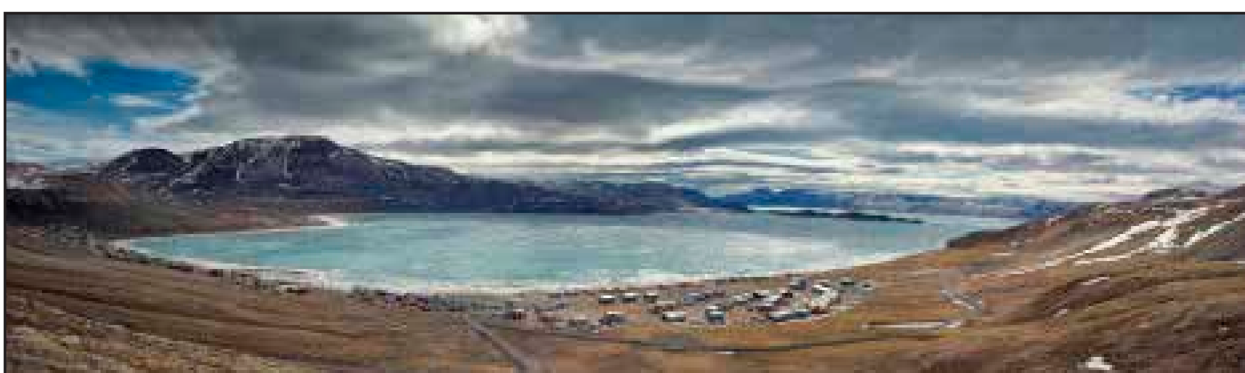


Figure 79: RADARSAT image from August 24, 2014, 12:25 UTC, showing stronger winds at the northern entrance to Admiralty Inlet due to channelling.

8.8.1.6 Arctic Bay

The hamlet of Arctic Bay is almost landlocked by the high hills that surround the waters of its bay. In the northern part of the Brodeur Peninsula, where the hamlet is located, mountains reach as high as 1300 m. Flat-topped King George V Mountain (at nearly 600-m high) dominates the view to the southeast of the community.



The community of Arctic Bay. Photo courtesy Government of Nunavut.

Residents of Arctic Bay report that, in the past, strong winds arrived gradually and nowadays seem to come on more quickly and without warning—and tend to last longer than they did before. Arctic Bay and Adams Sounds are often foggy.

Southeast and East Winds

Intense winds occur in a southeasterly flow due to the combination of a strong pressure gradient and channelling in Adams Sound and cornering around the edge of King George V Mountain. These intense winds are more marked at the higher elevations to the north and west of the community.

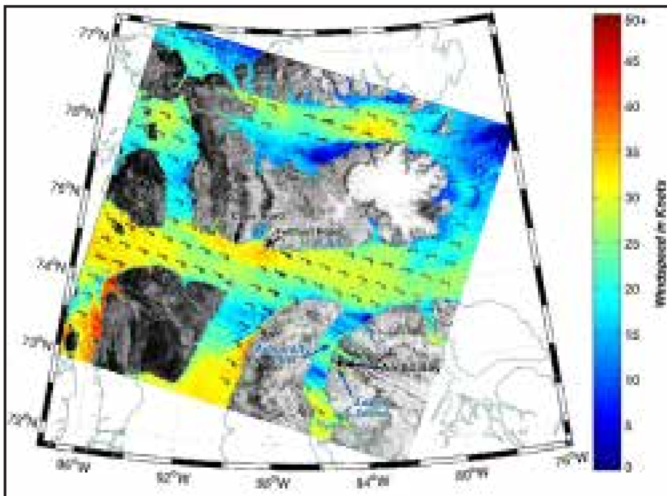


Figure 80: RADARSAT image from September 22, 2011.

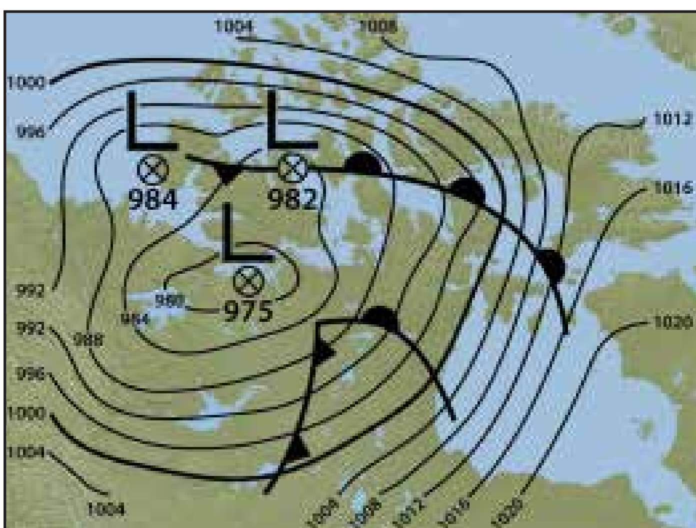


Figure 81: Surface analysis from September 22, 2011.

RADARSAT image (above) and surface analysis (below) taken on September 22, 2011. Strong southeasterly outflow winds were reported along the fiords on the eastern side of Admiralty Inlet, including Adams Sound, with the Arctic Bay weather station reporting southeast winds of 30 kt.

Northwest and West Winds

Northwest and west winds can be as strong as southeast winds due to the strong pressure gradient and channelling effect in Adams Sound.

Mariners' Tips:

Locals in Arctic Bay usually avoid going out to the sea if Adams Sound looks dark and threatening.

8.8.2 Waves, Tides and Currents, and Ice Conditions

8.8.2.1 Waves

The most damaging waves occur in a southwesterly flow due to the long fetch available. Fortunately, although Arctic Bay is open on its southwestern side, its southeastern side is protected by a long, narrow peninsula topped by Holly Cross Point. Much of the coastal erosion witnessed by residents of Arctic Bay has been attributed to strong southwesterlies that occur with storms in late summer or early fall, when the water is open.

8.8.2.2 Tides and Currents

The strongest high-tides occur in Admiralty Inlet during a full moon, especially around the summer solstice, with streams as strong as 4 kt. Tidal currents are also strong in the northern part of Easter Sound. In June, they can initiate the ice-breaking process.

Tides and winds affect ice movement, especially in narrow channels such as Adams Sound. Tidal currents in the sound are strong and can suddenly reverse, causing large chunks of ice to be grounded along its shores. Westerly winds blowing through the sound against the outgoing tide can also create an ice jam that blocks the entrance to Arctic Bay. Tidal rips have been reported off Holly Cross Point, and navigation can be difficult in Arctic Bay and Adams Sound when westerly or easterly winds oppose the tidal current.

The light, southward current that enters Admiralty Inlet from Lancaster Sound can be observed along the western coast of the Inlet. The strong, north-northeastward current that exits the inlet into Lancaster Sound is observed near the coast of Borden Peninsula.

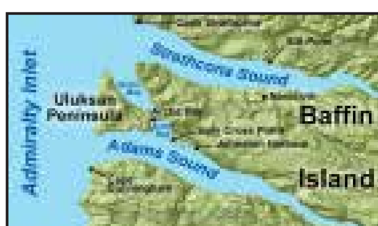


Figure 82: Adams Sound.

8.8.2.3 Ice Conditions

Ice in Arctic Bay normally breaks up in mid-July, with freeze-up early October. Admiralty Inlet is normally ice free from mid-August to early October; however, during bad ice years, only the northern part of the inlet is clear. Icebergs are often observed in the inlet. Adams Sound is reported to freeze over a few days later than Arctic Bay. West winds can pack the sound with ice pans, thereby blocking its entrance.

8.9 Navy Board Marine Region

Navy Board Inlet is a body of water that separates the western side of Bylot Island from Baffin Island. It stretches southward from Lancaster Sound to Eclipse Sound.

Figure 83: Local effects for the Navy Board Marine Region.

8.9.1 Winds and Weather

Winds in Navy Board Inlet are strongly dependent on its configuration and geographical position. Known for its accelerated winds, this narrow channel is aligned north to south, so winds from these directions are strongly influenced by channelling.

Figure 84: RADARSAT-derived wind roses for June, July, and August for the Navy Board Marine Region.

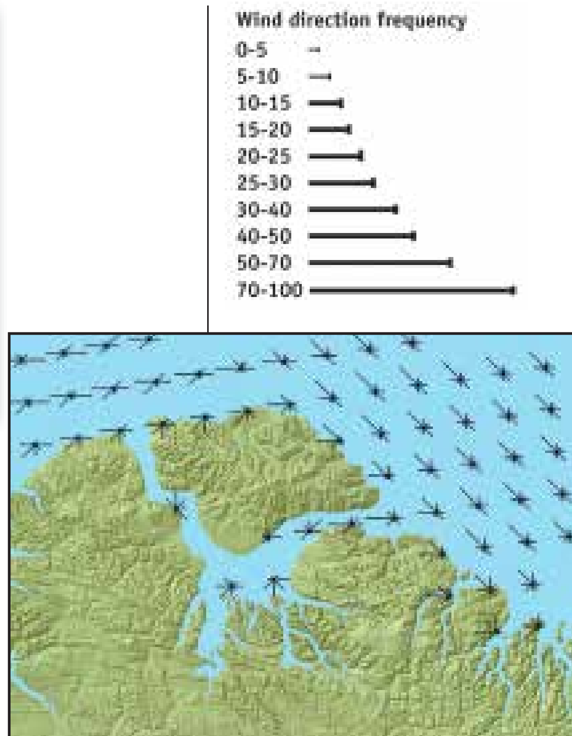


Figure 85: RADARSAT-derived wind roses for September, October, and November for the Navy Board Marine Region.

8.9.1.1 Northerly, Northeasterly, and Northwesterly Flow Pattern

Strong to gale-force winds are possible in the region when local effects are supported by an intense low-pressure system with a strong northerly, northeasterly, or northwesterly flow. Northerly winds can experience channelling and gap-wind effects in Navy Board Inlet, with speeds known to reach 25 kt inside the inlet, while light northeasterlies are flowing just beyond its entrance.

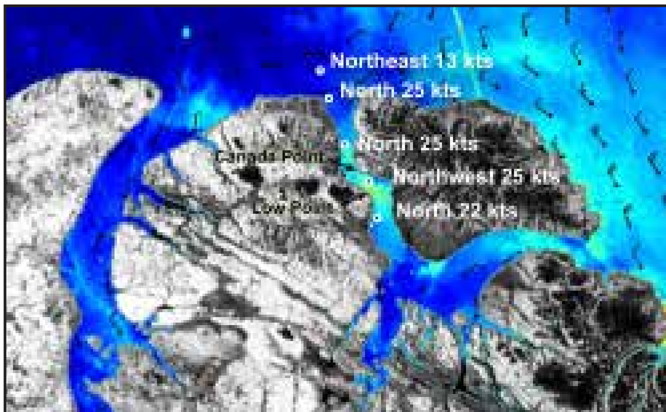


Figure 86: RADARSAT image from July 31, 2011.

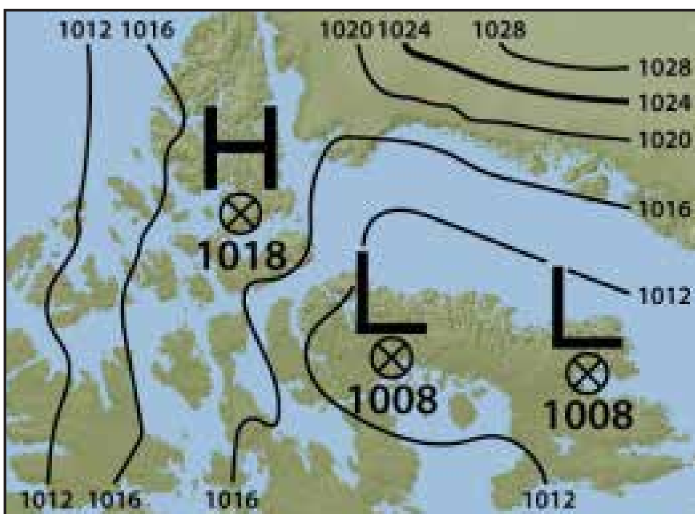


Figure 87: Surface analysis from August 1, 2011.

RADARSAT image (above) taken on July 31, 2011, and surface analysis (below) from August 1, 2011. Winds were enhanced between Canada Point and Low Point, in the middle of Navy Board channel. In addition to channelling, the winds were also increased by gap winds and coastal convergence, which occurs when north winds hit the coast north of Low Point and shift, converging with the winds over the water. The pressure difference between Devon and Bylot islands was nearly 10 mb.

8.9.1.2 Westerly and Easterly Flow Pattern

Navy Board Inlet is sheltered from west, southwest, east, and southeast winds, which may accelerate over Lancaster and Eclipse sounds but subside sharply over the inlet. Mariners should be careful when exiting Navy Board inlet into Lancaster Sound when light winds over the sound are easterly or westerly, as they can suddenly increase to moderate or strong. Tay Bay can offer protection from all winds and moving ice.

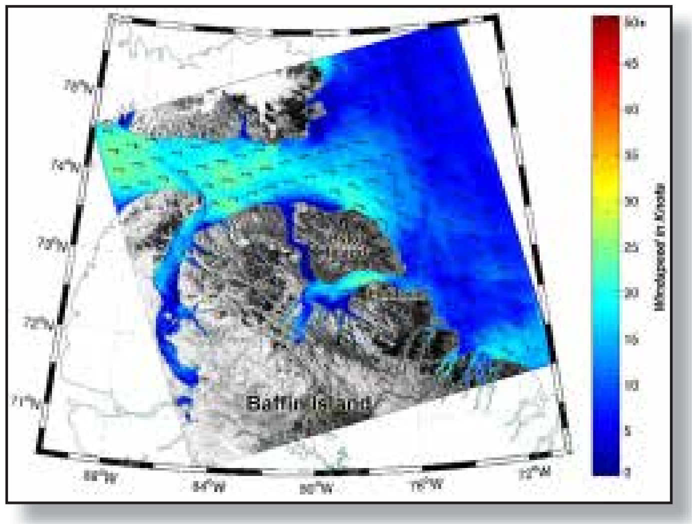


Figure 88: RADARSAT image from August 20, 2012, at 22:30 UTC.

Significant Event: August 11, 2012

"We manage to find more open water closer towards the eastern part of [Lancaster] Sound. The wind stays light and the water is without any swells. Fog comes down for shorter periods but never for long. As soon as we get out of the Navy Board Inlet the cold westerly winds blow right in our faces . . . We slalom through the ice for a while and get out in open water again, 25 kt of freezing winds blow right into our face." – Mark van de Weg, Skipper of the Jonathan III

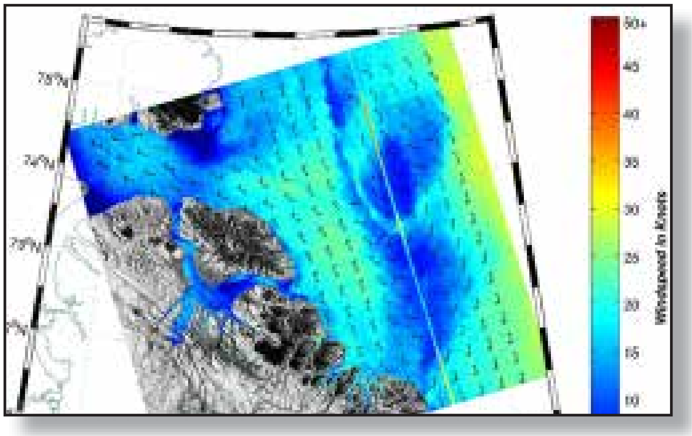


Figure 89: RADARSAT image from August 12, 2012.

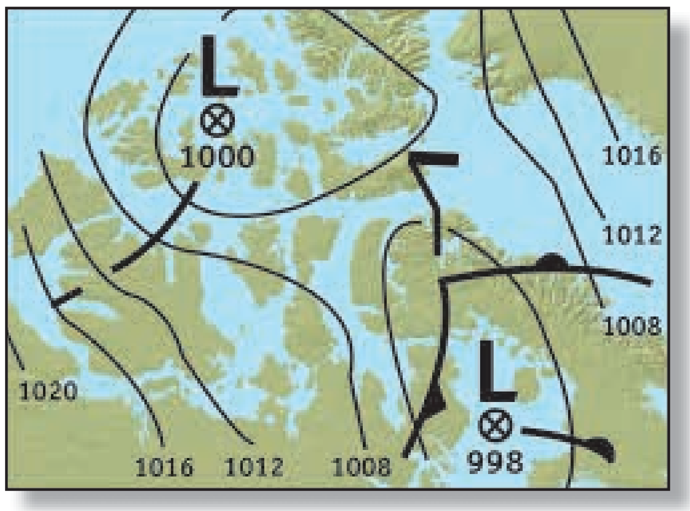


Figure 90: Surface analysis from August 12, 2012.

RADARSAT image (above) and surface analysis (below) from August 12, 2012.
While Navy Board Inlet was relatively calm, with only a slight wind increase noticeable at its exit point, mariners experienced westerly winds of 25 kt over Lancaster Sound.

8.9.2 Tides, Shoals, and Ice Conditions

8.9.2.1 Tides

Tidal streams are reported to create tidal rips in the vicinity of Wollaston Islands and across the northern entrance of Navy Board Inlet.

8.9.2.2 Shoals

Shoals are found northeast of Bluff Head.

8.9.2.3 Ice Conditions

Navy Board Inlet is normally ice free from late August to the end of September, but some ice may still be present. Ice remnants in the inlet can make passage challenging for small boats.

8.10 Pond Marine Region

The eastern part of the Pond Marine Region includes Eclipse Sound, the main marine transportation route to Bylot Island, Navy Board Inlet, and Borden Peninsula. The western part includes Pond Inlet. The sound is aligned west to east and connected at its western end to Navy Board Inlet.

Figure 91: Local effects for the Pond Marine Region.

8.10.1 Winds and Weather

As with many other regions in the area, the wind regime in the Pond Marine Region is determined by its geographical position, configuration, and topography. The northern coast of Eclipse Sound is marked by the glacial cliffs on southern Bylot Island, while the southeastern coast is occupied by mountains nearly 1500 m high. The southwestern coast of the sound is mostly uniform.

Powerful katabatic winds have been reported between Cape Khud Jordensen and Frechette Island.

8.10.1.1 Easterly, Southeasterly, and Southerly Flow Pattern

These flows can be produced by low-pressure systems tracking north over Hudson Bay and toward the east to southeast from the Arctic Ocean to Baffin Island. East, southeast, and south winds begin channelling when they enter the eastern end of Eclipse Sound. Easterly and southeasterly flows can grow to strong or gale-force, even when the synoptic flow is relatively weak, and usually turn northeast after Beloeil Island due to the shape of the channel. East winds cornering around the southeastern tip of Bylot Island (Cape Graham Moore) have been reported at 25 kt in a weak easterly flow.

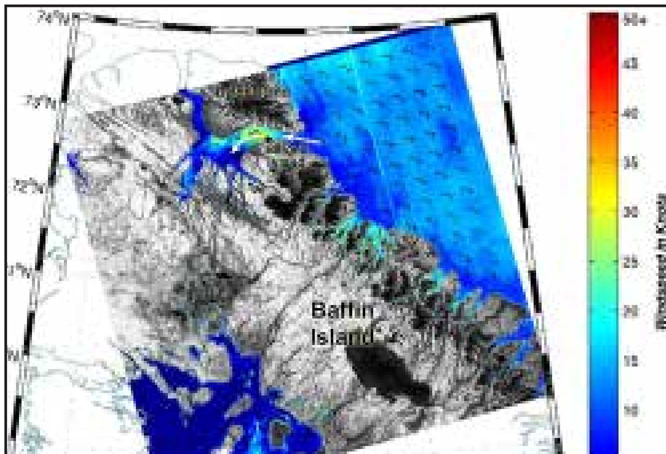


Figure 92: RADARSAT image from August 4, 2011, at 22:18 UTC. A relatively weak southerly flow produced bands of strong east winds in Eclipse Sound and east-northeast winds of near 20 kt in Pond Inlet, in the western part of the sound.

8.10.1.2 Westerly Flow Pattern

A westerly or northwesterly flow can often produce channelling and gap outflow winds at the mouth of Eclipse Sound. With this flow, winds corner around the southwestern tip of Bylot Island (Dufour Point).

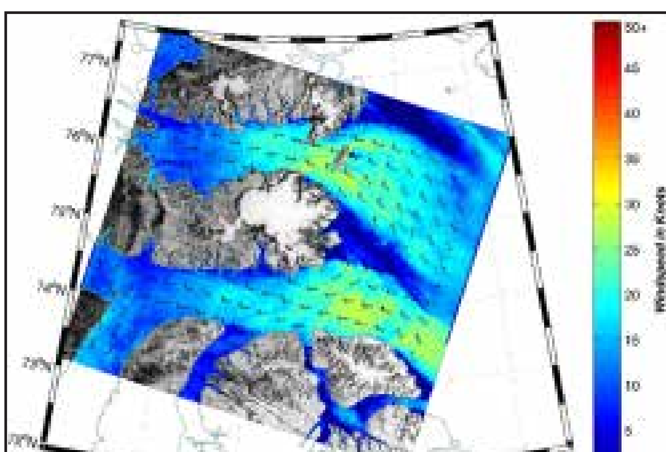


Figure 93: RADARSAT image from September 3, 2012, at 12:25 UTC, showing channelling and gap-outflow winds at the mouth of Eclipse Sound in a westerly or northwesterly flow.

8.10.1.3 Northerly and Northwesterly Flow Pattern

While north and northwest winds are channelling through Navy Board Inlet, they subside in Eclipse Sound.

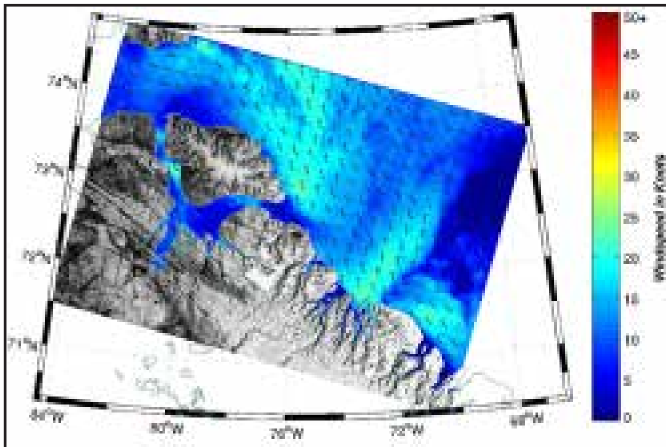
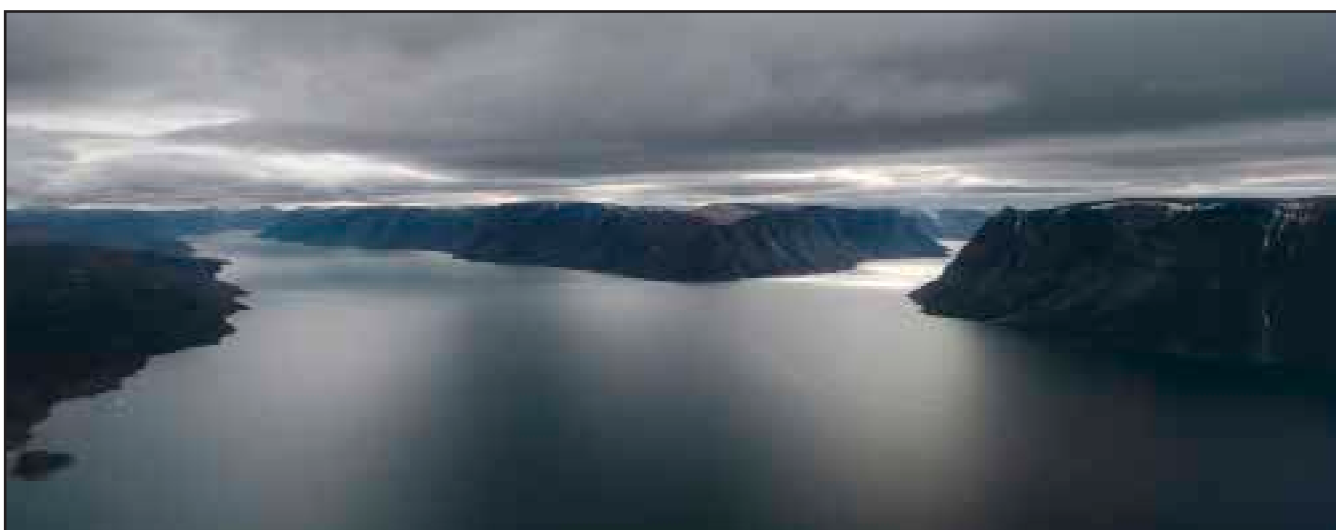


Figure 94: RADARSAT image from September 11, 2012, at 11:52 UTC. While north and northwest winds strengthen through Navy Board Inlet, they subside in Eclipse Sound.

The best shelter from all the winds can be found in Albert Harbour, which lies between Beloeil Harbour and the coast of Eclipse Sound.

8.10.1.4 Pond Inlet

The hamlet of Pond Inlet is located on the northern tip of Baffin Island, on the shore of Eclipse Sound.



The community of Pond Inlet. Photo courtesy Government of Nunavut.

Summers in the inlet feature 24 hours of sunshine from the beginning of May to the beginning of August and temperatures on land ranging from 5°C to 15°C. While fog can be a problem at the end of the summer, the fall is often very windy and more likely to experience rain or snow.

Pond Inlet's location places it near a major "graveyard" for storms in the Davis Strait-Baffin Bay areas. Although it does not generally experience significant winds from these storms (likely due to its surrounding topography), strong winds are possible in the rare instance when a low-pressure system to its south or southwest moves north. They can also occur when a low moves north from the Cambridge Bay area to west of Prince of Wales Island.

East and Northeast Winds
Strong winds and prevailing summer winds most often come from the east to northeast due to channelling and funneling effects. The strongest easterlies occur when the pressure is low or falling in Foxe Basin.

West and Southwest Winds
Winds occasionally blow from the west and southwest, but rarely with any strength.

North Winds
North winds are rare. Strong northerly flows can result in light southerly winds in Pond Inlet, most likely due to the eddy that forms when these flows channel through Navy Board Inlet and are reflected off the southwestern coast of Eclipse Sound.

8.10.2 Tides and Currents, and Ice and Icebergs

8.10.2.1 Tides and Currents
Tides and currents are strong and dynamic in Eclipse Sound. East and west winds can often oppose the tidal currents in the sound.

Tidal streams at Pond Inlet set eastward on the outgoing stream and westward on the ingoing stream at a rate about 2 kt.

8.10.2.2 Ice and Icebergs
Eclipse Sound is often covered by pack ice until mid-summer and can be frozen by mid-September, but freeze-up usually occurs in early October. Some icebergs become grounded in the shallow waters of the sound and can remain there for several years before floating into Baffin Bay.

The waters around Pond Inlet are usually free of ice from late August until late September, although drifting ice is a possible hazard year-round.

ARCTIC REGIONAL GUIDE PART 5: FOXE BASIN

9. Foxe Basin Marine Area

Foxe Basin is an extensive and shallow sea basin located north of Hudson Bay, between Baffin Island and the Melville Peninsula. It is bounded on its southern side by Southampton Island. Two channels lead to Foxe Basin from the south—Roes Welcome Sound and Foxe Channel—while the Fury and Hecla Strait enters the basin from the northwest.

This section provides information on local weather, wind, sea state, and ice conditions for four of the five marine regions in Foxe Basin, all of which are part of the Northern Marine Transportation Corridor: Roes Welcome, West Foxe, Igloolik, and Prince Charles.

Figure 1: The Foxe Basin Marine Area.

During the navigation season, low-pressure centers normally move into the basin from the northwest, west, and southwest, with those approaching from the southwest often stalling there. Centres of high pressure move slowly out of the region. In mid-summer, the mean pressure gradient over the basin is weak and the mean flow pattern is from the north to northeast. During September and October, the pressure gradient increases and the mean flow pattern backs to between northwest and north.

North and northwest winds prevail year round, although they are less frequent in mid-summer, when winds from other directions become almost as common. In the warmest months, land and sea breezes are evident along the coast. Gales are rarest in July and August but occur several days a month during September and October with strong northwest or east to northeast winds. Winds off the water can be quite chilly in July, while land breezes can be quite warm.

The mean temperature for the months of July and August is about 4°C, and the temperature on the surrounding coast can rise to above 16°C and drop to freezing at any time. In September, the mean temperature drops below 0°C and, by October, is already near -10°C.

Precipitation usually falls in the forms of rain in July and August, with snow becoming more common by the middle of September. The cold waters of Foxe Basin stabilize the atmosphere at low levels, inhibiting shower development (convection) in the area at summer time. Fog is most frequent in July and August and occurs when the winds are mainly south and southeast.

Mariners' Tips:
The dirty appearance of the ice in Foxe Basin is caused by bottom deposits picked up by the hundreds of square kilometres of pack ice that become grounded at low tide in the shoal water and tidal flats of the basin. During the early part of the navigation season, the extra dirt—which includes rock particles—does not affect the navigability of the ice pack. As more melting occurs, however, it becomes concentrated in the ice surrounding the particles due to the radiative heat they have absorbed. Ice floes become honey-combed and contain numerous isolated pockets of melt-water, making them least resistant to icebreakers in late August and early September.

Water in Foxe Basin generally flows in a counter-clockwise direction, sending a net flow south into Hudson Strait. A current flows from the north side of Hudson Strait around the Foxe Peninsula, then northward along the eastern shore of the basin, then southward along the western shore, before it flows back into Hudson Strait. A much stronger current exists in Foxe Basin due to the inflow of frigid water from the Gulf of Boothia through the narrow Fury and Hecla Strait and flows southward along the western coast into Hudson Bay. There, it joins the cyclonic circulation before exiting and merging with the southeast surface-flow along the south side of Hudson Strait.

9.1 Roes Welcome Marine Region

Roes Welcome Sound divides the mainland, to the west, from Southampton Island, to the east. Topographic features—including hills as high as 550 m on Melville Peninsula and further inland, to the southwest—determine local weather effects. The valleys between the hills create corridors that accelerate northwest and southeast winds. In addition, hills of about the same height on the northern parts of Southampton Island enhance channelling effect in Roes Welcome Sound.

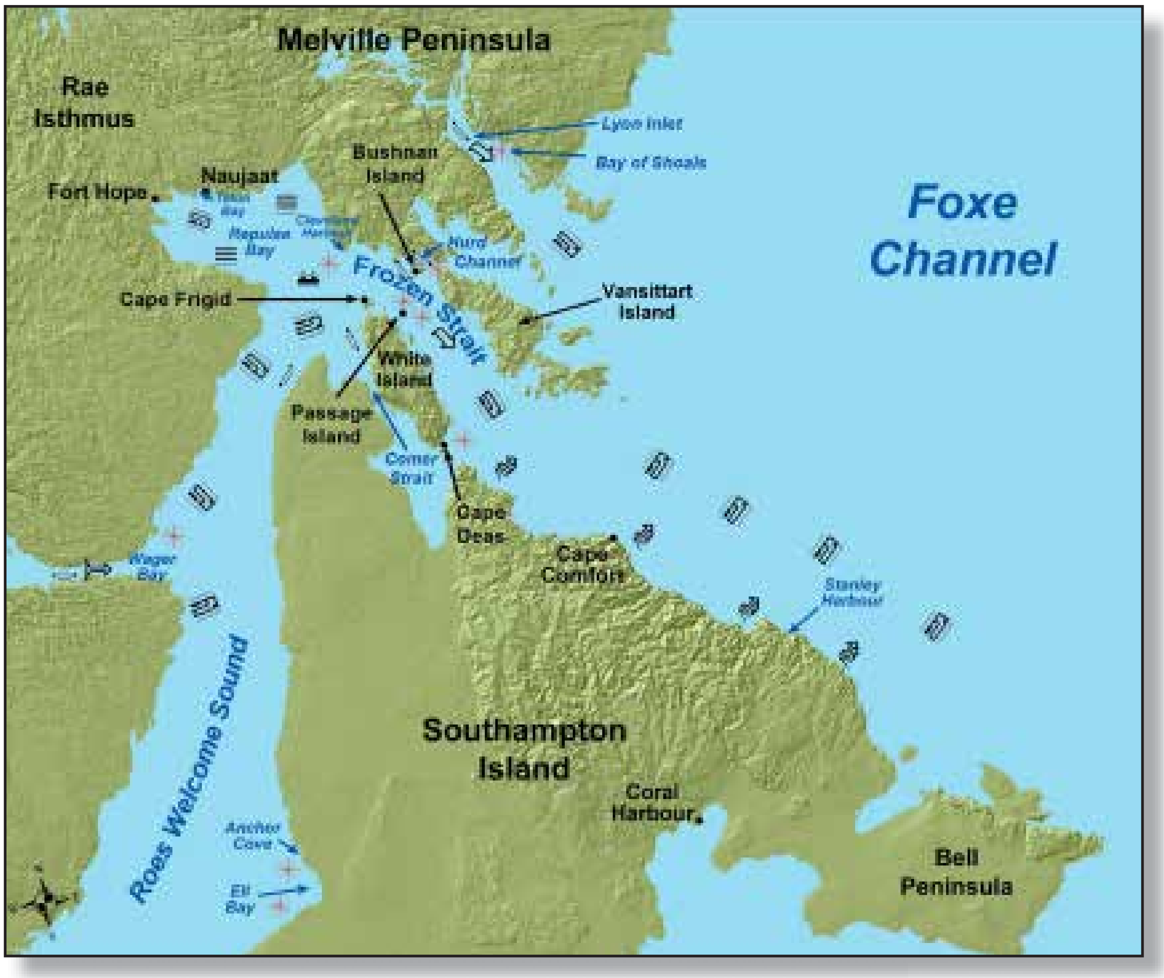


Figure 2: Local effects for the Roes Welcome Marine Region.

9.1.1 Winds and Weather

9.1.1.1 Northerly and Northwesterly Flow Pattern

This flow is usually generated behind storms that come from the west or southwest into Foxe Basin. The winds are stronger due to channelling by the local topography and also enhanced by a gap-wind effect due to synoptic forcing. Lee waves on a RADARSAT image indicate that wind speeds fluctuate downstream in certain atmospheric conditions.

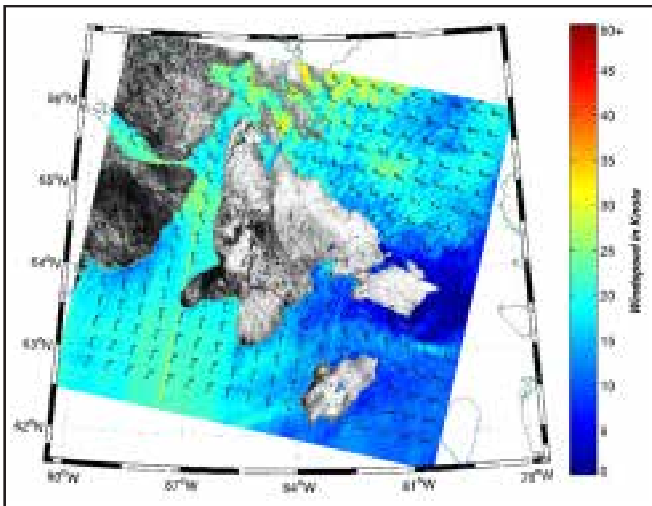


Figure 3: RADARSAT image from September 2, 2012.

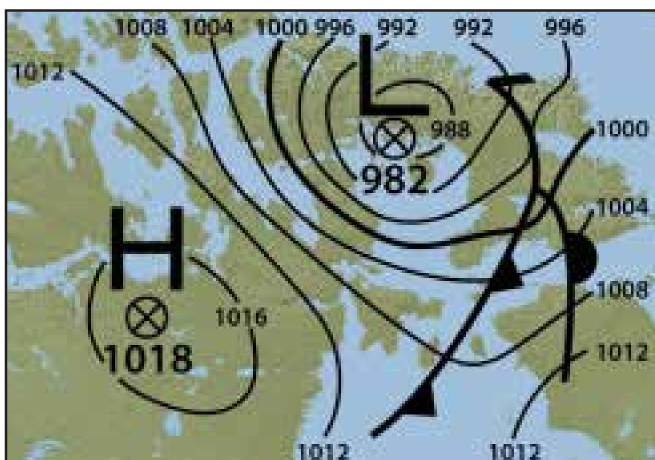


Figure 4: Surface analysis showing an intense low-pressure system on September 2, 2012.

RADARSAT image (above) and surface analysis (below) showing an intense low-pressure system on September 2, 2012, coming from the west and proceeding through the northern parts of the Foxe Basin Area. The high-pressure area was observed to the southwest of the low. The RADARSAT image shows lee waves (wavy pattern) across Roes Welcome Sound, northeast of Southampton Island, and in Wager Bay, Repulse Bay, Lyon Inlet, and Frozen Strait. Near gale-force winds occurred in Frozen Strait.

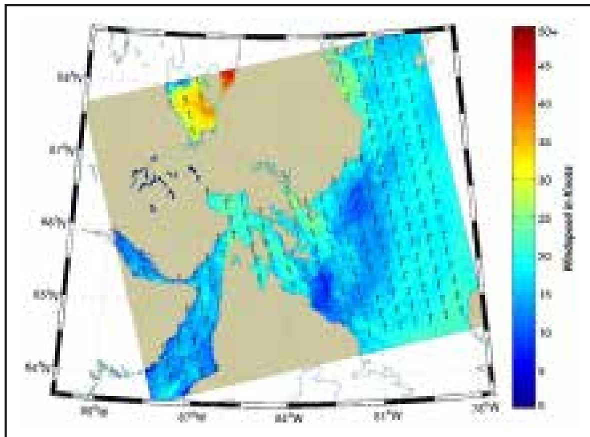


Figure 5: RADARSAT image from September 17, 2013.

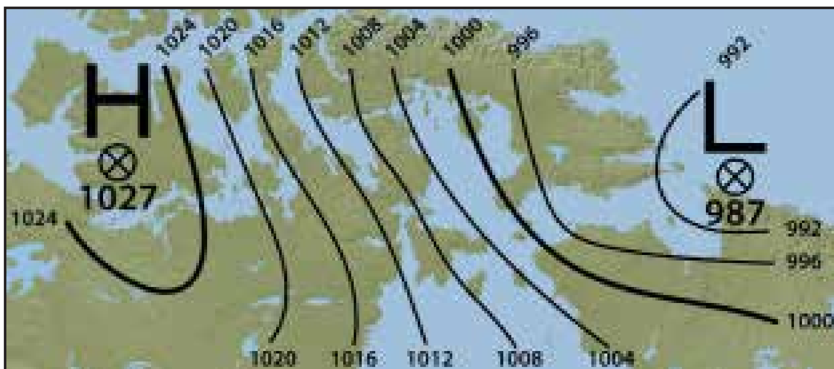


Figure 6: Surface analysis from September 18, 2013.

RADARSAT image (above) and surface analysis (below) from September 17 and 18, 2013, respectively, during a northerly flow pattern in which a low tracking south of Foxe Basin into Davis Strait generated moderate to strong winds in Repulse Bay, Frozen Strait, and Lyon Inlet. The winds were enhanced by channelling through the hills as well as a gap-wind effect. Repulse Bay reported strong north to northwest winds at speeds of 20-25 kt, gusting to 34 kt, for almost two days. The synoptic flow, however, was not very strong. The winds subsided when the high-pressure centre moved over the region.

Wager Bay, which can often be mistaken for a large river or strait, often sees northwesterly winds strengthen in its entrance due to enhanced funneling effects. Winds in the area can be 10 kt stronger than those experienced over the surrounding waters.

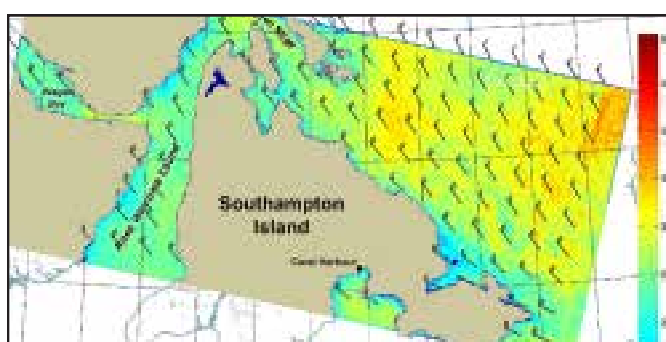


Figure 7: Larger-scale RADARSAT image showing an increase in the speed of northwest winds in the narrow entrance to Wager Bay.

9.1.1.2 Westerly and Southwesterly Flow Pattern

This flow is usually generated by low-pressure systems tracking eastward, southeastward, or to the north of the Roes Welcome Region. Southwesterly flow develops ahead of the low. In the case of a well-defined warm front , southwest winds develop ahead of the front and continue after its passage until the flow shifts to northwesterly or northerly. In a southwest flow, the higher elevations on Southampton Island, Melville Peninsula, and the mainland west of Roes Welcome Sound often result in the generation of lee waves, indicating fluctuating wind speeds along the water surface.

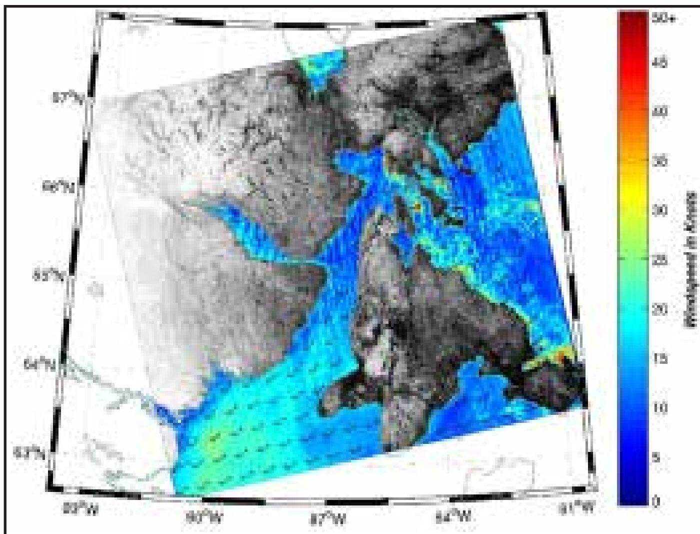


Figure 8: RADARSAT image from September 1, 2012.

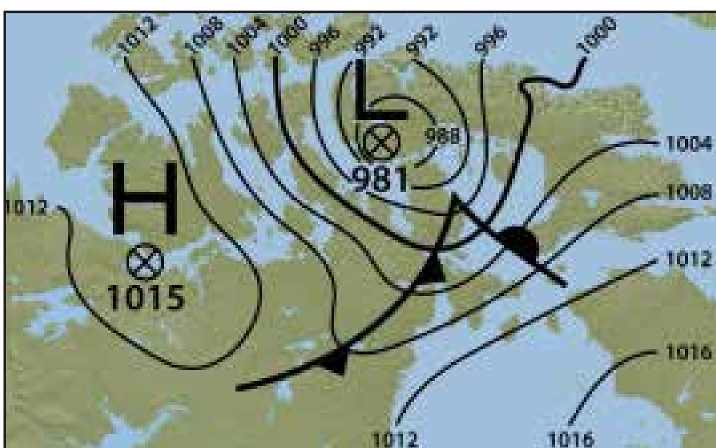


Figure 9: Surface analysis from September 2, 2012, 00 UTC.

RADARSAT image taken at 23:18 UTC, September 1, 2012 (above) and surface analysis taken the following day of 00 UTC, September 2, 2012 (below), after the passage of a cold front. Lee waves have developed almost everywhere in Roes Welcome Sound, Wager Bay, Repulse Bay, Frozen Strait, and Lyon Inlet and can spread even further into West Foxe Marine Region.

In a southwesterly flow, downslope winds can form along the northeast coast of Southampton Island. These winds are often 10 to 20 kt stronger than the synoptic flow and can sometimes reach gale-force.

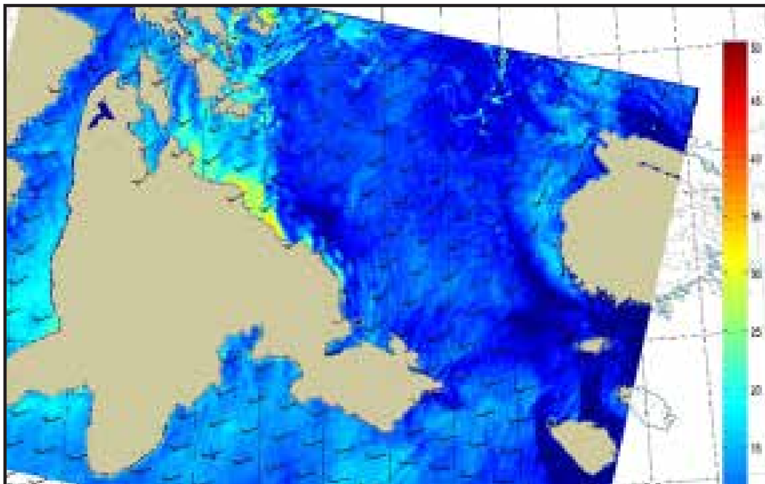


Figure 10: RADARSAT image from August 25, 2015.

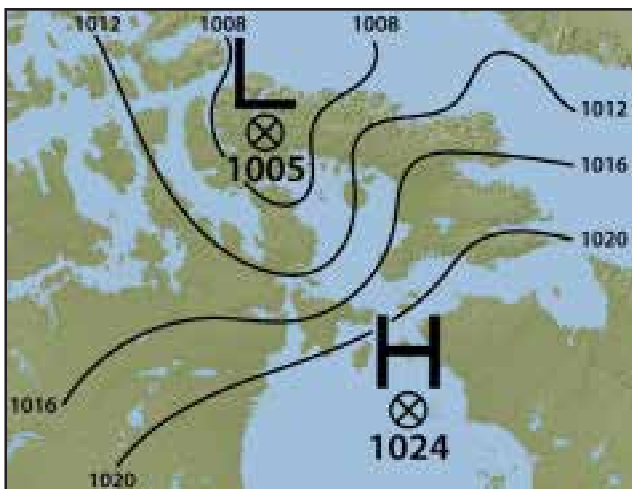


Figure 11: Surface analysis from August 25, 2015.

RADARSAT image (above) and surface analysis (below) from August 25, 2015, showing that, with a southerly or southwesterly flow, lee waves and strong downslope winds develop along the northern coast of Southampton Island.

9.1.2 Tides and Currents, Shoals, and Ice Conditions

9.1.2.1 Tides and Currents

The tidal currents in the narrows of Wager Bay are so powerful they can cause waterfalls to reverse and patches of the sea to remain open all year round. These open-water polynyas attract scores of beluga whales, narwhals, walruses, and seals.

Strong tidal currents are observed in northern part of Roes Welcome Sound, with tidal streams of 7 kt reported in Wager Bay Narrows, 3 kt in the northwest end of Frozen Strait near Cape Frigid, 6 kt near the eastern entrance to Hurd Channel, in Cormer Strait, and in the narrower parts of Lyon Inlet, and 4 kt near Bushnan Island. There are many whirlpools and eddies, mainly on the southern side of the sound, when the tidal stream is set strongly.

9.1.2.2 Shoals

Shoals are found along the coast of Southampton Island, from Cape Kendall to Anchor Cove; southeast of Tikilak Point, in Wager Bay; north of Wager Bay; near the entrance to Cleveland Harbour, in Repulse Bay; northeast and east of Passage Island; and near Cape Deas, in Comer Strait. There are dangerous rocks and shoals in the Bay of Shoals, in Lyon Inlet.

9.1.2.3 Ice Conditions

Roes Welcome Sound rarely freezes completely due to the strength of the tidal stream and is open for navigation from early August to the end of September. The same holds true for Wager Bay Narrows; however, moving ice can pose a serious hazard to navigation. Some years, Frozen Strait is open for navigation only in September and, in a very severe ice-season, may remain covered with drift ice throughout the summer.

9.1.3 Naujaat

The community of Naujaat (formerly known as Repulse Bay) is located on the Arctic Circle, on the northwest coast of Repulse Bay, in a fairly well sheltered harbour in Talun Bay.

9.1.3.1 Winds and Weather

A corridor of lowland stretching from northwest to southeast makes Naujaat vulnerable to northwest and southeast winds. Stronger winds are observed in the fall, when there is increased contrast between the air-mass temperature over the land and the water. This causes pressure systems in the area to become more intense.

Easterly or southeasterly onshore flows from areas of open water can bring sea smoke or freezing fog to the region—with freezing drizzle common in October under such conditions. Strong storms in the fall can generate rain, snow, and freezing precipitation. Overnight fog is often reported in early July.

North and Northwest Winds

These winds are the most dominant in Naujaat because the area often experiences high-pressure systems to its west and low-pressure systems to its east. A strong northerly flow pattern frequently results in strong northwest winds behind the low-pressure system due to wind channelling through the lowland corridor.

Southeast Winds
Southeast is another significant wind direction in Naujaat in the summer and fall. This flow can be strong and gusty due to a combination of sea breezes and channelling effects and usually occurs ahead of a low-pressure system, especially if it approaches from the west and flows over warmer surface waters. With easterly or southeasterly winds, vessels can quickly get into danger in Talun Bay.

9.1.3.2 Waves and Ice Conditions

Waves
Rough seas can develop near Naujaat, especially with south winds.

Ice Conditions
Talun Bay is usually clear of ice by late July and begins to freeze up again at the end of September. Repulse Bay is typically navigable from early August to late September, although persistent southeast or east winds may block it with ice from Frozen Strait.

A nice day in Foxe Basin. Photo courtesy of Nicolas Peissel.

9.2 West Foxe Marine Region

The West Foxe Basin Marine Region includes Foxe Channel and the southwestern quadrants of Foxe Basin. Foxe Channel lies between Southampton Island, to the southwest, and Foxe Peninsula (off Baffin Island), to the northeast.

Figure 12: Local effects for the West Foxe Marine Region.

9.2.1 Winds and Weather

Storms are less common in this region—as they are in all of Foxe Basin—in summer. Winds from the north and northwest prevail, and gales are most frequent from the northwest and northeast. Strong storms occasionally occur in August and early September during the ice-free period, but the average annual sea-wave energy is low.

Fog is most likely to occur with winds from the south and southeast. Precipitation falls mainly as rain in July and August but usually turns to snow by mid-September.

9.2.1.1 Northeasterly and Easterly Flow Pattern

The rugged hills along the southwest coast of the Foxe Peninsula rise to some 360 m, creating a protective shadow from northeasterly or easterly flows on the lee side of the peninsula, in Foxe Channel. As a result, winds can be 5 to 10 kt lighter than they are elsewhere in the Foxe Channel.

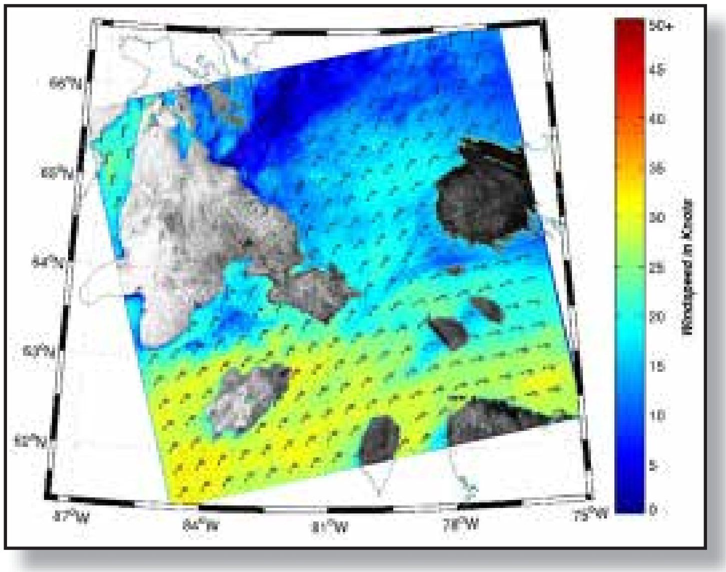


Figure 13: RADARSAT image from September 12, 2012.

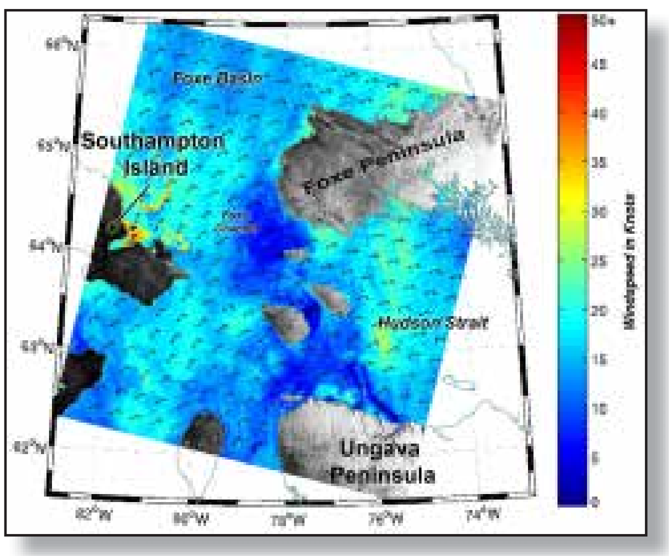


Figure 14: RADARSAT image from August 23, 2011.

RADARSAT images from September 12, 2012, and August 23, 2011, showing an area of lighter winds on the lee side of the Foxe Peninsula, where northeasterly and easterly flows experience something similar to an “island effect”.

9.2.1.2 Southerly Flow Pattern

Strong southerly winds can be generated ahead of a low-pressure system moving from the southwest towards Foxe Basin. This flow, which is associated with the approach of a warm front, can be especially strong if the high-pressure system to the east is well defined. Southerly winds flowing through Foxe Channel experience some channelling between Foxe Peninsula and Southampton Island.

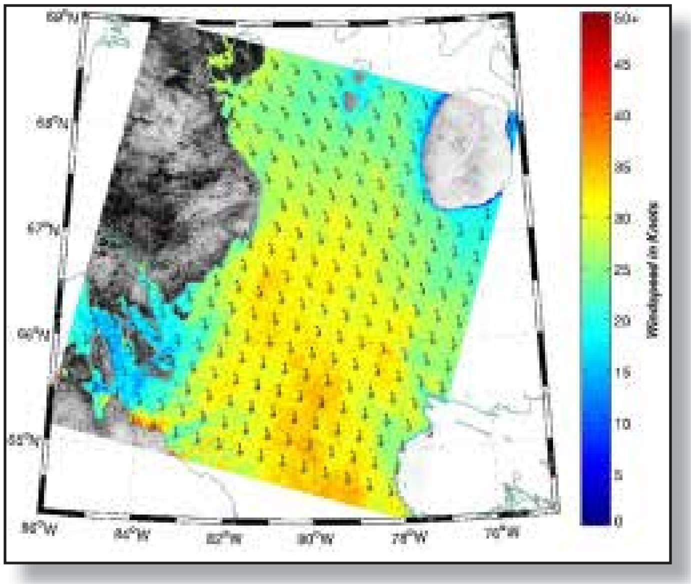


Figure 15: Radarsat derived winds from September 27, 2011.

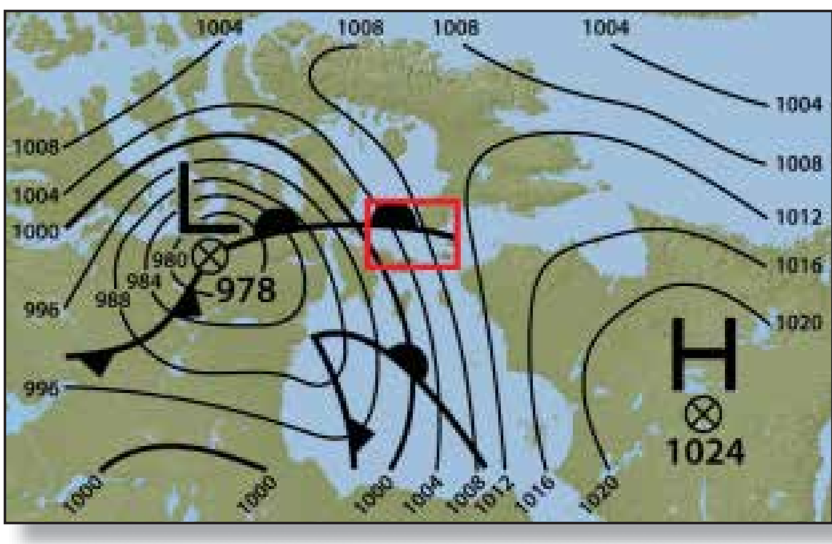


Figure 16: Surface analysis from September 27, 2011.

RADARSAT image (above) and surface analysis (below) from September 27, 2011, indicating the development of strong to gale-force winds over Foxe Channel, most likely enhanced by channelling and a gap-wind effect.

9.2.1.3 Northerly and Northwesterly Flow Pattern

The strongest and most common flow over Foxe Basin is northwesterly, especially during the coldest months of the year. It is often generated behind low-pressure systems moving from the west, northwest, and southwest that slow down over the basin. An intense northerly and northwesterly synoptic flow can generate strong to gale-force winds in the region, especially if it is followed by a high-pressure system. These winds can also be enhanced by gap-wind effects along the fiords and inlets off the coast of the basin. The strength of the Mackenzie Valley High and the Baffin Island–Davis Strait Low determines the strength of the flow and the weather in the Foxe Basin region.

Mariners' Tips:
The combination of a low-pressure system following a high-pressure system often creates strong pressure gradients that lead to stormy weather and rough seas.

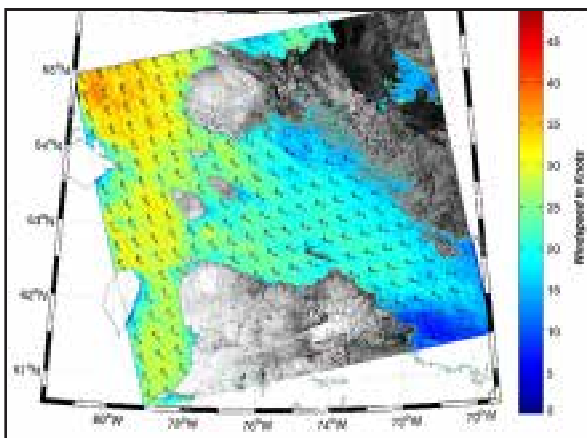


Figure 17: Radarsat derived winds from September 29, 2011.

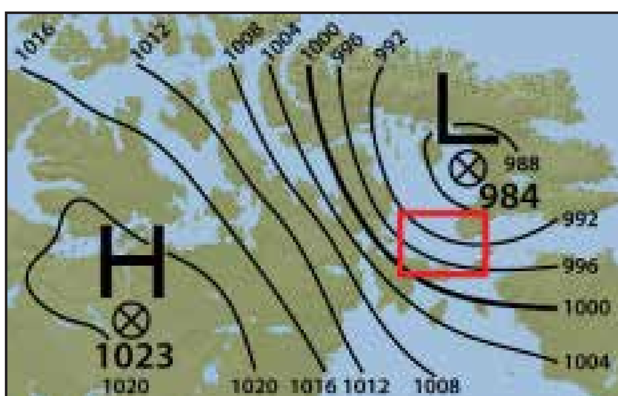


Figure 18: Surface analysis from September 29, 2011.

RADARSAT image (above) and surface analysis (below) from September 29, 2011, showing a northerly to northwesterly flow pattern.

9.2.2 Tides and Currents, Shoals, and Ice Conditions

9.2.2.1 Tides and Currents

Tidal streams generally run parallel to the coast of Foxe Basin and, in some places, can be as strong as 6 kt. They have been reported at 5 kt, set north and south, off the west coast of Foxe Peninsula up to and near Lloyd Point and at 4 kt south of Winter island (off Melville Peninsula). Strong eddies and tidal rips have been reported along the Foxe Peninsula, including near Cape Dorchester and inshore of the Trinity Islands.

9.2.2.2 Shoals

There are shoals near Cape Enauolik (northwest coast of Foxe Peninsula).

9.2.2.3 Ice Conditions

Ice conditions in Foxe Channel may vary considerably from year to year; however, it is normally navigable by ice-strengthened vessels from late August to mid-October. The strong current along its southwestern side (the northeast coast of Southampton Island) keeps much of the ice close to the shore throughout the summer—in particular, along Bell Peninsula (southeast part of Southampton Island) and near Cape Comfort (northeast coast of Southampton Island). If they blow continually for several days, strong westerly or southwesterly winds will push the ice off the coast, creating an inshore lead several miles wide. When they die down, however, it will drift slowly back to shore, becoming packed against it when a northerly or easterly wind starts to blow. Southerly winds push ice into Lyon Inlet, while north winds push it out.

Typical shoreline in Foxe Basin. Photo courtesy of Nicolas Peissel.

9.3 Igloolik Marine Region

The Igloolik Marine Region comprises northwestern quadrants of Foxe Basin, including the communities of Igloolik and Hall Beach. Fury and Hecla Strait—a narrow channel of water ranging from 1 to 20 km in width—belongs to this region as well. The strait separates the mainland (Melville Peninsula) from Baffin Island and connects Foxe Basin to the Gulf of Boothia. Its narrowest point is at Labrador Narrows, midway along its length.

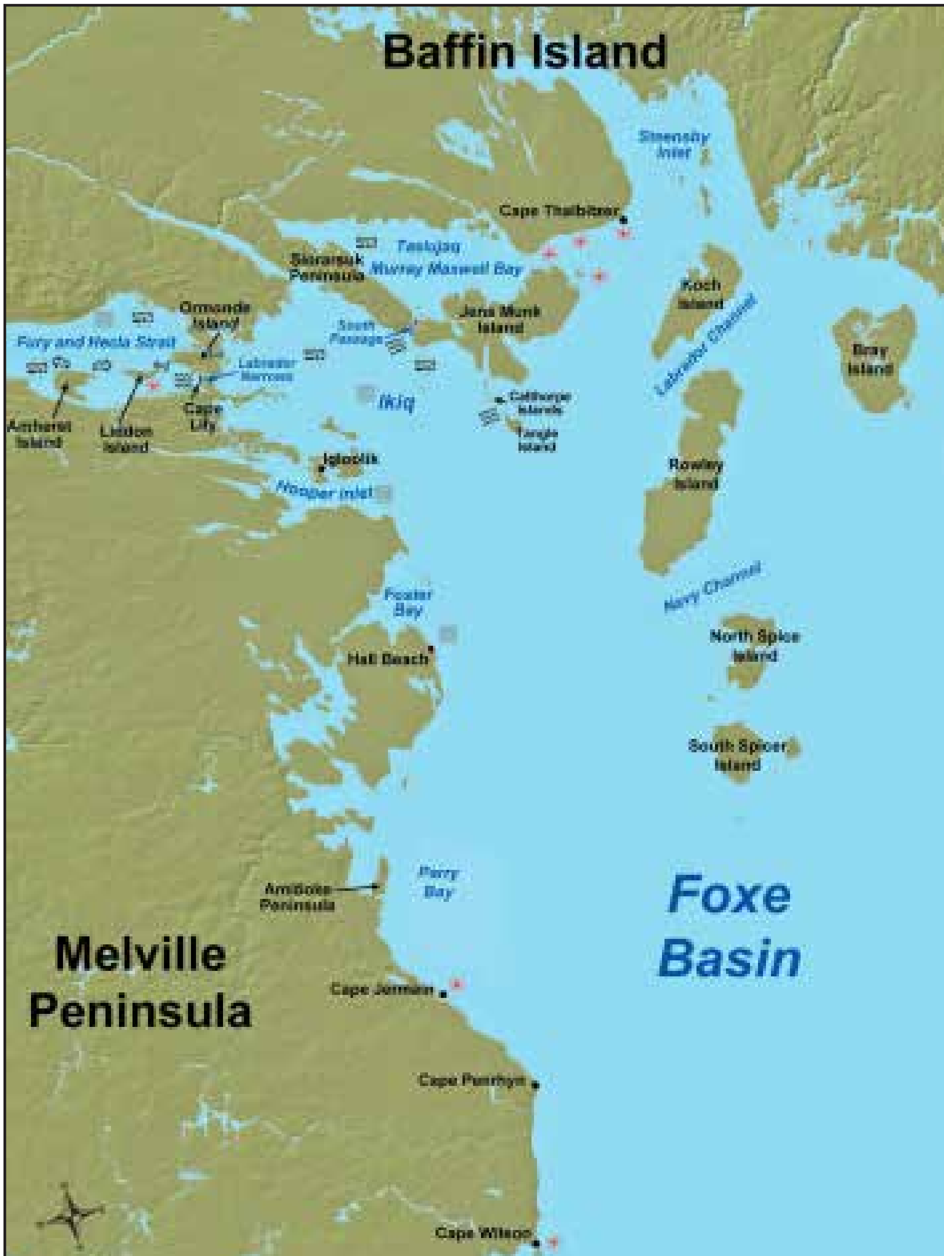


Figure 19: Local effects for the Igloolik Marine Region.

9.3.1 Winds and Weather

Only a few local effects are described in this chapter due to a lack of observations. Winds throughout the year are predominately from the north and northwest and less common from the south and southwest. The coastal topography of Fury and Hecla Strait generates some local effects in this part of Foxe Basin.

May and June, while often clear and sunny, frequently experience sudden snowstorms. July and August are usually overcast and sometimes foggy. May and October see the most precipitation.

> **Did You Know?**
> Bowhead whales can often be observed on their summer migration in Fury and Hecla Strait.

9.3.1.1 North and Northwesterly Flow Pattern

RADARSAT imagery often reveals lee waves in and downstream of Fury and Hecla Strait in a northerly or northwesterly flow. The waves, which are most likely generated by the high (up to 580 m) mountains on the Baffin Island coast, along the northern side of the strait, sometimes spread into Foxe Basin.

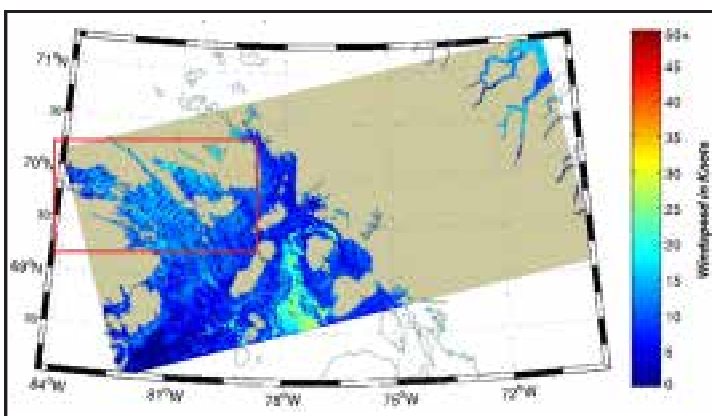


Figure 20: RADARSAT imagery from August 15, 2013, showing lee waves in Fury and Hecla Strait in a northerly or northwesterly flow spreading into Foxe Basin.

With a northwesterly flow, channelling and gap winds often occur—the strongest in the narrowest parts of the strait and along the eastern waterways into Foxe Basin.

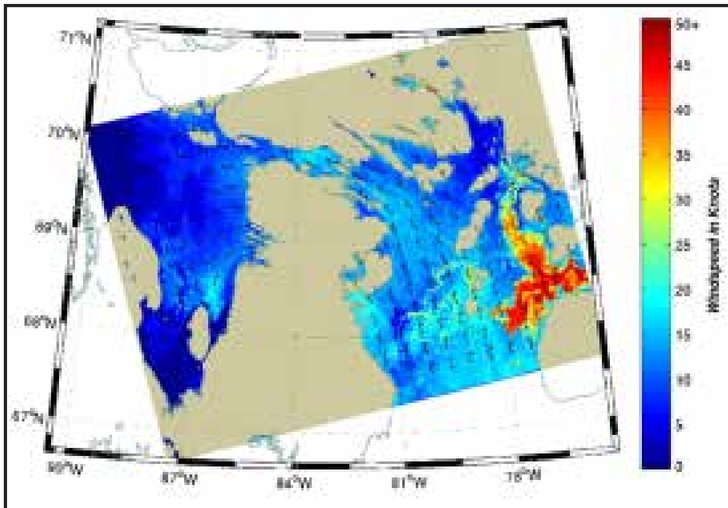


Figure 21: RADARSAT image showing a funneling effect in the narrowest parts of Fury and Hecla Strait, along with some lee waves, produced by a northwesterly flow.

9.3.1.2 Easterly to Southeasterly Flow Pattern

Southeasterly flows accelerate the same way northwesterlies do in Fury and Hecla Strait due to funneling, channelling, and gap-wind effects. Winds in the strait can be 5 to 10 kt stronger, especially near the exit into the Gulf of Boothia.

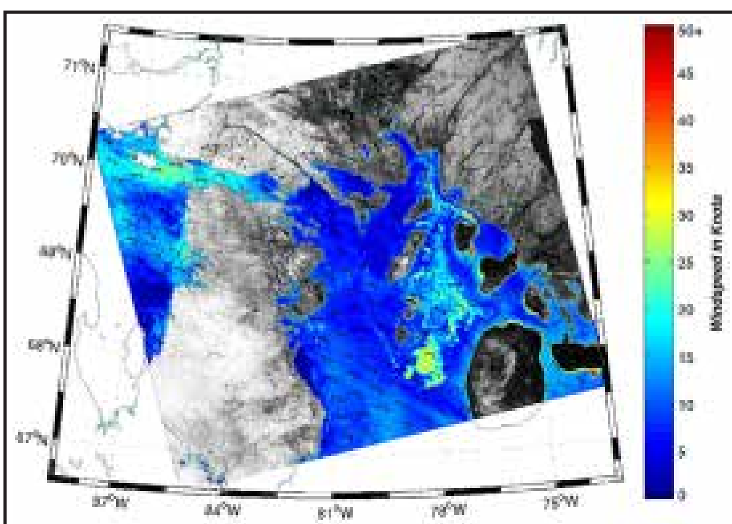


Figure 22: RADARSAT images from August 22, 2011, at 22:45 UTC, showing accelerated winds in Fury and Hecla Strait—especially at its exit to the Gulf of Boothia—during a southeasterly flow.

9.3.2 Tides and Currents, Shoals, and Ice Conditions

9.3.2.1 Tides and Currents

The permanent, east-flowing current in Fury and Hecla Strait is so strong that any west-flowing tidal stream is not always perceptible. In the wider part of the strait, it can vary in direction and often flows across the waterway. The rate of the current is up to 2 kt in this area but much stronger in Labrador Narrows, and 3 kt off Cape Penrhyn (midway along the west coast of Foxe Basin). Tidal currents of up to 7 kt cause dangerous tidal rips in South Passage. Strong tidal rips also occur near Tangle Island, due to an underwater ridge, and off Cape Lily.

9.3.2.2 Shoals

There are shoals southeast of Cape Wilson, along the coast between Cape Thalbitzer and the east entrance to Murray Maxwell Bay, southeast of Cape Jermain, and south of Liddon Island.

9.3.2.3 Ice Conditions

Foxe Basin is rarely ice-free until September, and freeze-up typically begins in mid- to late October. In recent years, however, there has been a shift towards earlier spring break-up and later freeze-up. Strong winds from the north or west can clear the ice in the northern parts of the basin.

Fury and Hecla Strait is normally navigable from mid-August to early October; however, much heavier ice conditions in the Gulf of Boothia often prevent navigation through the strait. Both in the strait and its adjacent seas, light ice conditions are associated with southeast or east winds in July, August, and September; however, with northwest winds, heavy ice conditions can develop.

Low stratocumulus cloud over water. Photo courtesy of Nicolas Peissel.

9.3.3 Igloolik

Igloolik is located on a small island of the same name, near the eastern entry to Fury and Hecla Strait, in Foxe Basin.

The community of Igloolik. Photo courtesy of the Government of Nunavut.

9.3.3.1 Winds and Weather

Northwest Winds

Northwest winds dominate in the summer and fall and can become quite strong during the latter season. They tend to be lighter at Igloolik than they are at Hall Beach due to the sheltering effect of the high terrain.

Northeast Winds

Northeast winds blow on shore and are likely to bring fog, low cloud, or rain.

Southeast Winds

Southeast winds can occur in the summer but are less common in the fall. These onshore winds can also bring fog, low cloud, or rain to the area, with fog persisting until the flow shifts to northwest (offshore). Southeasterly sea breezes in the summer are relatively light. In the late fall and early winter, this flow can bring streamers or snow squalls. Southeast winds also blow ice inland, making sea travel more difficult.

East Winds

East winds are not as common overall but are strong as often as northwest winds, especially in late fall. This is probably due to the instability of the air as it passes over the relatively warm water.

Southwest Winds

This flow is rarely strong due to the sheltering effect of the higher terrain.

9.3.3.2 Ice conditions

Ice break-up around Igloolik Island usually occurs in late July or early August. The subsequent open-water season lasts until mid-October.

9.3.4 Hall Beach

Hall Beach is located approximately 70 km south of Igloolik, along the west coast of Foxe Basin. It is a spectacular place to see walruses, seals, waterfowl, and other wildlife.

Shoreline near the community of Hall Beach. Photo courtesy of the Government of Nunavut.

9.3.4.1 Winds and Weather

Freezing precipitation occurs infrequently but when it does, it is usually between late May and mid-June or in October.

Northwest Winds

These winds are the most common and strongest in the area and happen most often in the fall. They occur after the passage of a low-pressure system that moves to the east or northeast of the site.

Southeast Winds

Southeast winds can also be quite strong and occur when lows are southwest to west of the community. Fog is associated with a southeasterly (onshore) flow, while rain or snow are generated by strong southeast winds. Streamers or snow squalls are possible in late fall, if the winds are from the east or southeast. Southeast winds also stir up the largest waves because they have the longest ice-free fetch.

South, East, and Northeast

Winds from these directions can, on occasion, be very strong. Since they are also onshore winds, strong flows can bring fog, rain, or snow to the area.

9.3.4.2 Waves, Tides, and Ice Conditions

Waves

Local residents report a recent increase in wave energy—both offshore and in the intertidal zone—likely due to an increase in the frequency and severity of high winds, coupled with shorter seasonal ice-coverage.

Significant Event: September 24-26, 2008

Winds were blowing from the southeast at over 20 kt for nearly 20 hours, generating waves of up to 2 m in height. They peaked at 32 kt from the northeast on September 26, 2008, at 01:00 UTC, around the same time that a significant wave height of 3 m was recorded. A few hours later, the winds shifted northerly and then westerly, dropping in strength back down to 20 kt. The waves followed the direction of the winds, diminishing rapidly when they turned westerly.

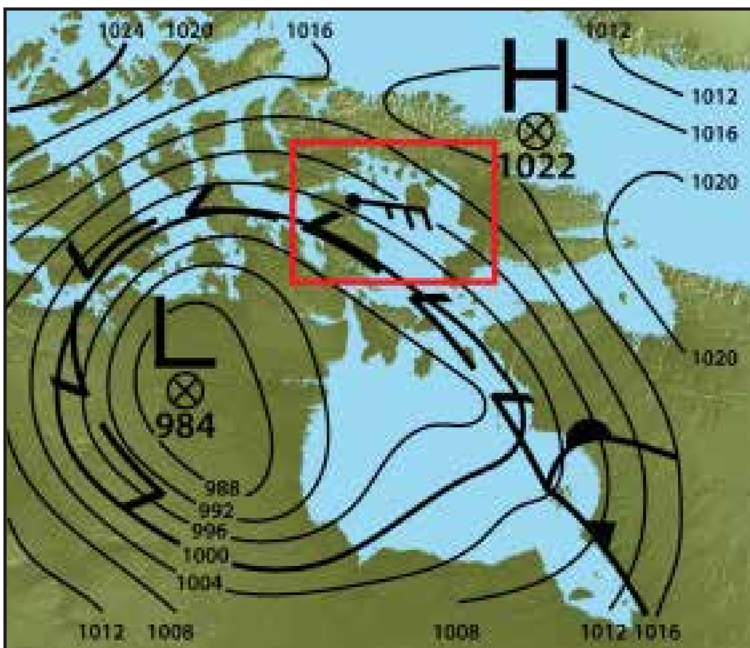


Figure 23: Surface analysis from September 25, 2008, showing a strong southeasterly flow over Foxe Basin. Measurements were taken within 500 to 1000 m east of the shoreline at Hall Beach. Ice coverage in the basin at the time was minimal (less than 1/10).

Tides

The tidal current near Hall Beach is 3 kt.

Ice Conditions

Break-up typically occurs in mid-June and freeze-up, in late October.

9.4 Prince Charles Marine Region

This region covers the northeastern parts of Foxe Basin. Not much navigation occurs in this area, except by local boats.

Figure 24: Local effects for the Prince Charles Marine Region.

9.4.1 Winds and Weather

Observations from the weather station at Longstaff Bluff (on the coast, southeast of Baird Peninsula) indicate that easterly winds predominate in the area year round. The second-most common winds are from the west and northwest, possibly due to the development of a very weak anticyclone over the cold waters of Foxe Basin during the late spring, summer, and early fall months. The sea breeze also adds to this effect, contributing to a light onshore flow. Northeast winds at the bluff could be associated with katabatic flow from the Barnes Ice Cap.

9.4.2 Shoals and Ice Conditions

9.4.2.1 Shoals

There are shoals between Prince Charles Island and Foley Island, south of Kotuko Point.

9.4.2.2 Ice Conditions

These waters are often filled with large chunks of ice during the summer season, making navigation very difficult.

Typical foggy day in Foxe Basin. Photo courtesy of Nicolas Peissel.

ARCTIC REGIONAL GUIDE PART 6: HUDSON STRAIT

10. Hudson Strait Marine Area

Nearly 850 km in length, Hudson Strait lies between Baffin Island and the Ungava Peninsula of Northern Quebec. Characterized by high, rugged shores and numerous islands, bays, inlets, and fiords, the strait presents a formidable challenge to mariners.

This section provides information on local weather, wind, sea state, and ice conditions for the three marine regions in the Hudson Strait Marine Area: Resolution, Ungava, and Nottingham.

Figure 1: The Hudson Strait Marine Area.

Hudson Strait is windy, cloudy, and cold, with strong storms affecting the area from a variety of tracks, especially during the fall and winter months. Lows moving north into Baffin Bay from the Labrador Sea and Quebec can bring strong winds and heavy precipitation from southern areas where heat and moisture abound. A number of storms come from the west or northwest and move across the Arctic Islands or the northern mainland—some heading southeast and stalling over Foxe Basin or Hudson Bay—while some move northeast from the Prairies. Storm centres tend to gravitate toward the Hudson and Davis straits, increasing the possibility of strong winds at any time of the year.

Although they can also occur in summer, gales are most common in the fall and spring, most often affecting the eastern and central parts of the strait due to the increased frequency of low-pressure systems passing through the area. Easterly gales typically occur with the approach of such systems and westerlies, with their passage. In late October and beyond, Atlantic storms are sometimes forced from their normal tracks and head north into the area, bringing sustained hurricane-force winds at speeds of over 100 kt, predominantly from the northeast.

Hudson Strait is prone to channelling, lee waves, and downslope winds due to its steep coastal topography, with prevailing wind directions being northwesterly or southeasterly, along its axis. Northwesterlies become more frequent in late September and October. Winds from the north and south can generate lee waves that spread for many kilometres and downslope winds at various locations along the strait. Sea breezes are common in July.

Precipitation in the strait usually falls as light rain or drizzle in July and August, although showers or thundershowers sometimes occur, with the first snowfall typically happening in September. Fog occurs most often with winds from the east and southeast, especially during periods of precipitation, but becomes less frequent as summer advances into fall. While it is often of short duration, it is persistent in Hudson Strait—in particular, over its eastern end, due to the proximity of the open waters of the Labrador Sea and southern Davis Strait. Visibility is good with west and north winds but can be reduced to just a few metres late in the season due to snow. Winds from the northwest cause variable visibility in such conditions.

The cold Canadian Current keeps the water temperature just above freezing for most of the navigation season. Hudson Strait has strong tidal streams, which are set northwest/southeast, except for the inflow into Ungava Bay. These streams usually mask its currents, which flow northwestward along the coast of Baffin Island and southeastward along the Québec coast.

Low tide. Photo courtesy of Nicolas Peissel.

10.1 Resolution Marine Region

The Resolution Marine Region encompasses parts of eastern Hudson Strait, including the communities of Kimmirut, on its northern coast, and Kangiqsujuaq and Quaqtaq, on its southern coast. Several large Islands lie in the extreme northeastern section of the region, just south of the entrance to Frobisher Bay: Resolution Island (the largest in the area), the Lower Savage Islands, and Edgell Island.

Figure 2: Local effects for the Resolution Marine Region.

10.1.1 Winds and Weather

10.1.1.1 Northerly and Northeasterly Flow Patterns

A northerly or northeasterly flow generates local wind effects in the waters of Gabriel Strait, Annapolis Strait, and around Resolution Island. Lee waves are generated in the southern part of Frobisher Bay by northeast winds over the extreme southeast coast of Meta Incognita Peninsula, in Hudson Strait. Downslope winds can be generated in the same area, near the coastline, by the same flow.

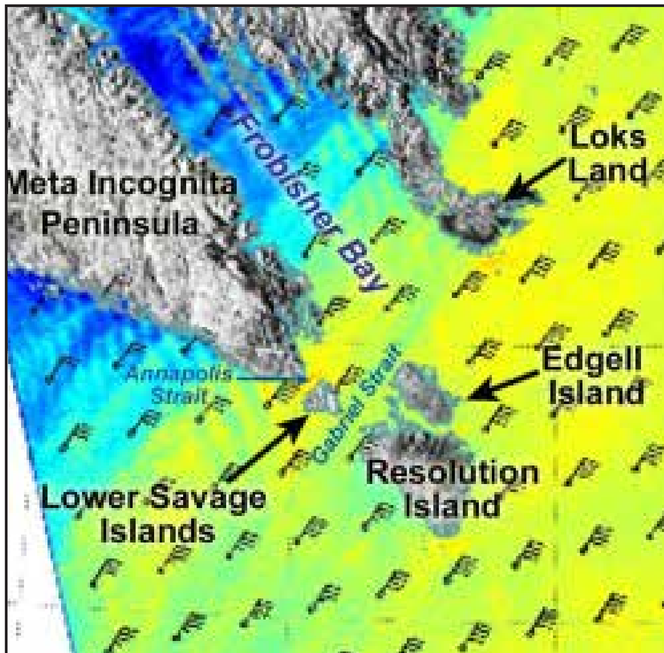


Figure 3: Local wind effects in the vicinity of the Meta Incognita Peninsula and Resolution Island.

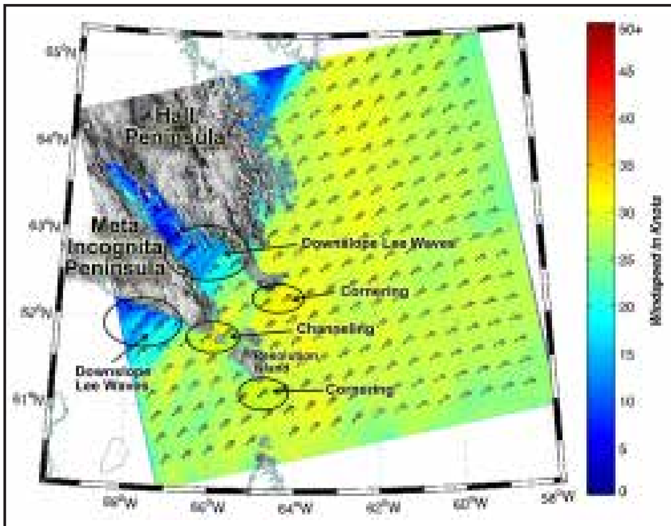


Figure 4: RADARSAT image from October 22, 2012.

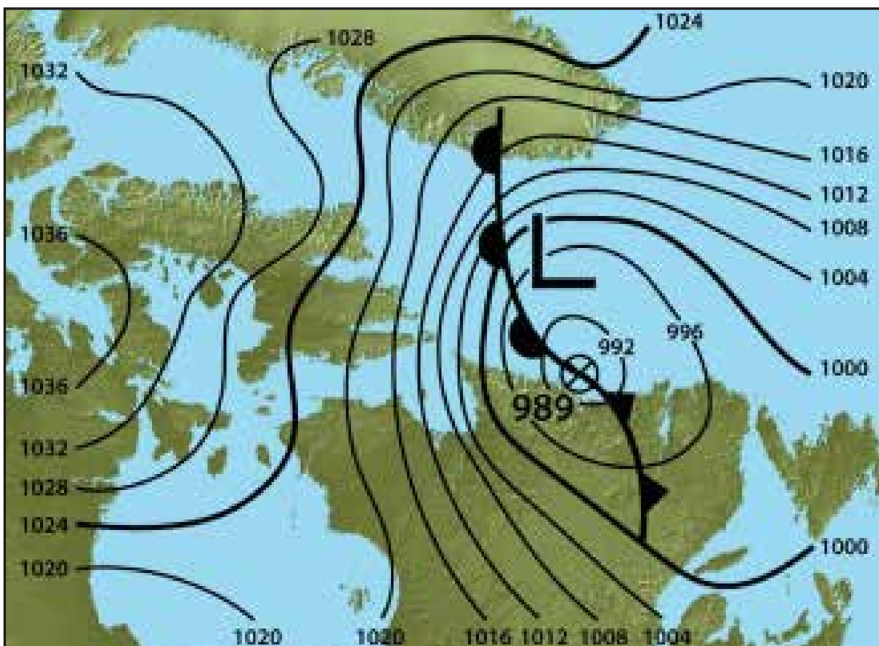


Figure 5: Surface analysis from October 23, 2012.

RADARSAT image (above) from October 22, 2012, and surface analysis (below) from October 23, 2012. Lee waves are evident, along with a fairly intense synoptic flow. Cornering occurred around the southern tip of Resolution Island and channelling in Annapolis Strait, between the Lower Savage Islands and the tip of the Meta Incognita.

10.1.1.2 Easterly and Southeasterly Flow Patterns

Easterly or southeasterly flows are moist and relatively warm, and occur ahead of lows approaching from the west, northwest, or southwest. Although channelling occurs along the length of Hudson Strait, it is most pronounced between Cape Hopes Advance and Cap de Nouvelle-France, where the terrain on the southern and northern coasts rises to 550 m and 900 m, respectively. The capes are the windiest areas in the region.

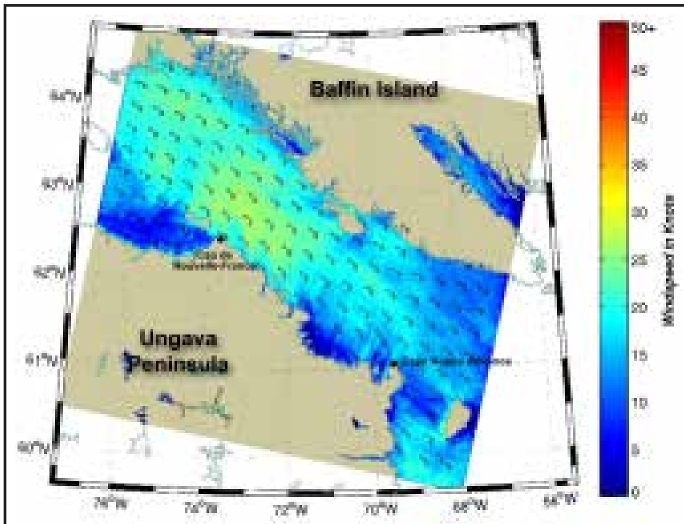


Figure 6: RADARSAT image from September 28, 2013.

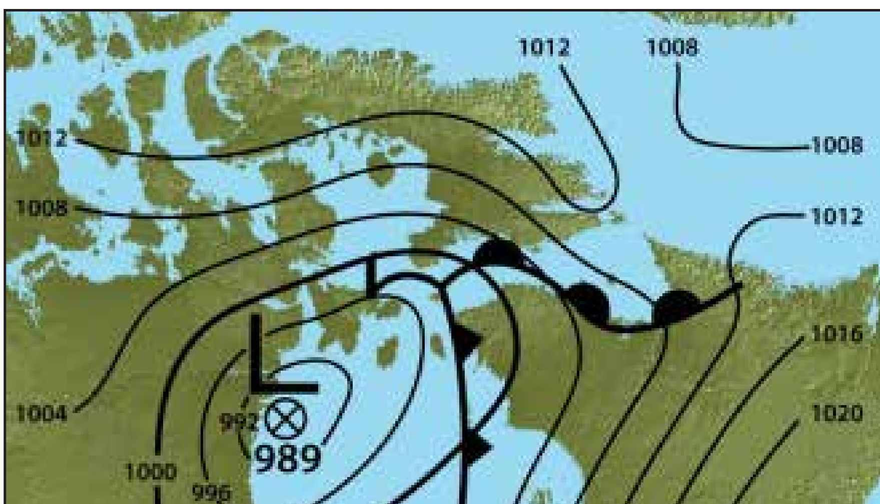


Figure 7: Surface analysis from September 28, 2013.

RADARSAT image (above) and surface analysis (below) from September 28, 2013, when a southeasterly flow was generated by a low-pressure system, ahead of a warm front. The system became stationary over Hudson Bay. Channelling occurred in the Resolution region and further to the northwest, over the Nottingham region. The protective shadow west of Cap de Nouvelle-France, between Charles Island and the mainland, offers shelter from strong southeasterly winds.

East winds can create a cornering effect around the southern tip of Resolution Island, with Sorry Harbour exposed to the strengthened flow and Brewer Bay sheltered from it. The same effect can occur in Annapolis Strait, between the Lower Savage Islands and around the tip of the Meta Incognita Peninsula.

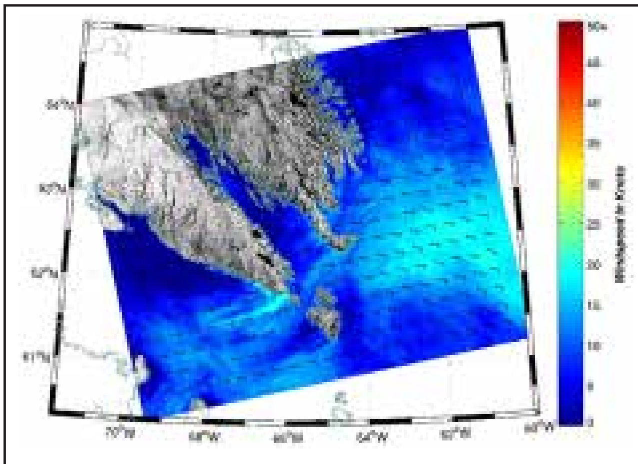


Figure 8: RADARSAT image from August 21, 2012. A cornering effect is evident around the southern tip of Resolution Island and in Annapolis Strait.

Easterlies can also generate downslope winds of up to 30 kt on the extreme southeast coast of the peninsula, even in a fairly weak synoptic flow. Effects are enhanced by cornering around East Bluff, a rock wall that rises nearly 300 m out of the water and extends for about 7 km along the coast on the southeastern tip of the peninsula. Tides and currents in the area are also complicated.

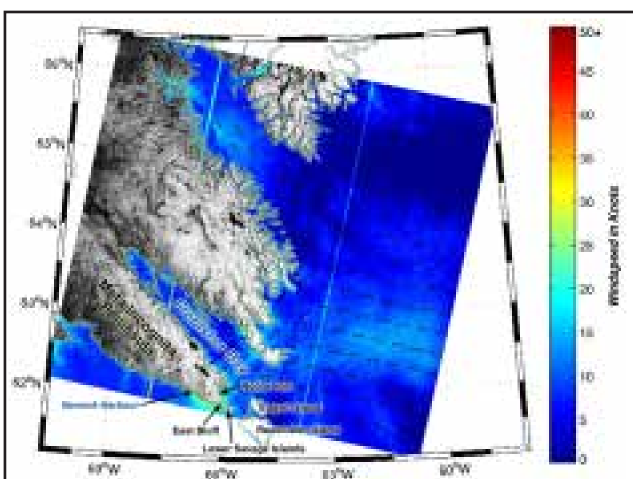


Figure 9: RADARSAT image from August 22, 2012.

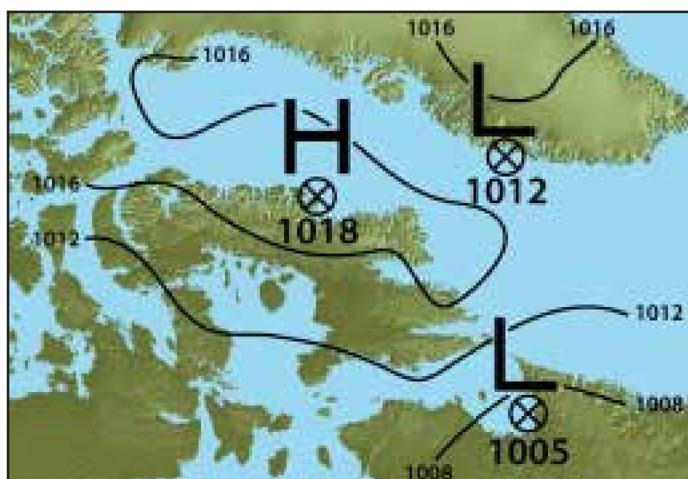


Figure 10: Surface analysis from August 22, 2012.

RADARSAT image (above left) and surface analysis (above right) from August 22, 2012. Downslope winds are occurring downstream of the extreme southeastern coast of Meta Incognita Peninsula.

As the flow becomes southerly or southeasterly, it begins to channel through Hudson Strait and between Big Island and the coast of the Meta Incognita Peninsula (White Strait). Cornering can also occur around the island.

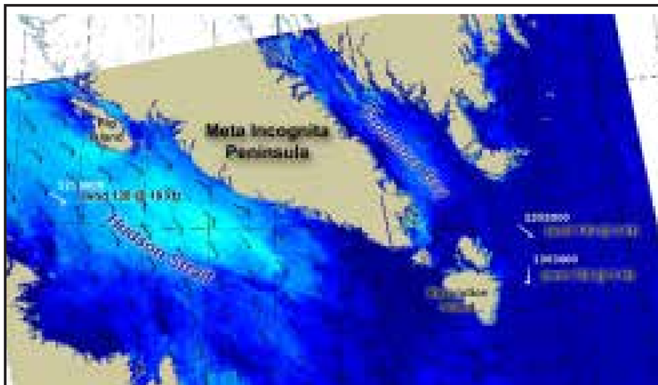


Figure 11: RADARSAT image from August 21, 2014.

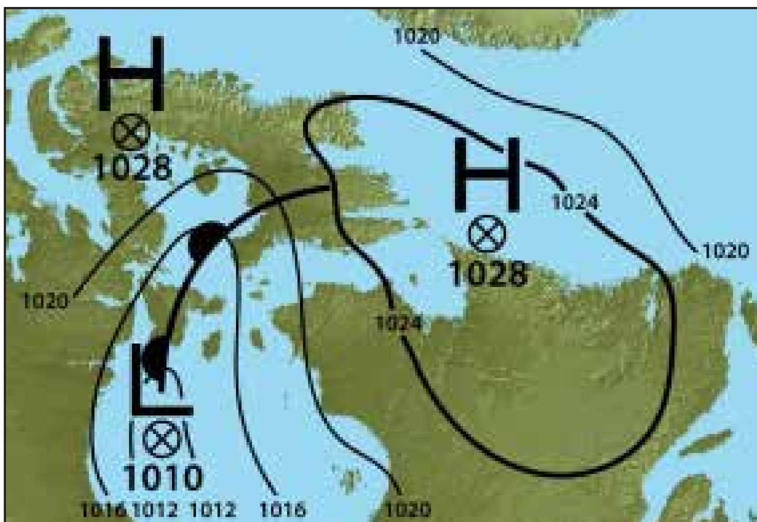


Figure 12: Surface analysis from August 21, 2014.

RADARSAT image (above) and surface analysis (below) from August 21, 2014. A low-pressure system over Hudson Bay was generating a weak southerly flow over Hudson Strait. As the winds became more southeasterly, their speed increased by at least 10 kt, according to ship reports.

Significant Event: August 1, 2002

The sailing vessel *Sedna IV* reported the development of strong southeast winds of 30 kt and waves of 5 metres in Hudson Strait. The ship took shelter for several days in Wakeham Bay to avoid the stormy conditions.

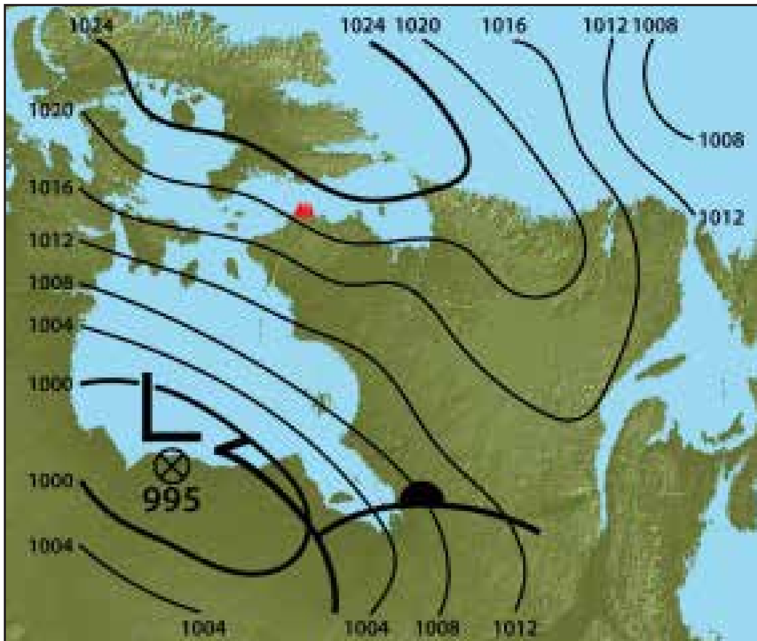


Figure 13: Surface analysis from August 1, 2002, showing the surface pattern that resulted in strong winds of 30 kt and the approximate position of the vessel Sedna that encountered them.

When the flow becomes easterly or southeasterly over Labrador Sea, the winds begin channelling through Gray Strait—a passage through the islands that lies between the coasts of Labrador and Ungava Bay—and increase in speed by up to 15 kt.

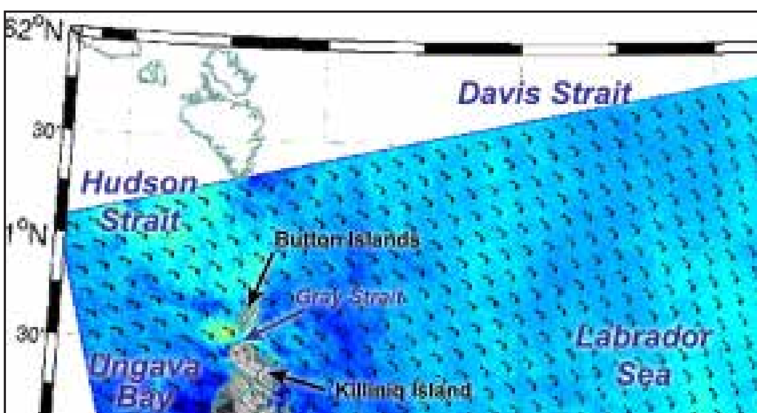


Figure 14: RADARSAT image from August 18, 2012, showing the channelling effect in Gray Strait.

Easterly gales are sometimes reported by ships just off the northern tip of the Labrador coast (north of Port Burwell) when the overall synoptic pattern supports winds of only 15 to 20 kt.

10.1.1.3 Southwesterly and Westerly Flow Patterns

The Hudson Strait area is prone to downslope winds and bands of lee waves, which can cause wind speeds to fluctuate by up to 20 kt. In a southwest flow, such conditions can occur at a number of locations on the strait's northern Quebec coast. For example, Fisher Bay (west of Kangiqsujuaq) is known for having strong squalls blow onto the anchorage from the mountains to its southeast and southwest—likely due to a combination of downslope and funneling effects.

Channelling can also occur when straits are aligned with the southwesterly or westerly flow, as happens in Gray Strait.

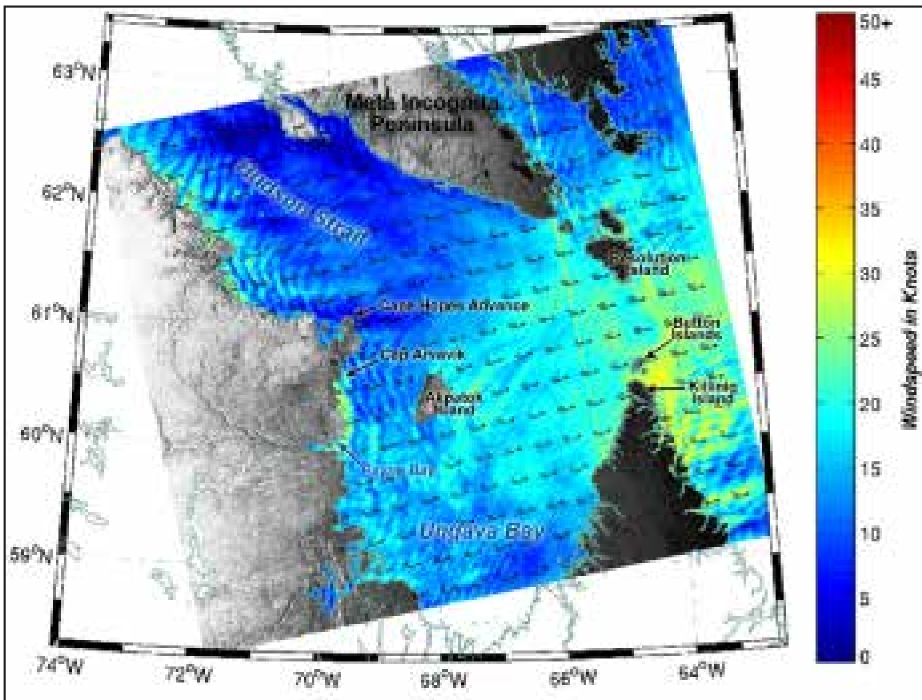


Figure 15: RADARSAT image from September 29, 2012, showing lee waves being generated across southwestern portions of Resolution marine area and downslope winds being generated along the coast. Lee waves and downslope winds cease as the southwesterly winds shift to south.

Mariners' Tips:
The presence of lee waves could be an indication of downslope winds, just off the coastline.

Strong gales have been reported to blow from the high land southwest of O'Brien Harbour (northeastern Killiniq Island) in this flow, and a funneling effect can occur through Wakeham Bay. West winds also corner around the southern tip of Resolution Island.

10.1.1.4 Northwesterly Flow Pattern

Strong northwest winds over Frobisher Bay are much weaker in the Gabriel and Annapolis straits. The high terrain of the Meta Incognita Peninsula creates a shadow that offers some protection from severe northwest winds, with Noble Inlet a good place for mariners to find shelter.

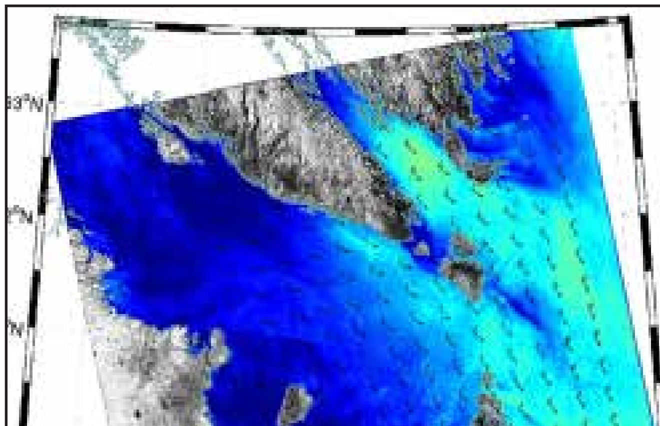


Figure 16: RADARSAT image from fall 2012 - Gabriel and Annapolis straits.

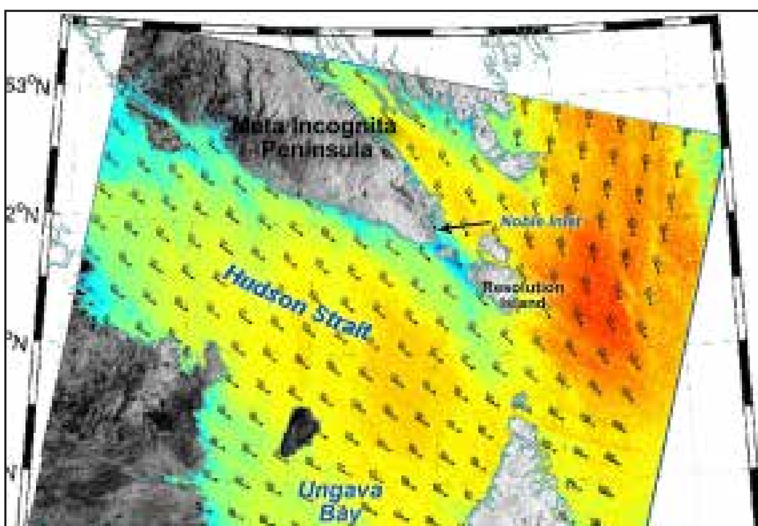


Figure 17: RADARSAT image from fall 2012 - Meta Incognita Peninsula.

RADARSAT images from fall 2012 showing weaker northwest winds in the Gabriel and Annapolis straits (above) and in the shadow of Meta Incognita Peninsula (below).

Resolution Island is one of the foggiest places in the world and a good indicator that there is fog across the eastern entrance to Hudson Strait. Such conditions occur when easterly winds carrying moisture they have picked up over the warmer waters of the northern Labrador Sea are suddenly cooled by the cold Canadian Current. West winds, on the other hand, are cooler and drier.

10.1.2 Waves, Tides and Currents, Shoals, and Ice Conditions

10.1.2.1 Waves

Acadia Cove, at Resolution Island, is affected by swell arising from southerly winds. Heavy swell has also been reported near Maiden Island (King George Sound) after easterly gales and sets into Boat Cove in northwest winds.

10.1.2.2 Tides and Currents

The tidal currents in Hudson Strait are strong and definite, with progress more rapid along its southern shore, where tidal variations of approximately 10 m can be seen in Diana Bay and Wales Island. The coast between Diana Bay and Cape Prince of Wales is indented by a number of shallow, irregular bays with underwater reefs and strong tidal currents. Strong tidal streams have been reported in Whitley Bay (7 to 8 kt), Wakeham Bay (The Narrows), Wales Sound (between Wales Island and northern Quebec), and around the islands in Fisher Bay. Overfalls—turbulent waters caused by currents over an underwater ridge—occur when winds oppose the tidal stream in Wales Sound and also near the northern coast of Peak Island. Strong tidal currents are found in King George Sound and between its nearby islands and are actually deflected by these islands.

A tidal current of 5 kt flows through the northeastern part of the strait between Resolution Island and Killiniq Island. In the spring, an east-flowing tidal stream of 7 kt has been reported at Cape Chidley (eastern shore of Killiniq Island). Strong tidal streams around the bays and coves of the island can create heavy tidal rips and swells. A current of 6 to 7 kt flows parallel to its southwestern shore and a rate of 2 to 3 kt has been reported 24 km offshore, to its east, in late July and early August. Strong tidal rips occur about 16 km to its south. Sorry Harbour experiences tidal variations of some 5 m.

When winds blow against the stream along the Meta Incognito Peninsula (between Pritzler Harbour and Maniittur Cape), heavy seas occur. Tidal streams of 5 kt are set with the incoming tide off the east side of Cabot Island. Whirlpools have been reported off Gould Point (eastern shore of Killiniq Island) and Cape Chidley and turbulent waters in O'Brien Harbour (northeastern Killiniq Island). Tidal streams of 5 to 7 kt occur in Gray Strait and between the Button Islands, causing very heavy tidal rips. Balcom Inlet sees heavy seas break to the bottom against the outgoing stream when the water level is low. Reversing tidal rips occur in Barrier Inlet.

In the deep waters around East Bluff, at the southeastern extremity of Baffin Island, strong tidal currents sweep past the cliffs, strike the Lower Savage Islands, and are deflected well out into Gabriel Strait. During the spring tide, navigation in the strait is hazardous for small boats: when the tidal currents are strongest, ships can be set strongly toward the islands.

The Lower Savage Islands are separated from Baffin Island by more than 6 km of turbulent water in Annapolis Strait and from Resolution Island by Gabriel Strait. Both straits are potentially dangerous for small vessels due to strong tidal streams, which cause confused seas with whirlpools and tidal rips. There are strong tides moving both in and out of Gabriel Strait, where the difference between the spring and neap tides is nearly 6 m.

Strong tidal streams, dangerous eddies, and irregular depths are observed in McLelan Strait (between Killiniq Island and Labrador), which is recommended only for small vessels. A tidal current of 5 kt has been reported in Grenfell Sound (eastern opening of McLelan Strait) and of 8 kt in the strait's narrows.

10.1.2.3 Shoals

Shoals are found northwest of Cape Kakkiviak (southeast of Argo Island, between Cape Kakkiviak and the Gasper Islands), in Williams Harbour, in Clark Harbour (at the junction of McLelan Strait and Grenfell Sound), east of Cape Warwick, in Sorry Harbour, in Barrier Inlet, around Beacon Island (in North Bay southeast of Kimmirut), at Cape Wight, in Ash Inlet (Big Island), in Stupart Bay, east of Cape Prince of Wales, in Wakeham Bay, in the Narrows, in Fisher Bay, around the Pinnacle Islands, near Cleft Island, in Douglas Islet (King George Sound), and near Outer Island. The Labrador Reef, located 10 to 18 km east of the Button Islands, is also a navigational hazard.

10.1.2.4 Ice Conditions

Freeze-up usually starts in late October in the western parts of the region and progresses eastward, with the entire area ice-covered by the end of November. By the end of July, the strait is mostly clear of ice.

In early summer, extended masses of sea ice, icebergs, and growlers can be carried southward by the Baffin current to within 200 km of the coastline and can enter Hudson Strait, posing a serious hazard to navigation. Small icebergs have also been reported to pass through McLelan Strait.

Rare white rainbow "fog bow". Photo courtesy of Nicolas Peissel.

10.1.3 Kimmirut

Formerly known as Lake Harbour, Kimmirut is a community on the south coast of Baffin Island. It is located on the Meta Incognita Peninsula, at the western end of Westbourne Bay, on the shores of Glasgow Inlet. Hudson Strait is situated approximately 12 km to the south.

Kimmirut, Nunavut. Photo courtesy of the Government of Nunavut.

10.1.3.1 Winds and Weather

In the summer, southeast and west winds are the most common in Kimmirut. Before the ice reforms, stronger winds are most likely to be experienced in the fall, mainly from the southeast and west.

Southeast is the most prevalent direction, as the winds funnel through Glasgow Inlet, which is aligned from southeast to northwest. Kimmirut is generally protected from winds coming from other directions. Strong east to southeast winds are generated ahead of storms passing over Hudson Bay.

North, northeast, and northwest winds in the area are usually generated by storms moving from Québec into Davis Strait or from the Labrador Sea towards Baffin Bay. West and east winds in Kimmirut are influenced by the wind regime of Hudson Strait, as winds from these directions channel through the strait.

10.1.3.2 Tides and Ice Conditions

Tides in Kimmirut reach 11 m in the summer months. Combined with strong currents, these racing tides often create rough seas near Kimmirut. The hazard to mariners is exacerbated by the presence of sheer granite cliffs rising from the sea.

Ice usually breaks up in Westbourne Bay in the middle of July or early August. Freeze-up normally occurs by late November.

10.1.4 Kangiqsujuaq

Kangiqsujuaq is located about 10 km from Hudson Strait, on the southeast shore of Wakeham Bay. The village is nestled in a valley hollow, surrounded by mountains.

10.1.4.1 Winds and Weather

Wakeham Bay and Kangiqsujuaq offer shelter from strong southeast winds and waves generated by these winds in Hudson Strait. North winds can be quite strong in Kangiqsujuaq due to a channelling effect through Wakeham Bay.

10.1.4.2 Tides

Wakeham Bay has a maximum tidal range of nearly 12 m.

10.1.5 Quaqtaq

The village of Quaqtaq is one of the most northerly inhabited places in Quebec. It is located on the eastern shore of Diana Bay, on Quaqtaq Peninsula.

10.1.5.1 Winds and Weather

The dominant winds in the community come from the northwest and can often be observed behind cold fronts at speeds of 50 kt or more. Strong southeast winds (also up to 50 kt) can be observed ahead of such systems, while northeast winds are rare and usually light. Storms and bad weather are often announced by high waves from the northwest. Advection fog is possible from most directions and can be persistent, even in high winds.

10.1.5.2 Tides, Currents, and Ice Conditions

Extreme tides can reach 8.4 m in Diana Bay and Quaqtaq. The strongest currents occur around the end of the Quaqtaq Peninsula, with areas of particular turbulence along the shoreline between Quaqtaq, Hearn Island, and the tip of the peninsula. Strong spring tides also generate dangerous eddies along the shores. On the Ungava Bay side of the peninsula, converging marine currents can combine with strong winds to create large pile-ups of ice (36 m deep or more).

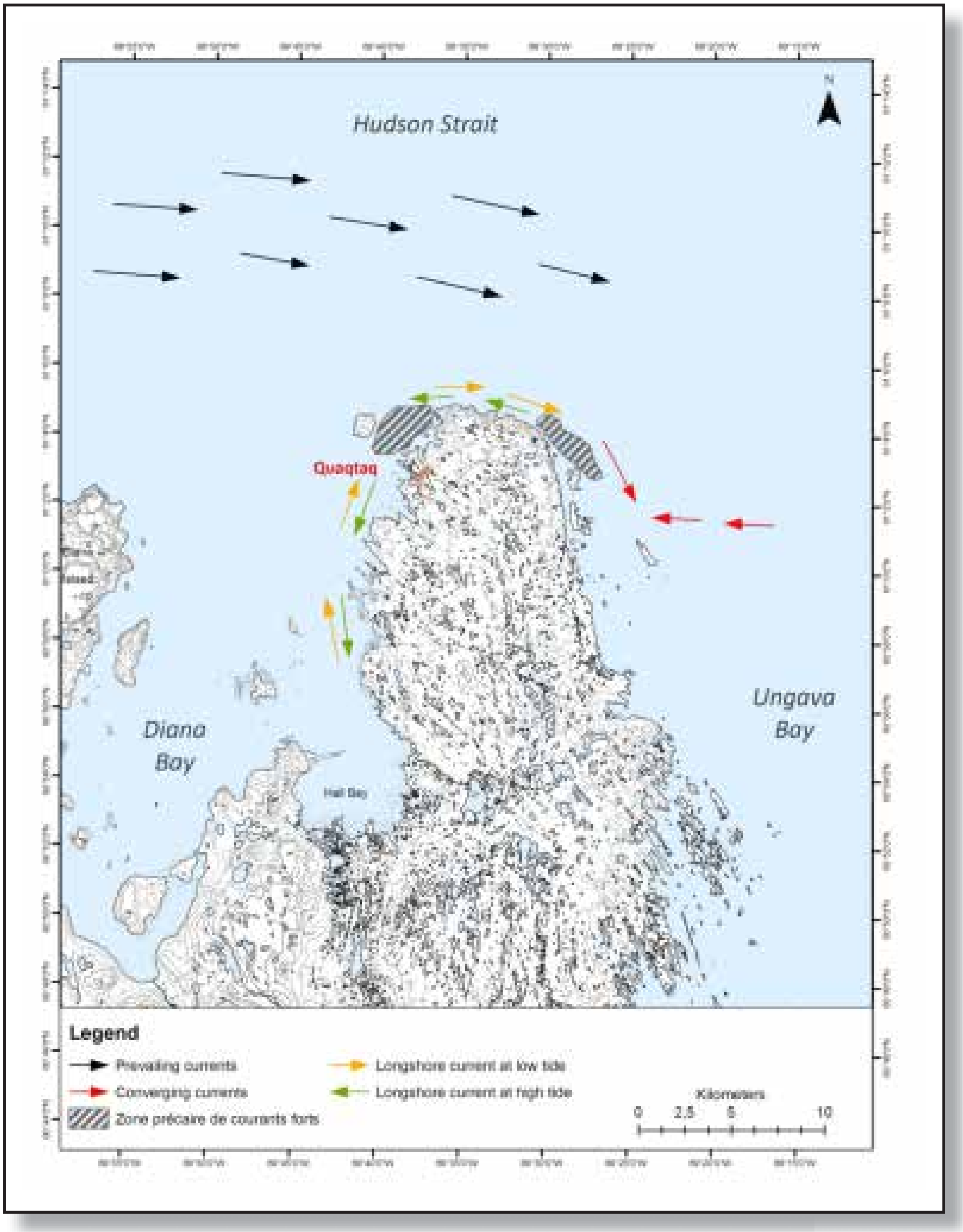


Figure 18: Prevailing currents around the Quaqtaq Peninsula. Source: Clerc et al, 2011: Climate Change and marine Infrastructures in Nunavik – Local expert knowledge and community perspective in Quaqtaq, Umiujaq and Kuujjuaq. Final report for Indian and Northern Affairs Canada.

Ice formation in Diana Bay starts around the third week of November and ends just before Christmas. Northerly winds delay the break-up and clearing of ice in the bay, which usually begins in May and is generally complete by the beginning of July.

10.2 Ungava Marine Region

Ungava Bay is a large, funnel-shaped body of water off Hudson Strait, on the northeast coast of the Nord-du-Québec administrative region. It is 265 km wide at its mouth, while the remainder of the bay is about 180 km wide. Akpatok Island, located at the northwest end of the bay, rises sharply from the northern waters of the bay and is known for its forbidding coastal cliffs and extensive marine abrasion platform, since the island is made mostly of limestone. It is generally covered with ice from November to June. Six villages are found in the Ungava Bay territory: Quaqtaq, Kangirsuk, Aupaluk, Tasiujaq, Kuujjuaq and Kanggiqsualujjuaq.

Did You Know?

Polar bear and walrus migrate from Hudson Strait down the west coast on ice floes and can be seen in considerable numbers on Akpatok Island in the summer.

Figure 19: Local effects for the Ungava Marine Region.

10.2.1 Winds and Weather

The same weather systems that affect Hudson Strait also affect the Ungava region. Low clouds and fog begin to appear in June, when the ice in Ungava Bay begins to melt. Westerly winds help spread the low cloud along the eastern coast of the bay.

10.2.1.1 Northeasterly Flow Pattern

A northeasterly flow can accelerate through Hudson Strait and into Ungava Bay, generating downslope winds and lee waves on the southwestern side of Akpatok Island.

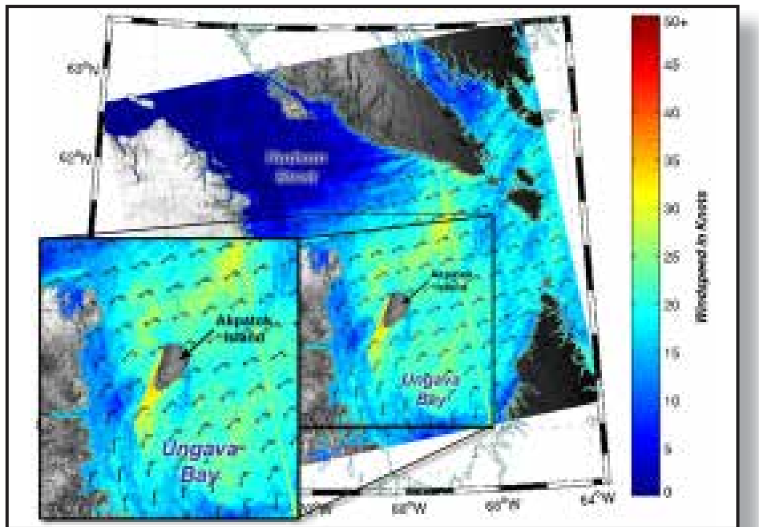


Figure 20: RADARSAT image from August 29, 2012, showing strong to gale-force downslope winds on the western and southern sides of Akpatok Island, with a distorted field of lee waves extending for many kilometres south.

10.2.1.2 Easterly and Southeasterly Flow Pattern

With an easterly flow perpendicular to Akpatok Island, downslope winds and lee waves can occur on the lee side of the island. With an easterly or southeasterly flow, air piles up and slows down as it interacts with the steep-walled terrain (which rises to 150 to 250 m), causing a wall of lighter winds to extend out on either side of the island.

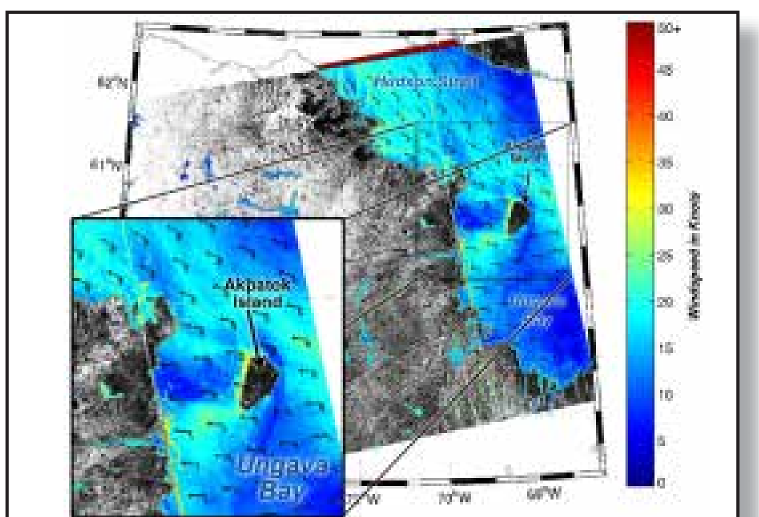


Figure 21: RADARSAT image from June 27, 2011, showing cornering around Akpatok Island and a downslope wind effect, combined with lee waves, on the western side of the island.

East and southeast winds channel through the Gray and McLelan straits, with strong outflow winds (10 to 15 kt higher than the local winds) extending many kilometres west into Ungava Bay.

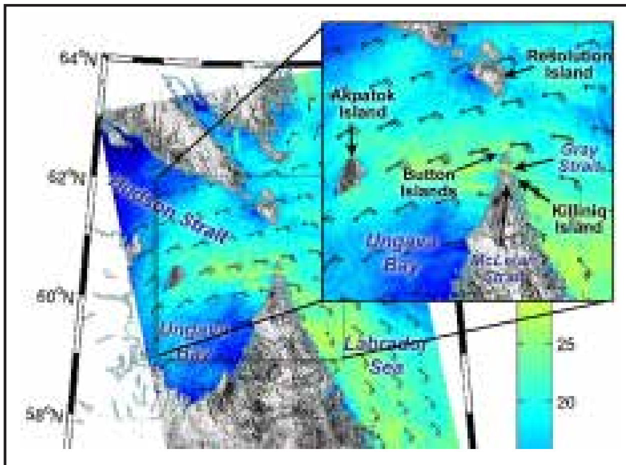


Figure 22: RADARSAT image from October 20, 2012.

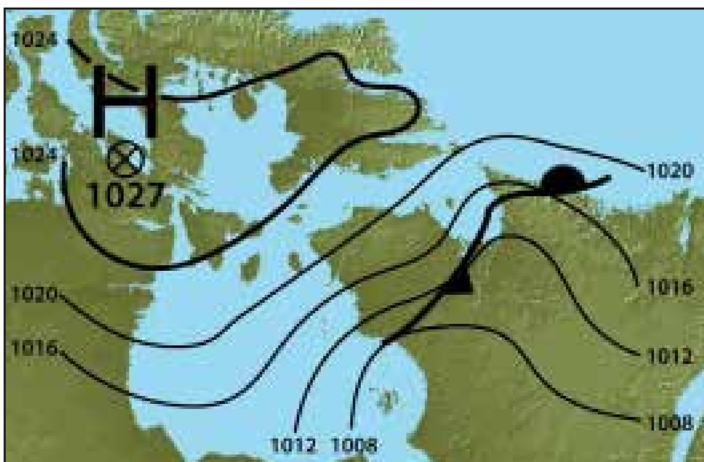


Figure 23: Surface analysis from October 20, 2012.

RADARSAT image (above) and surface analysis (below) from October 20, 2012, showing that even a weak synoptic flow can generate outflow winds of 30 kt in Ungava Bay near the Gray and McLelan straits.

Port Burwell Harbour offers good shelter from most winds but is affected by strong breezes drawn in through gaps in the surrounding hills, when conditions outside may be calm.

10.2.1.3 Westerly and Southwesterly Flow Pattern

Westerly and southwesterly flow can generate a lee wave effect across almost all of northern Ungava Bay, with high terrain playing a role in the formation of both lee waves and downslope winds in the area. Whether the two occur together or not depends largely on the vertical profile of the atmosphere.

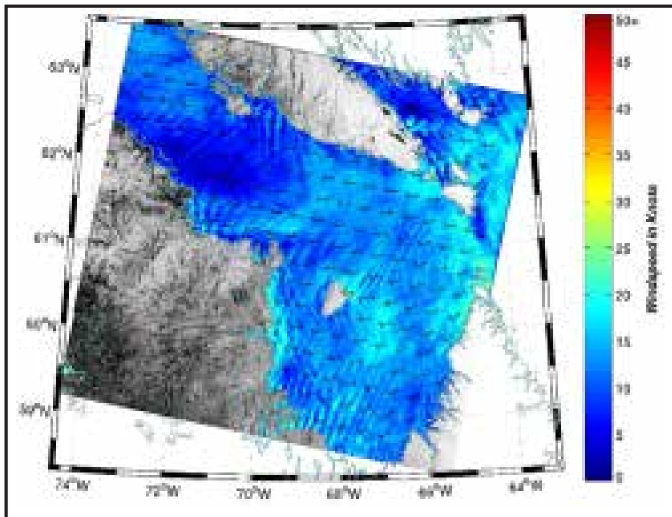


Figure 24: RADARSAT image from September 30, 2012, showing lee waves being generated across the entire body of Ungava Bay and downslope winds being generated along the west coast of the bay, from Payne Bay north to Cape Arvavik and on the lee (east) side of Akpatok Island. Lee waves and downslope winds cease as the southwesterly winds shift to south.

Strong west winds cause heavy squalls in Gray Strait. Frequent gales occur in the vicinity of Cape Hopes Advance, especially during the fall, in this flow.

10.2.2 Tides and Currents, Shoals, and Ice Conditions

10.2.2.1 Tides and Currents

Ungava Bay has the second highest tides in the world, reaching up to 15 m at the head of the bay. Navigation of the shallow waters along the west coast of the bay is hazardous due to the rise and fall of the tide. Strong tidal streams set within 19 to 24 km of the east and west shores of the bay, therefore navigation along the shores is hazardous due to the rapid rise and fall of the tide.

The maximum tidal range is approximately 5 m at the Button Islands, almost 11 m at Hopes Advance Bay, 11 to 12 m at Koksoak River, and 15 to 17 m in Leaf Bay, which is known for its swift and dangerous tidal currents.

Tidal currents in McLelan Strait, between the mainland tip of Labrador and Killiniq Island, can reach 10 kt during spring tide. A tidal current of 8 to 10 kt occurs in the George River, creating heavy turbulent waters when the wind blows in opposition. Strong tidal currents with eddies/whirlpools are found in the Arnaud River (7 to 10 kt), the harbour near Kangiqsualujjuaq, Koksoak River, and in Passe Smokey. Strong tidal streams also occur in Lac aux Feuilles and around Akpatok Island (4 kt). The tide races in Gray Strait, even in good weather. When the stream is opposed by strong winds, a breaking sea is formed that is dangerous to small vessels.

10.2.2.2 Shoals

Shoals are found in Port Burwell Harbour, Forbes Sound, between Cape Kernertut and Cap Naujaat, northwest of Pointe Qirniraujaq, in Hopes Advance Bay, Payne Bay, and north, east, and south of Akpatok Island.

10.2.2.3 Ice Conditions

Ice covers Ungava Bay from November until June. Break-up and freeze-up usually begin at the head of the bay, and open water can be present along the west coast before Hudson Strait is open. Icebergs drifting with the tidal currents have been seen in the bay in August and September.

10.2.3 Kangirsuk

Kangirsuk is located on the northern shore of the Arnaud River (former Payne River), about 13 km inland from Ungava Bay.

> **Did You Know?**
> The “Hammer of Thor” archaeological site was found near Kangirsuk in 1964. While the site was originally thought to be erected by Vikings, scholars now believe that it is likely an artifact of Inuit culture.

10.2.3.1 Winds and Weather

Northeast winds are the most dominant and strongest winds during the summer navigational season, likely due to channelling along the river. West and southwest winds are also frequent and can be quite strong.

10.2.3.2 Tides

The tides in Kangirsuk rise and fall many metres each day, reaching a maximum of up to 10 m. This, combined with the large rocks in the bay, can create chaotic ice conditions.

10.2.4 Aupaluk

Aupaluk, the smallest Nunavik community, is located on the southern shore of Hopes Advance Bay, an inlet on the western shore of Ungava Bay. The village is built on the lowest of a series of natural terraces, about 45 m above sea level.

10.2.4.1 Winds and Weather

Winds in Aupaluk are generally southeast and northeast. The community is exposed to the waters of Ungava Bay, so northerly winds can bring fog into the area. Northwest winds can be quite strong, especially with the passage of a cold front.

10.2.4.2 Tides and Ice Conditions

The spring tidal range at Hopes Advance Bay is near 11 m. The waters of the bay usually freeze by late January and melt by late June or early July.

10.2.5 Tasiujaq

Tasiujaq sits on the shores of Leaf Lake at the head of Deep Harbour, a few kilometres north of the tree line. It encompasses the whole of Leaf Basin, including Leaf Lake, Leaf Passage, and Leaf Bay.

10.2.5.1 Winds and Weather

The most dominant wind direction in the summer is northeast, but west and southwest winds can also be quite strong. In the fall, west and southwest winds become more dominant and stronger. Northeast winds often bring fog.

10.2.5.2 Tides and Ice Conditions

Leaf Basin is renowned for its high tides, which exceed 15 m. Tidal currents of 10 kt occur during the spring, accompanied by dangerous eddies.

Open water occurs in Leaf Basin before Ungava Bay is free of ice, but the strong tidal currents cause the ice to jam. Full passage into Leaf Basin is possible after the middle of July. Freeze-up occurs in late December; however, stretches of open water may remain throughout the winter.

10.2.6 Kuujjuaq

Kuujjuaq is Nunavik's largest community. It is located on the west shore of the Koksoak River—one of the largest rivers in the Nunavik region—about 50 km upstream from Ungava Bay.

10.2.6.1 Winds and Weather

Southwest, west, and northeast are the most dominant wind directions in the summer in Kuujjuaq. Sea breezes often occur in the early evening. In the fall, winds from the west and southwest are the most common, although strong winds can also be generated from westerly and northerly quadrants. Northeast winds prevail at the mouth of the river and can pose a serious danger to small vessels during outgoing tides.

10.2.6.2 Tides and Ice Conditions

Spring tidal currents, with a range of 11 to 12 m, can reach 12 kt with the outgoing tide, creating many whirlpools in the area.

The ice on the Koksoak River breaks-up in the middle of June and begins to reform along the shoreline between mid-October and the beginning of November. Although strong northerly winds delay ice formation, freeze-up is typically complete in December.

10.2.7 Kangiqsualujjuaq

Kangiqsualujjuaq is the easternmost village in Nunavik, located about 160 km northeast of Kuujjuaq. It sits at the end of Akilasakalluq Cove on the George River, about 25 km from Ungava Bay.

10.2.7.1 Winds and Weather

Northwest and west winds are the most dominant directions due to channelling and funneling effects along the George River.

10.2.7.2 Tides

The tide reaches as far upstream as the village and almost entirely from the cove at low tide. The spring tidal range on the river is 8 to 10 m, and strong rips and eddies can occur during the summer. Tidal streams can reach 10 kt, resulting in heavy overfalls when they are faced by opposing winds.

10.3 Nottingham Marine Region

The Nottingham Marine Region comprises of the western parts of Hudson Strait and includes the communities of Cape Dorset and Salluit. Three large islands are located in its westernmost area: Nottingham Island (the largest), Salisbury Island (the highest, at 450 m), and Mill Island (the lowest, at 150 m). Charles Island lies at the southeastern end of the region.

Figure 25: Local effects for the Nottingham Marine Region.

10.3.1 Winds and Weather

Its location near a major west-east corridor for systems moving along Hudson Strait from the Western Arctic cause this area to be affected by frequent storms. These systems follow a broad range of tracks extending from northern Quebec to the more southerly Southampton Island and from central Baffin Island to the northern Foxe Basin.

The first snowfall can be expected over the western end of the strait by the end of August, when dense snow squalls—caused by the heating of the frigid arctic air over the open water—can sometimes reduce visibility to zero.

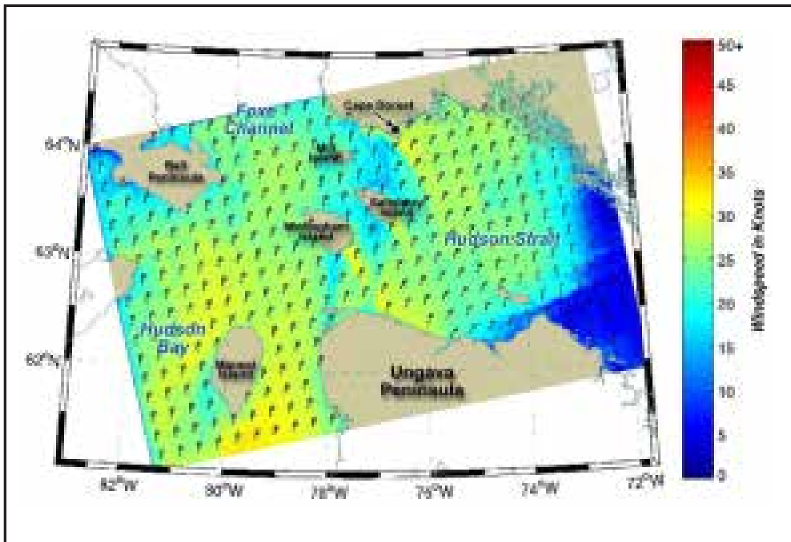


Figure 26: RADARSAT image from September 4, 2013, showing cornering effects around Nottingham and Salisbury islands in a northeasterly flow, generated by a low-pressure system moving across Hudson Bay, south of the Nottingham Marine Region. The strongest winds are observed on the east to southeast sides of the islands.

10.3.1.1. Northerly, Northwesterly, and Northeasterly Flow Patterns

This flow pattern is usually generated behind storms, sometimes after the passage of a cold front. Nottingham, Salisbury, and Mill islands generate a cornering effect with northerly, northwesterly, or northeasterly flows, which can increase wind speeds around the corners of the islands by 5 to 10 kt. Lighter winds (and greater protection) can be found on their lee sides.

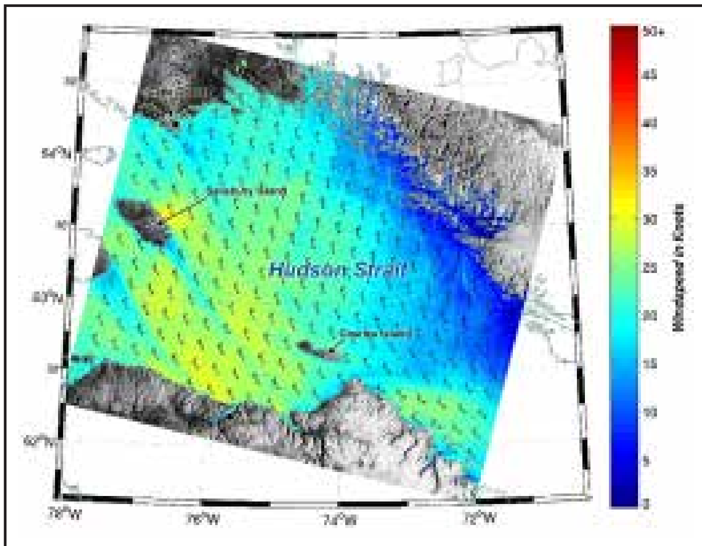


Figure 27: RADARSAT images from September 10, 2012.

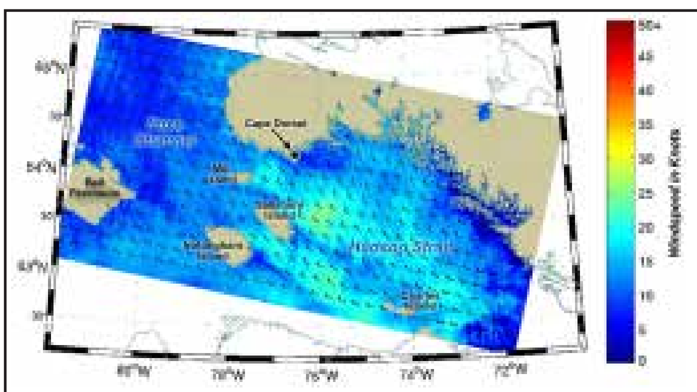


Figure 28: RADARSAT images from August 24, 3013.

RADARSAT images from September 10, 2012 (above), and August 24, 2013 (below) showing cornering effects around Nottingham, Salisbury, and Mill islands in a northwesterly flow. The winds were also most likely channelled between the Nottingham and Salisbury islands.

Many inlets on the Quebec coast are exposed to north winds. North winds funneling down Kugluk Cove can reach gale-force and generate significant swell.

10.3.1.2 Southerly and Southwesterly Flow Pattern

These flows are generated ahead of storms approaching from the northwest, west, or southwest. South and southwest winds routinely foster strong gusty wind conditions across the northwestern Quebec coast and can reach gale force at times. As such, mariners should exercise caution when travelling along this steep stretch of coastline in a southerly or southwesterly flow. Strong downslope winds have also been observed on the lee side of Nottingham, Salisbury, and Mill islands.

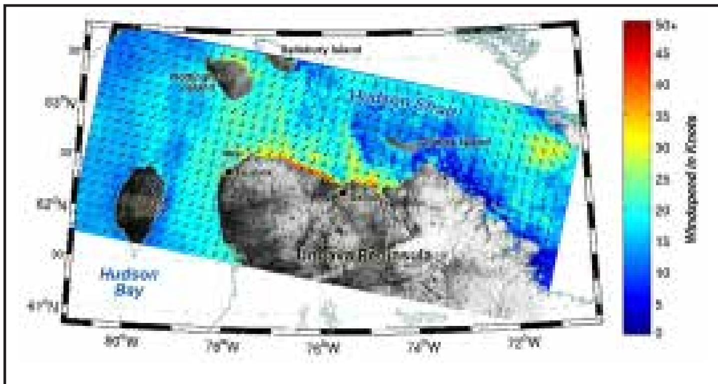


Figure 29: RADARSAT image from August 12, 2012.

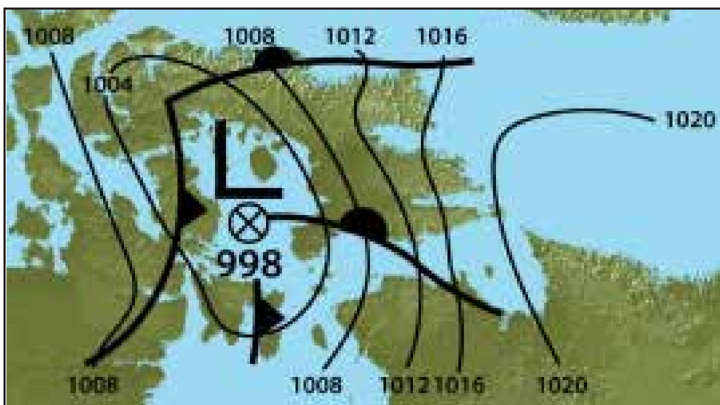
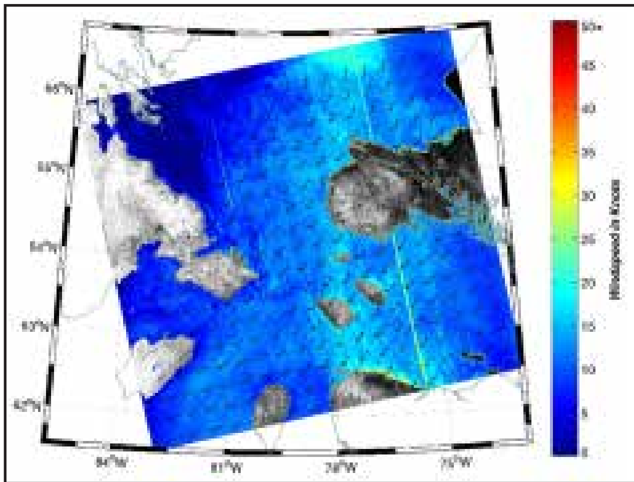


Figure 30: Surface analysis from August 12, 2012.

RADARSAT image (above) and surface analysis (below) from August 12, 2012. The southerly synoptic flow was quite intense, with winds near the coast as strong as 40 kt while those at Salluit reached only 22 kt, gusting to 28 kt from the southwest.



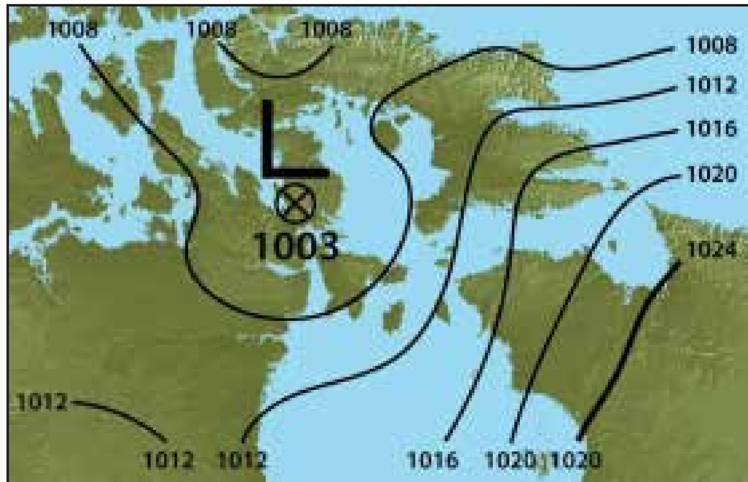


Figure 31: RADARSAT image from September 14, 2012.

Figure 32: Surface analysis from September 15, 2012.

RADARSAT image (above left) from September 14, 2012, and surface analysis (above right) from September 15, 2012, showing that even a relatively weak flow can generate near gale-force winds along the northern Quebec coast.

The steeply rising region of the northern Quebec coastline and the islands in the western sections of Hudson Strait generate both strong downslope winds and lee waves. There is also a tendency for strong winds to funnel through the inlets on the northern Quebec coast, due to a combination of downslope and funneling effects. Violent southwesterly winds of the same origin are reported to blow from the southwest arm of Douglas Harbour, while hurricane-force winds have been known to blow out of Kugluk Cove and violent southerly winds and squalls out of Eric Cove. Funneling also occurs in these inlets in north winds. When winds are strong, vessels are advised to leave anchorage as conditions near shore can become hazardous.

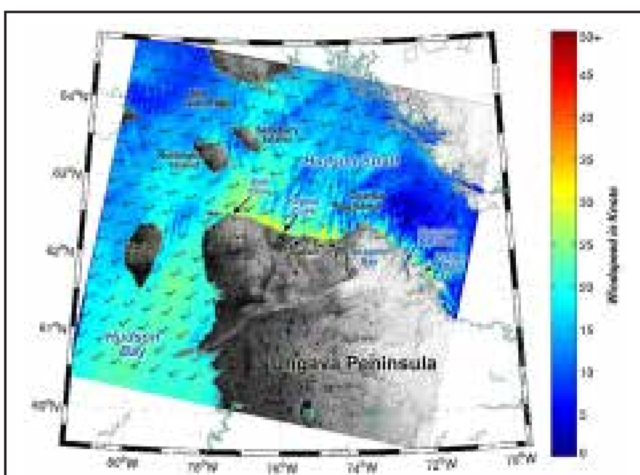


Figure 33: RADARSAT image from September 29, 2012, showing downslope and funnelling effects in coves along the northern coast of the Ungava Peninsula.

10.3.1.3 Easterly and Southeasterly Flow Patterns

As with northerly flows, easterly and southeasterly flows create a cornering effect around the Nottingham, Salisbury, and Mill islands. In addition, winds between the islands may be enhanced by channelling. As a result, a light to moderate southeasterly or easterly flow can produce strong bands of wind between the islands as well as between them and the mainland.

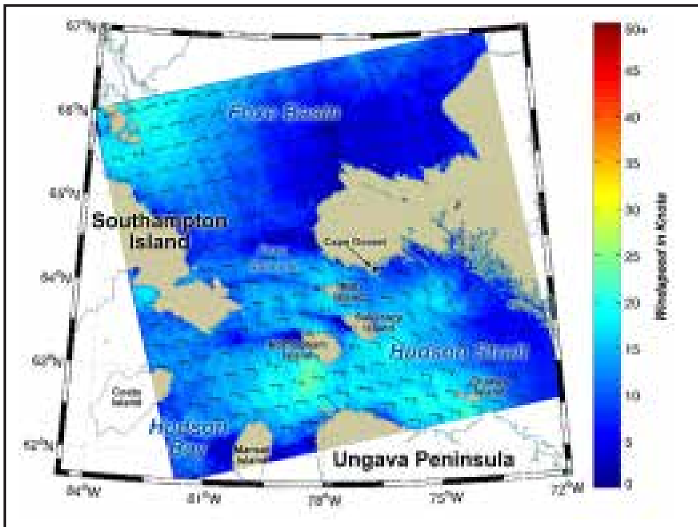


Figure 34: RADARSAT image from October 22, 2013.

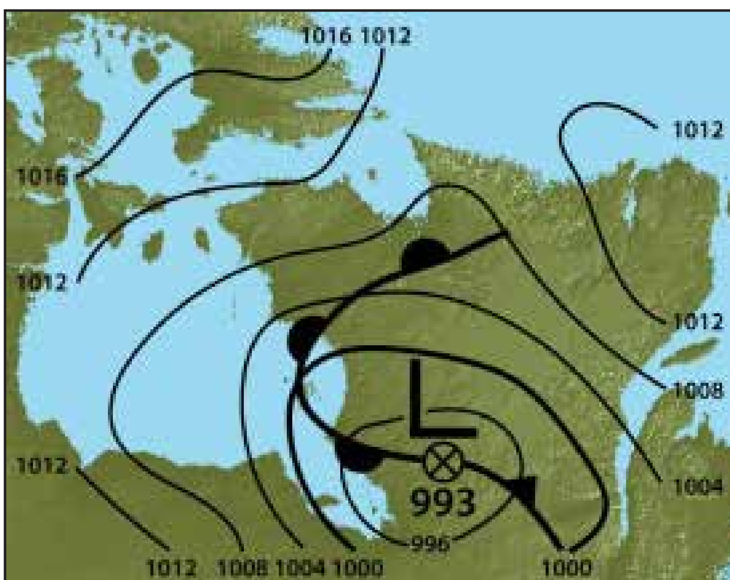


Figure 35: Surface analysis from October 22, 2013.

RADARSAT image (above) and surface analysis (below) from October 22, 2013, showing areas of stronger and lighter winds around Nottingham, Salisbury, and Mill islands in an easterly or southeasterly flow.

A stronger southeasterly or easterly flow can create similar conditions around the islands as those described for Akpatok Island, with winds piling up and slowing down in response to the influence of the steep-walled terrain. The high terrain causes a sharp division between the stronger and lighter winds and a wall of lighter winds to extend out on either side of the islands.

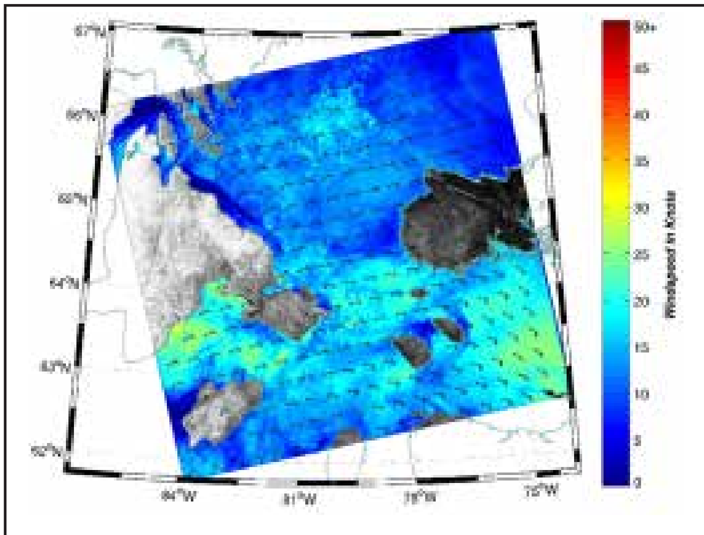


Figure 36: RADARSAT image from August 26, 2012.

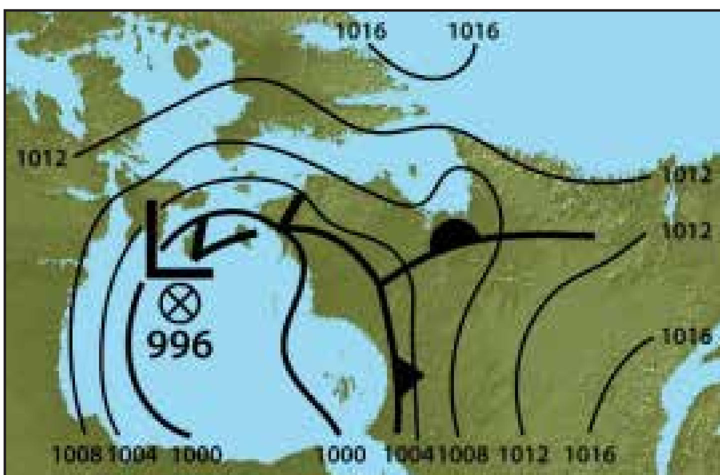


Figure 37: Surface analysis from August 27, 2012.

RADARSAT image (above) from August 26, 2012, and surface analysis (below) from August 27, 2012. Southeasterly or easterly flows interact with the terrain to create areas of lighter and stronger winds around the Nottingham and Salisbury islands.

10.3.2 Waves, Tides and Currents, Shoals, and Ice Conditions

10.3.2.1 Waves

High waves can develop in Hudson Strait in stormy conditions when easterly and southeasterly winds channel through the strait.

A heavy sea with strong tidal rips and eddies is generated when an easterly-flowing current is opposed by east winds near Cape Wolstenholme. The same occurs in Eric Cove when the winds blow against the tide.

Significant Event: October 3-5, 2014

As a major storm approached the Nottingham region from the southwest, several ships in the area and the Salluit weather station reported east winds from 24 to 32 kt. Locals stranded on an island 120 km east of Cape Dorset reported waves of up to 1.5 m on Hudson Strait during the storm.

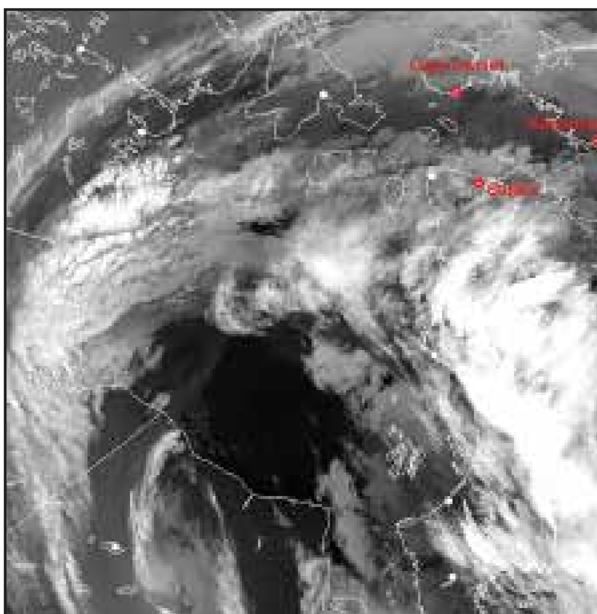


Figure 38: RADARSAT image from October 5, 2014.

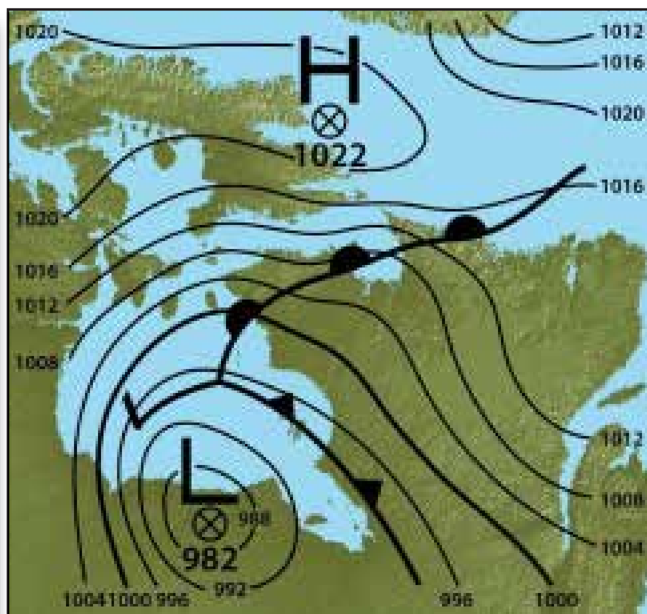


Figure 39: Surface analysis from October 5, 2014.

Satellite image (above left) and surface analysis (above right) taken during a storm that occurred from October 3 to 5, 2014, when high winds and waves were reported in the Hudson Strait near Cape Dorset.

10.3.2.2 Tides and Currents

When wind blows in opposition to the strong tidal streams between the Mill Island group and land to the north, heavy seas occur in the area.

Strong tidal streams and whirlpools are also found in Morrissey Harbour (northern Mill Island).

Strong tidal streams and shoals exist southeast of Salisbury Island, with strong, turbulent currents occurring between it and Nottingham Island. A powerful and turbulent east-flowing current also forms nears the southern point of Nottingham Island.

Strong tidal streams are found between the islands west of Fair Ness and out of White Bear and Amadjuak bays. Andrew Gordon Bay is also known for its strong tidal currents and rips.

Heavy overfalls, swirls, and eddies are observed in Eric Cove and further west along the shore, up to Cape Wolstenholme, posing a hazard to small craft.

When the wind opposes the outgoing tidal current in Douglas Harbour, the seas at its entrance are choppy.

10.3.2.3 Shoals

There are many shoals between the islands and in the bays and coves west of Fair Ness, along the coast of Baffin Island.

10.3.2.4 Ice Conditions

Freeze up in the area usually begins in late October, with ice formation progressing eastward to cover the whole area by the end of November. Waters are usually clear by the end of July, although ice jammed or piled up against the coastline can linger and move with destructive force with the winds and tides.

Did You Know?

Mill Island was named by explorer William Baffin for the great grinding of ice that occurs in the area as a result of its strong tidal streams.

10.3.3 Cape Dorset

Cape Dorset is a hamlet on the north shore of Dorset Island that is reachable by foot from the neighboring islands during low tide. Less than 2 km to the east is Hudson Strait, while only a few kilometres to the north is the rugged coast of Baffin Island. The strong currents of the strait maintain areas of open water throughout the winter.

The hamlet of Cape Dorset. Photo courtesy of the Government of Nunavut.

10.3.3.1 Winds and Weather

Cape Dorset is affected by frequent storms, which can come from just about any direction, including Hudson Bay and Foxe Basin.

West winds are the most frequent in the area and tend to be strong and gusty due to funneling and deflection effects caused by the higher terrain to the west. When the atmosphere is unstable after the passage of a low, wind speeds may be much higher than expected.

East winds take second place in terms of both frequency and speed, due to the same funneling effect. Moderate winds from the southwest and southeast are common at Cape Dorset in the summer.

In the fall, when systems generally intensify in strength, the winds in Cape Dorset tend to be stronger and more frequent from the west and east. The strongest often occur when a low-pressure system north or northwest of the cape moves eastward or northeastward. Winds from the west to southwest often funnel between Dorset Island and Mallik Island (to its northwest). It is not uncommon to see gusts of 30 to 40 kt during the colder months of the year.

Intense low-pressure systems in the fall also carry mixed precipitation in the cold westerly or northwesterly flow behind a storm. At the same time, when an arctic air mass enters an area where low-level moisture is abundant, fog occurrence increases. Moderate winds from the east and southeast frequently bring fog to the area during the summer navigation period. Freezing precipitation can also occur at Cape Dorset, usually during May and sometimes in October.

Local reports indicate that, in recent years, the prevailing wind direction has become less consistent and more prone to shifts, with winds generally more southeasterly and less northwesterly. Also, more frequent southerly winds are pushing pack ice into the floe edge, leading to more ice instability and break-off events.

Northwest winds are more frequent and stronger during the fall and sometimes bring heavy swell into Cape Dorset Harbour.

10.3.3.2 Tides and Ice Conditions

The tidal range in Cape Dorset is 7 to 9 m.

The strong Hudson Strait currents prevent solid ice formation from extending far offshore, creating a dynamic sea-ice environment. Break-up usually occurs in Cape Dorset Harbour in the middle of July; freeze-up, in early November.

10.3.4 Salluit

The village of Salluit, located 10 km inland from Hudson Strait on Sugluk Inlet on the northern coast of Quebec, is surrounded by mountains rising up to 500 m.

10.3.4.1 Winds and Weather

In Salluit, the dominant wind directions during the summer are southwest and northeast due to the funneling effect in Sugluk Inlet. The rest of the year, winds blow predominantly from the southwest—sometimes with great force due to a downslope effect.

Northwest winds often bring fog to the area that can persist for several days. Fog, in general, is frequent during the ice-free period.

10.3.4.2 Tides and Ice Conditions

The tidal range in Sugluk Inlet is 3.4 to 5.5 m.

The inlet usually freezes up in the middle of November and opens by the first week of August.

ARCTIC REGIONAL GUIDE PART 7: BAFFIN BAY AND DAVIS STRAIT

11. Southern Baffin Bay and Davis Strait Marine Area

The Southern Baffin Bay and Davis Strait Marine Area comprises nine regions. The six covered in this chapter form part of the Northwest Passage Route: West Clyde, West Davis, Cumberland Sound, West and Central Brevoort, and Frobisher Bay.

Figure 1: The Southern Baffin Bay and Davis Strait Marine Area and its marine regions.

Winds and Weather

Low-pressure centres that affect these waters during the navigation season usually develop outside the area—often moving north through Davis Strait along a mean track that lies near the Greenland coast. In Baffin Bay, these storms normally slow down, gradually losing their identity and strength as they fill. Some move northeastward from the Prairies to Davis Strait, where they slowly shift direction and track northward through Baffin Bay. Storms that originate in the Western Arctic may also reach Davis Strait or southern Baffin Bay. A low-pressure trough along the west Greenland coast is an important synoptic feature. The most intense storms occur during the winter and the weakest, during the summer. A ridge of high pressure is usually found from the Arctic Basin southeastward to the Great Slave Lake area, while a weak, secondary low-pressure system often occurs over Foxe Basin.

The prevailing direction of winds in the coastal waters of Baffin Bay and Davis Strait tends to be parallel to the coastline. The most frequent winds off Baffin Island blow from the north and the west. Southeast winds are next in line, especially during the summer, when east winds also become more frequent. Land and sea breezes occur in the warmest months of the year.

The mean air temperature along the coast of Baffin Island does not usually exceed 5°C as a result of the Baffin Current. During September and October, it falls rapidly. The coastal air near Greenland is slightly warmer due to the warm southern current.

Rain is the most common form of precipitation during July and August, especially in Davis Strait. Snow can also occur—most often, in Baffin Bay—and becomes more frequent starting in September.

Poor visibility and fog are quite common along the east coast of Baffin Island with a southeasterly onshore flow. Dense fog often forms along the ice edge in mid-summer, often due to light to moderate south to east winds. If winds from these directions are accompanied by precipitation, the probability of fog formation is much greater. Visibility is generally good with winds from the north and northwest.

Although they often go unobserved, strong katabatic winds are quite common in the Arctic and can be reinforced to even higher speeds by a pressure-gradient force.

Ice Conditions

Ice begins to puddle in mid-June, with separation between the Baffin Bay and Davis Strait ice packs starting to occur at Cape Dyer (northeast Cumberland Peninsula) when the tidal motion is strong.

During July and August, the pack usually melts more quickly on the north Baffin coast than it does in the centre of the bay. Its retreat is aided by wave and tidal motion and by the warmth of the water arriving from the north, where it has been exposed to the sun for several months. The remaining “middle pack” extends from Cape Dyer and Home Bay to a latitude of about 72N in early August but is reduced to a number of offshore patches by the end of the month. The ice in vicinity of Cape Mercy (southeast Cumberland Peninsula) and Cape Dyer also melts gradually during this period, with very little southward drift.

The complete clearing of Baffin Bay does not occur every year, but floes remaining in late September are easily dispersed by autumn storms and almost always carried out of the bay before the growing ice attains appreciable thickness. During this season, intrusions of ice through Smith Sound (between Ellesmere Island and Greenland), if they occur, are the only significant source of old ice in the area. Patches of this ice may be carried into the Devon and Bylot islands area in October, where they become cemented into the main pack. The total area of such intrusions, however, would amount to only a small percentage of the total ice cover.

Baffin Bay is the birthplace of many thousands of icebergs produced off the west coast of Greenland and from glaciers on Ellesmere Island. Most are calved in the vicinity of Disko Bay (near Illulisaat, on the west coast of Greenland) and Melville Bay (east of Thule, Greenland), which reaches its seasonal maximum in late summer. From there, they are carried by the current (and, to some extent, also by wind and ice motion) to the northwest corner of the Baffin Bay, where the cold Canadian Current draws them southward toward Cape Dyer and beyond. The minimum frequency of icebergs in the bay is during the ice-free period in late summer, before the new crop begins to arrive.

Mariners' Tips:
Steady onshore winds can cause ice flows to drift into fiords, restricting passage to only small boats. This ice will remain until the offshore winds and currents remove it from the fiord.

Baffin Bay, seen from Akpait National Wildlife Area, Baffin Island, Nunavut. Photo courtesy of Garry Donaldson.

11.1 West Clyde Marine Region

The West Clyde Marine Region primarily covers southwestern parts of Baffin Bay, including the coastal waters from Home Bay (Arguyartu Point) northward to Cape Jameson (Ragged Point), between Coutts Inlet and Buchan Gulf. The ragged coast is broken by numerous inlets, fiords, bays, and islands. The main topographic feature in the area is a northwest to southeast-oriented mountain range along the eastern coast of Baffin Island.

Figure 2: Local effects for the West Clyde Marine Region.

11.1.1 Winds and Weather

Surface winds on Baffin Island are strongly influenced by fiords and the surrounding mountains and their passes. Due to the high elevation and the prevalence of snow and ice atop the steep topography near shore, katabatic winds are very common.

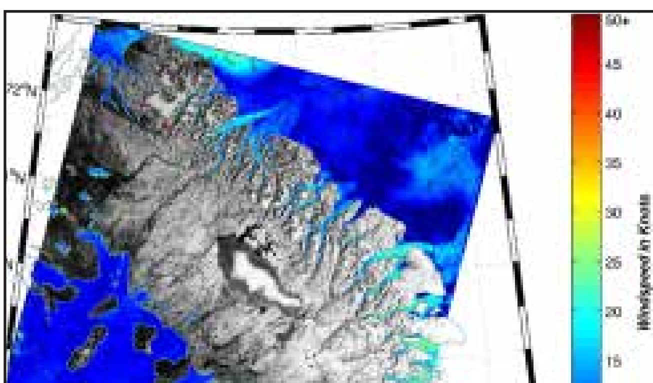


Figure 3: RADARSAT image from September 15, 2012, showing moderate to strong katabatic winds.

Most of the precipitation during July and August is generated by low-pressure systems moving through Davis Strait toward Baffin Bay. Drizzle and moderate rain are the most common form in July and August; however, in September, precipitation may fall as either rain or snow, with snow more common in Baffin Bay and rain, farther south. Rain seldom falls in October.

Dense fog often forms along the ice edge, especially in light to moderate south to east winds. If they are accompanied by precipitation, the probability is even greater.

11.1.1.1 Northeasterly and Easterly Flow Pattern

This flow is most often generated by a West Greenland low-pressure trough or a low-pressure system moving northward toward Baffin Bay. Northeasterly and easterly flow in the bay forms a band of strong winds along the coast called a "barrier jet" or "barrier wind". Although a ridge of high pressure (an isobar "kink") along the coast is often a good indicator of the presence of a barrier jet, this is not always the case. These winds can occur anywhere along the eastern coast of Baffin Island.

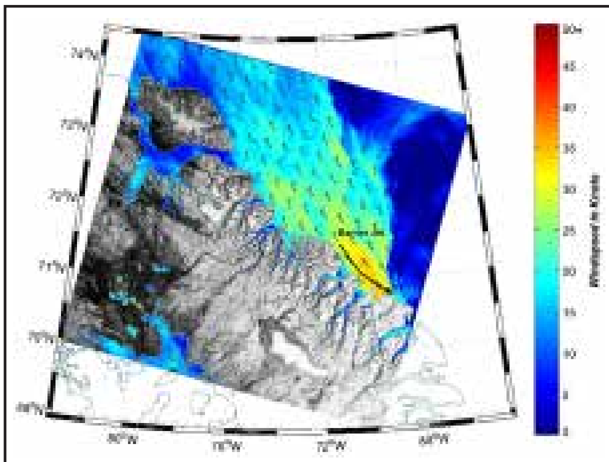


Figure 4: RADARSAT image from October 19, 2012.

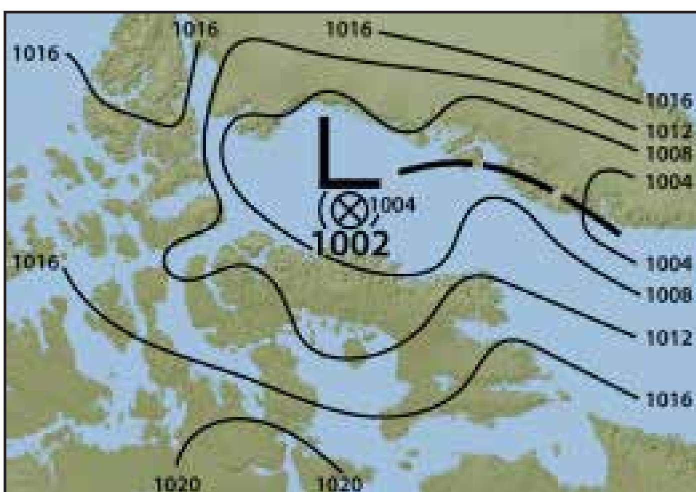


Figure 5: Surface analysis from October 19, 2012.

RADARSAT image (above) and surface analysis (below) from October 19, 2012. Barrier jet winds were generated by a weak quasi-stationary low-pressure system rotating over Baffin Bay. Northwest winds of 30 kt were observed in Clyde River the same day, in the morning and afternoon.

11.1.1.2 Westerly and Southwesterly Flow Pattern

Westerly or southwesterly flows generate numerous wind effects in the region, including downslope, gap, outflow, and fiord winds, and lee waves.

Strong southwest winds can occur in two different set-ups. One is when there is a general southwesterly flow over a large portion of Baffin Island, creating a downslope effect over the mountain range. This set up is more typical in the summer and can be strengthened not only by downslope winds but also by a strong southwesterly synoptic flow over Baffin Island. When this type of flow occurs, winds channel through the fiords of the Baffin Island coast, including Clyde Inlet. A well-defined trough of low pressure along the coast near Clyde River is sometimes an indicator of stronger southwest winds in the area.

A second pattern occurs when a strong pressure gradient develops along and parallel to the coast, leading to gap-wind effects in the fiords when the winds are blowing toward an area of lower pressure. This effect could increase southwesterlies and westerlies in Clyde Inlet to moderate or even strong. This pattern is more typical in winter.

Strong southwest outflow winds are possible out of the Sam Ford Fiord and Clyde Inlet and can extend 100 km or more into Baffin Bay, with "trains" of lee waves capable of spreading up to 30 km or more. Locals describe Sam Ford Fiord as "going with the wind," most likely to due to the channelling that occurs through it.

Mariners' Tips:
When travelling along the coast in lee waves (intermittent bands of stronger and lighter winds), mariners should exercise caution at the mouth of fiords, where strong outflow winds could force them out to sea.

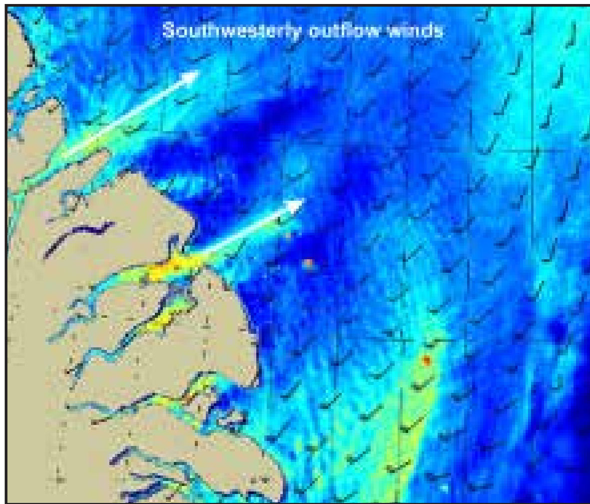


Figure 6: RADARSAT image from August 20, 2014.

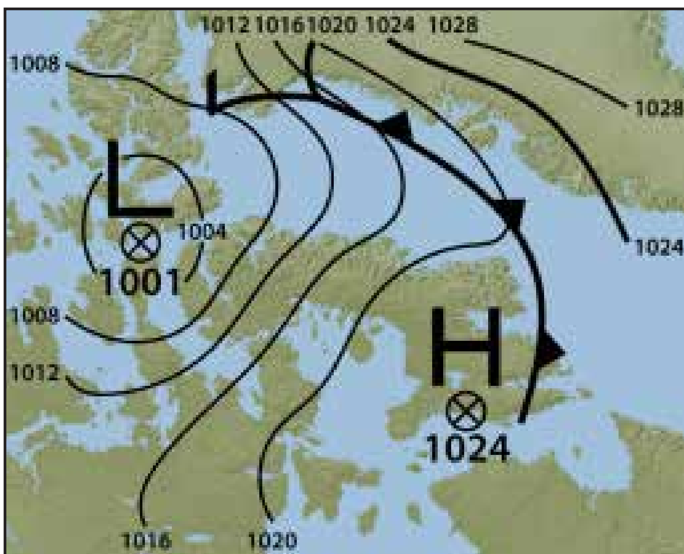


Figure 7: Surface analysis from August 20, 2014.

RADARSAT image (above) and surface analysis (below) from August 20, 2014. Strong southwest outflow winds were blowing out of Sam Ford Fiord and Clyde Inlet. Winds at Clyde River were 24 gusting to 31 kt from the southwest. Lee waves are visible on the RADARSAT image around Henry Kater Peninsula.

The strongest southwest winds occur around Govan Point (Clyde Inlet) and between the northern coast of Aulitivik Island and northern coast of Isabella Bay, most likely due to a combined cornering and channelling effect. The blow is nearly always strong in Suluraq Point, north of Steel Island (Suluraup Qikiqtanga), where locals describe the sound of the wind like a "whip cracking" as well as in Tisunaarajuttuq Point, on the northern side of Clyde Inlet. Strong outflow winds can also be generated out of Buchan Gulf and its surrounding channels and fiords.

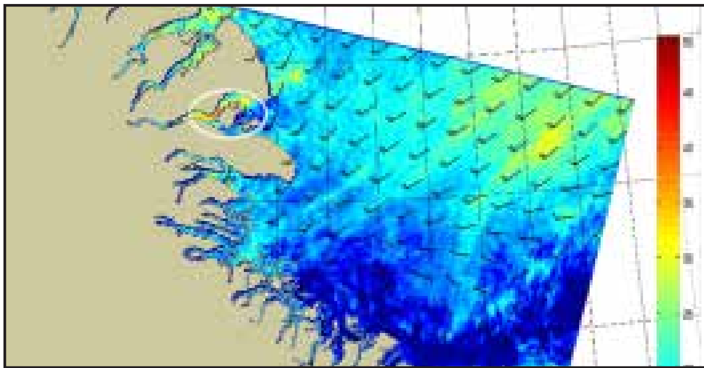


Figure 8: RADARSAT image from August 13, 2014.

RADARSAT image from August 13, 2014, showing wind speed distribution in Isabella Bay (white circle) in a southwesterly flow.

Mariners' Tips:

Mariners should exercise caution when they are travelling along the coast of Baffin Island, especially in a small boat, as strong southwesterly outflow-fiord winds may push them away from the coast. Such winds are accompanied by choppy seas at the mouth of the fiords.

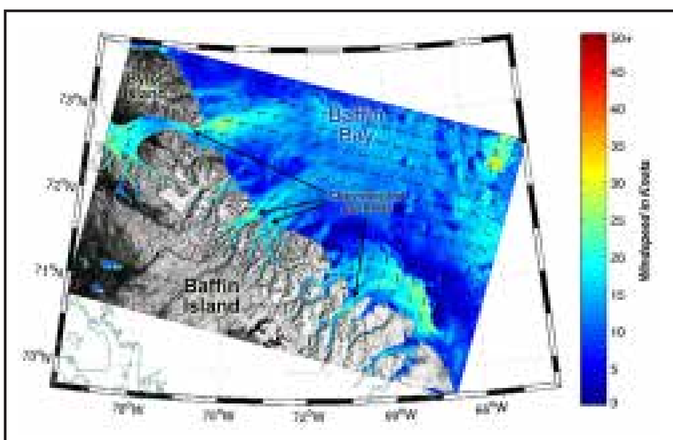


Figure 9: RADARSAT image from October 9, 2012.

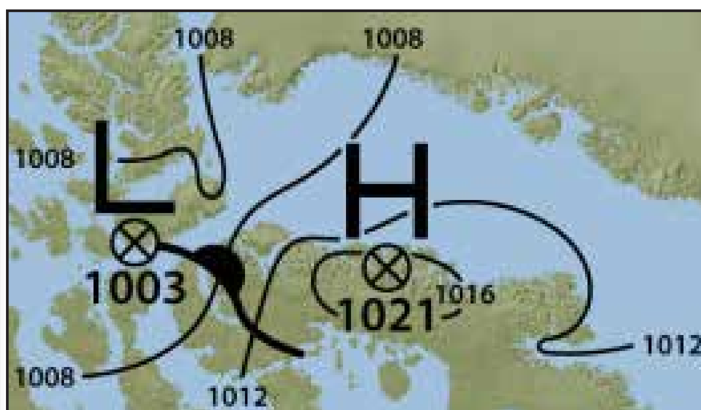


Figure 10: Surface analysis from October 9, 2012.

RADARSAT image and surface analysis from October 9, 2012. Bands of strong winds extended east into Baffin Bay, where they slowly diminished. Synoptic flow around the high-pressure center was weak, yet southwest winds near 20 kt were generated out of many fiords along the coast of the bay, most likely enhanced by a gap wind effect.

11.1.1.3 Southeasterly and Easterly Flow Pattern

Channelling occurs with a southeasterly onshore flow into fiords along the coast of the West Baffin region. Even when the synoptic flow is very weak, moderate east to southeast winds are generated in Buchan Gulf, Drever Arm, Scott Inlet, and Sam Ford Fiord, as well as in other fiords and small inlets along the coast.

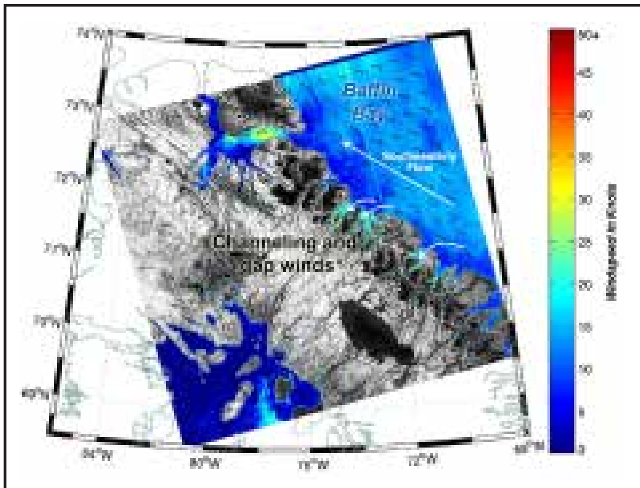


Figure 11: RADARSAT image from August 4, 2011.

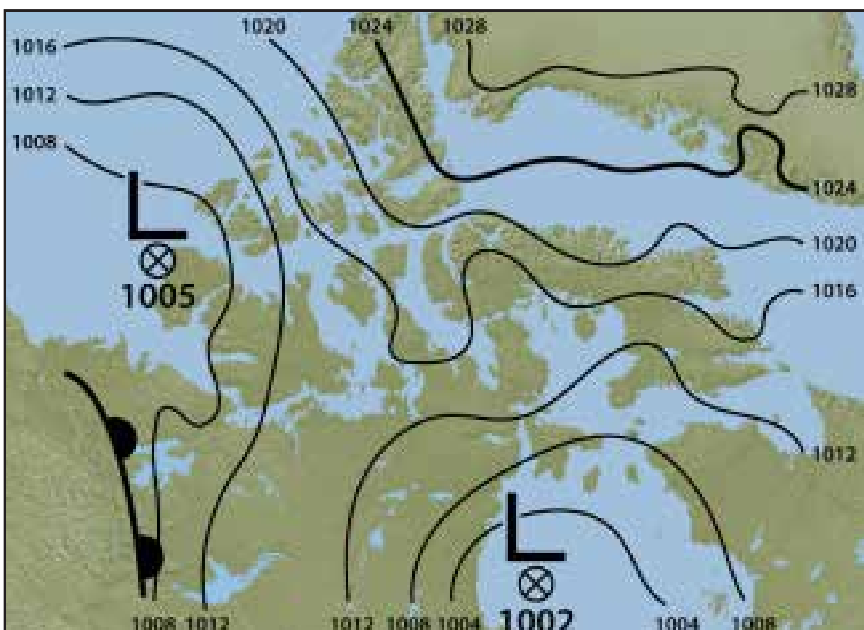


Figure 12: Surface analysis from August 4, 2011.

RADARSAT image (above) from August 4, 2011, showing the effect of channeling with a southeasterly onshore flow into fiords on the West Baffin region coast.

11.1.2 Waves, Shoals, and Tides

11.1.2.1 Waves

The greatest wave fetches in the Baffin Bay region generally occur in late August and early September. The entrances to Sam Ford Fiord, Eglinton Fiord, and Clyde Inlet are noted, in particular, by locals as experiencing large waves.

11.1.2.2 Shoals

Shoal water extends up to 10 km south and southwest of Cape Raper. Breakers reportedly extend to nearly 2 km north of Burns Island (Clyde Inlet).

11.1.2.3 Tides

Tidal streams off Cape Christian set north with the incoming stream and south with the outgoing stream at a rate of 1 to 2 kt. Mariners may, therefore, find themselves in difficulty when the wind opposes the current.

11.1.3 Clyde River

The community of Clyde River is located on the north side of Clyde Inlet, in the sheltered cove of Patricia Bay. The main topographic feature is a mountain range, oriented from northwest to southeast, located approximately 70 km to its west.

11.1.3.1 Winds and Weather

When storms move north through Davis Strait and Baffin Bay, they often stall to the north or northeast of Clyde River. In the fall, a deepening trough of low pressure in western Greenland begins to interact with the relatively warm waters of Baffin Bay, creating a stronger northerly gradient and low-level instability.

Clyde River is a foggy place—in particular, in August. The terrain allows fog to be easily blown into the area with winds from any direction except west and southwest. Northeasterly and easterly winds often bring fog from the sea during the summer, especially when the winds are above 20 kt.

Mariners' Tips:
When fog or low clouds are observed over Big Boss Mountain (Sawtooth Mountain) located west of Clyde River, travelers in the area should watch out for windy conditions.

North and Northwest Winds

North to northwest winds are frequent throughout the year. Strong northwest winds are dominant in both summer and fall, with higher wind speeds occurring in the fall. In September, northwest winds in Clyde River often cause large waves and colder temperatures.

Strong northwesterlies can even develop with a weak ridge over the spine of Baffin Island. The head of Patricia Bay offers good shelter from prevailing north and northwest winds.

Mariners' Tips:
Falling pressures over Davis Strait can often be predictor for strong northwest winds in Clyde River.

East and Northeast Winds

Northeast winds bring more rain during the summer, especially when the wind speed is above 10 kt. Easterly and northeasterly winds can generate a strong barrier jet along the northeast coast of Baffin Island that is closely aligned with the mountain range. The development of a small ridge of high pressure (isobar "kink") along the northeast coast of Baffin Island in the vicinity of Clyde River indicates that a barrier jet has developed. The strong winds associated with the barrier jet diminish fairly quickly as the low-pressure centre passes far enough to the north or northeast of the site.

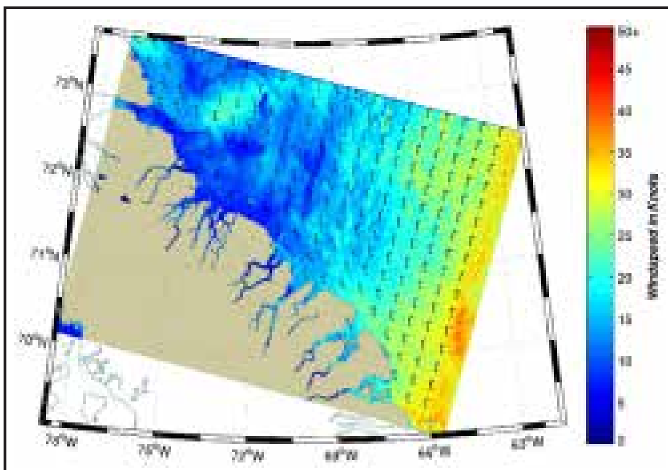


Figure 13: RADARSAT image from August 31, 2013.

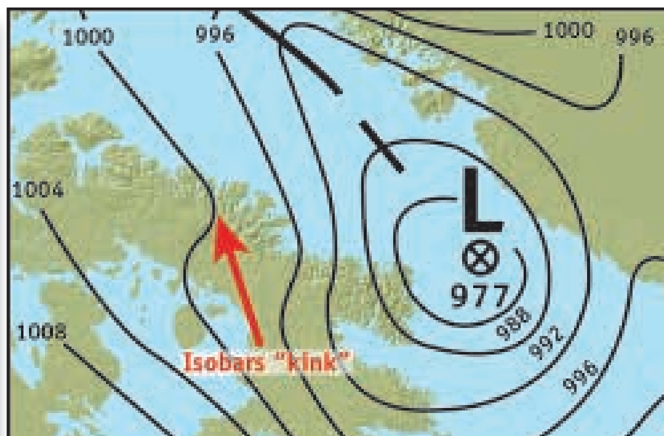


Figure 14: Surface analysis from August 31, 2013.

RADARSAT image and surface analysis from August 31, 2013. A strong, low-pressure system had moved from the northern Hudson Bay area, generating a trough along the coast of western Greenland. The system resulted in strong northwest winds of 20 kt, gusting to 24 kt, south of Clyde River, and near gale-force to gale-force winds further south along the coast. The "kink" in the isobars indicates the development of a barrier jet.

Mariners' Tips:
According to local lore, northwest and southeast winds create a rough water surface, while winds from the east "clean up" and stabilize the weather, making them ideal for marine travel.

Southeast and South Winds

Southeast winds are more frequent but weaker during the summer and less frequent but stronger in the fall. They can weaken shore-fast sea ice, as they are warm and increase the melting of snow and ice.

Southwest and West Winds

Southwest winds are less frequent than southeast winds but can be quite strong. When they flow over Baffin Island, they can channel through the fiords along the coast, including Clyde Inlet. Typically warm and gusty, southwest winds help break up ice and melt snow. There is a slight shift toward southwesterlies in July.

Although gap-type flows that develop as a result of a strong pressure gradient along the coast can strengthen southwesterly to westerly winds in Clyde Inlet, Clyde River is sheltered from these flows. This pattern occurs more typically in the winter.

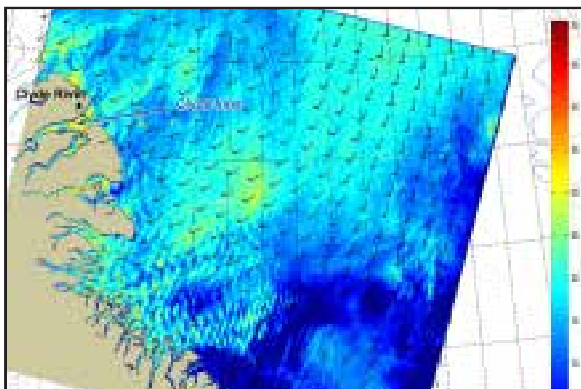


Figure 15: Radarsat image from August 10, 2014.

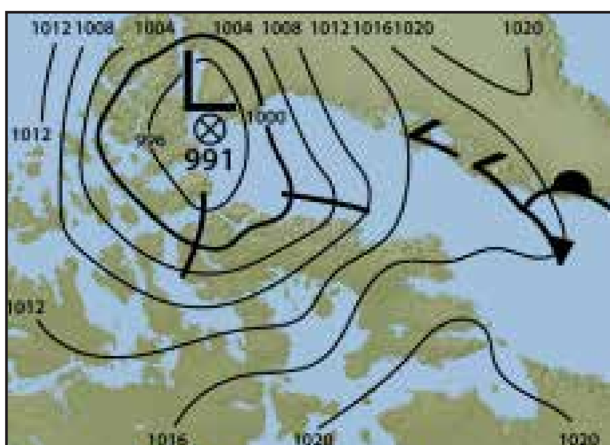


Figure 16: Surface analysis from August 10, 2014.

RADARSAT image (above) and surface analysis (below) from August 10, 2014, when a strong southwesterly flow was generated over large portions of Baffin Island and there was a well-defined trough over the West Clyde Marine Region. While winds at Clyde River had diminished to southwest at 15 kt gusting to 23 kt, gale-force winds continued in Patricia Bay and Clyde Inlet.

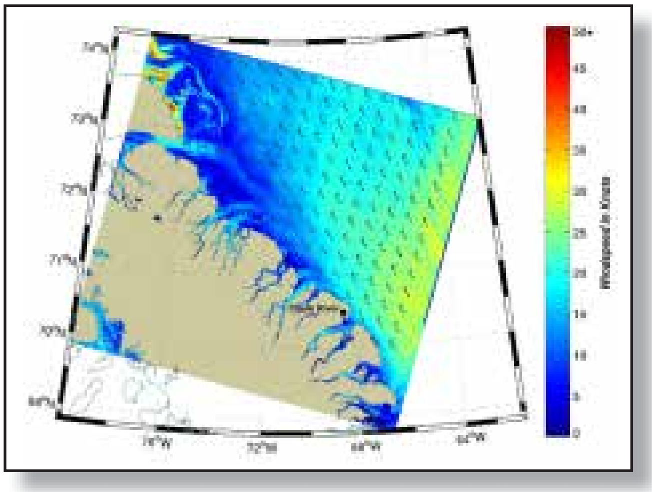


Figure 17: Radarsat derived winds from October 11, 2013.

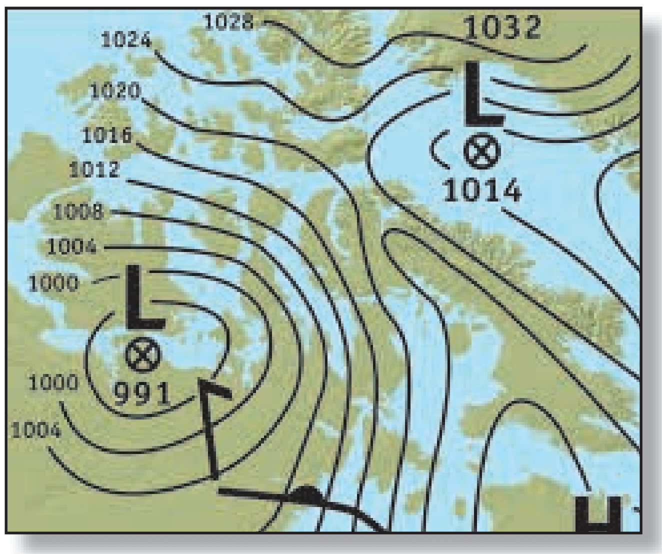


Figure 18: Surface analysis from October 11, 2013.

RADARSAT image (above) and surface analysis (below) from October 11, 2013, when a pressure gradient forced air from an area of higher to lower pressure. Relatively light westerly-southwesterly flow turned to moderate outflow winds from the Clyde Inlet and other inlets and fiords on the Baffin coast. Clyde River observed only light westerly winds.

11.1.3.2 Tides and Ice Conditions

Tidal Streams at the head of Patricia Bay are negligible.

Clyde Inlet freezes up at the end of October and breaks up at the end of July. Ice may continue to drift in Patricia Bay for a month after break-up.

11.2 West Davis Marine Region

The West Davis Marine Region includes the coastal waters of Davis Strait from Home Bay (Arguyartu Point) south, past the Cumberland Peninsula, to Cape Mercy. The communities of Qikiqtarjuaq, Cape Hooper, and Cape Dyer are situated on the peninsula's northern shores, while the Northern Marine Transportation Corridor is located approximately 50 to 100 km off the coast.

Figure 19: Local effects for the West Davis Marine Region.

11.2.1 Winds and Weather

The same storms and weather patterns that affect the West Clyde Marine Region affect the West Davis Marine Region, as well. There are only a few weather stations and airports on this part of the coast, at Qikiqtarjuaq, Cape Hooper, and Cape Dyer.

Cape Hooper is a coastal settlement located north of Broughton Island, between Nudlung Fiord in the south and Home Bay in the North. It is situated on an irregularly shaped peninsula marked by numerous fiords at an altitude of approximately 430 m above sea level. Pilot reports suggest that katabatic winds affect the area. Nudlung Fiord lies south of the cape and extends into the glaciated east coast mountain range. It is an ideal path for cold outflow winds caused by dense, cold air to the west of the cape.

Cape Dyer lies on the extreme eastern headland of Baffin Island and is bounded by rugged peaks and fiords to the west and Davis Strait to the east. Cape Dyer is a windy place. Violent katabatic winds have been reported to channel from the cape as well as out of Exeter Bay. Katabatic winds can also occur at Padle and Sunneshine fiords and Exeter Sound.

During the summer, sea ice melts and breaks up, producing cool, moist air over nearby low-lying areas, with fog most common in August. Patches of low cloud and fog are widespread over the sea and along the coasts and sometimes spread well inland in persistent onshore flows. The inland areas of larger islands, fiords, and inlets usually experience better conditions than exposed coasts, although cumulus clouds and towering cumulus clouds can sometimes develop over the interior of larger islands.

The southeastern Baffin Island regions are warmer and tend to have more frequent storm activity than the northern parts. In general, pressure systems are weaker in the summer than the winter, so winds tend to be lighter during the navigation season.

11.2.1.1 Northeasterly and Easterly Flow Pattern

A northeasterly or easterly flow can be generated by the West Greenland trough or by intense systems from the Prairies that move north once they reach Davis Strait. When it blows against the eastern Baffin coast, it causes a barrier jet.

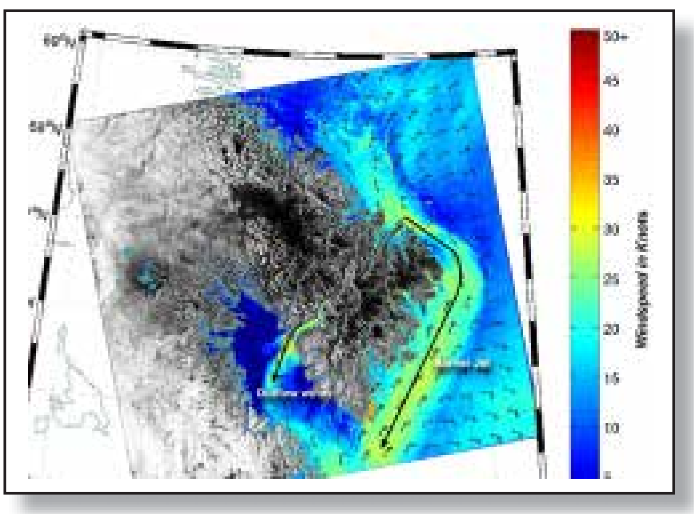


Figure 20: RADARSAT image from July 29, 2010.

RADARSAT image from July 29, 2010, showing northeast winds streaming along the southeast side of Cumberland Peninsula, generating a barrier jet. Strong northeast outflow winds out of Kingnait Fiord are also shown.

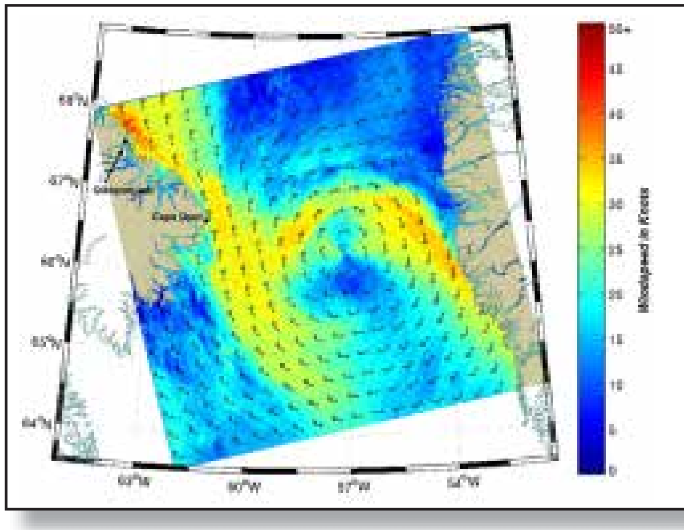


Figure 21: Radarsat image from August 31, 2013.

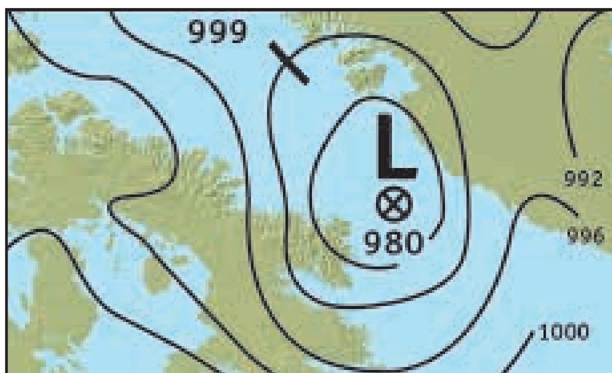


Figure 22: Surface analysis from August 31, 2013.

RADARSAT image (above) and surface analysis (below) from August 31, 2013, when a much stronger barrier jet developed along the eastern Baffin coast, with north winds reaching up to 27 kt at Qikiqtarjuaq, 32 kt at Cape Hooper, and 46 kt at Cape Dyer. Winds at Clyde River reached 20 kt from the northwest. A weak ridge of high pressure is visible over northern Baffin Island on the surface analysis; a barrier jet is visible along the coast of Baffin Island on the RADARSAT image, as well as cornering effect around Cape Dyer.

11.2.1.2 Northerly and Northwesterly Flow Pattern

A northerly or northwesterly flow can be generated when there is a low or trough near the coast of Greenland. Westerly and northwesterly flows are common in most fiords on Baffin Island because of their topography and geographical orientation. Northerly flows that blow over the island can also generate a barrier jet.

West winds are strong and the most frequent kind experienced at Cape Hooper due to orographic channelling and katabatic winds. When the pressure gradient and katabatic mechanisms align, severe west winds are sure to occur and have been known to persist for days.

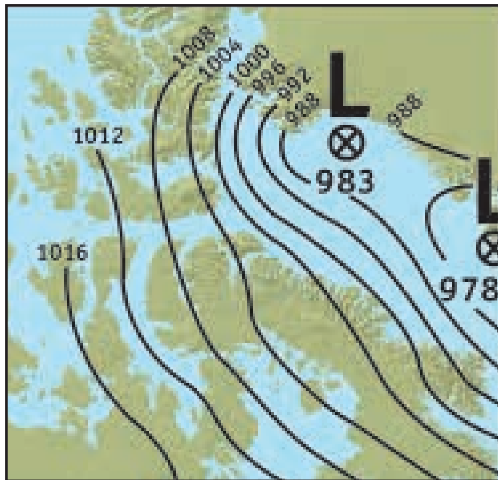


Figure 23: Surface analysis from September 10, 2013.

Figure 23: Surface analysis from September 10, 2013, when a strong northerly flow generated near gale-force north winds of 33 kt in Qikiqtarjuaq and gale-force west winds of 43 kt in Cape Hooper, due to a channeling effect. North winds of 45 kt were also observed at Cape Dyer.

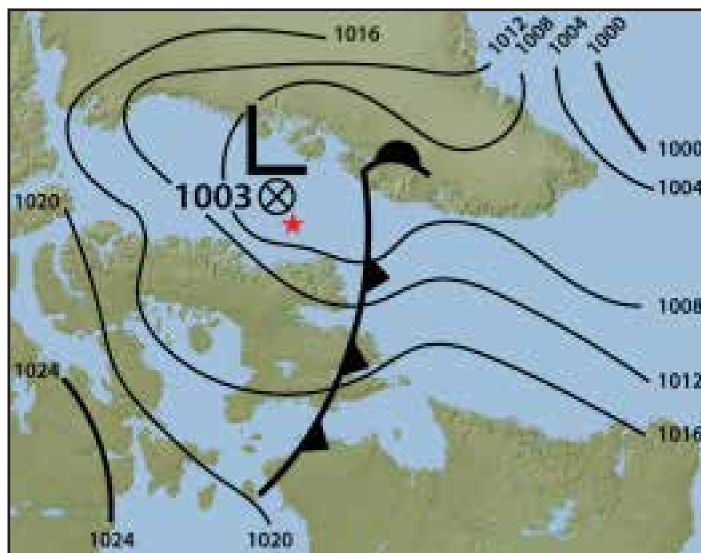


Figure 24: Satellite image from September 8, 2010.

Figure 25: Surface analysis from September 8, 2010.

Satellite image and surface analysis from September 8, 2010. West winds were channeling at Cape Hooper at up to 36 kt, while winds from the northwest were observed at Qikiqtarjuaq at 20 kt and Clyde River at up to 29 kt. Mariners experienced storm-force northwest (barrier jet) winds up to 51 kt in Baffin Bay in the vicinity of the low. Northwest winds of at least 35 kt continued to howl near the area for over 12 hours.

A cornering effect can occur at Cape Dyer with a northerly or northwesterly flow, causing wind speeds of 10 to 15 kt higher around the cape and extending southeastward over the open water for many kilometres.

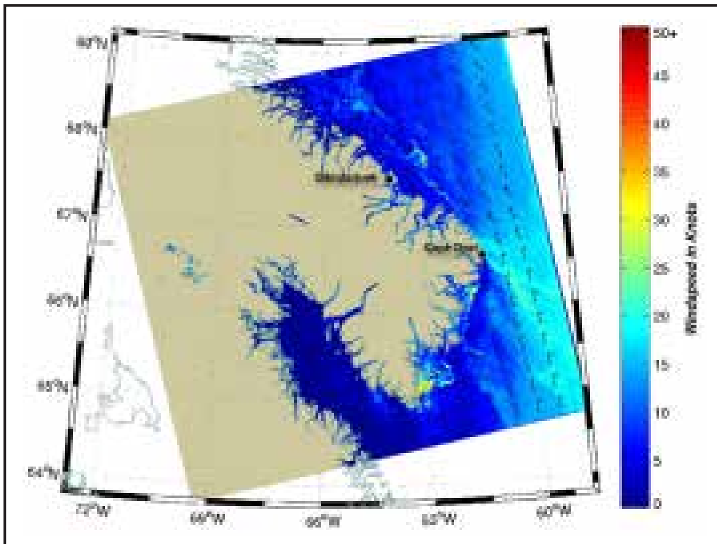


Figure 26: RADARSAT image from August 6, 2013.

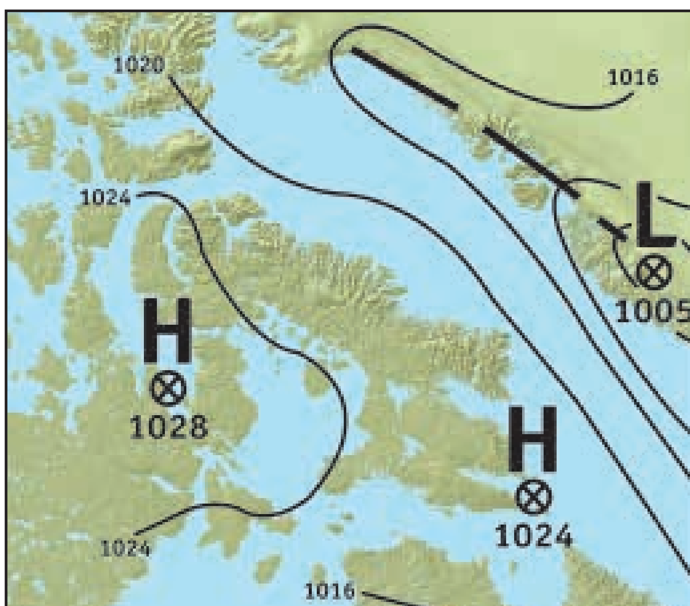


Figure 27: Surface analysis from August 7, 2013.

RADARSAT image (above) from August 6, 2013, and surface analysis (below) from August 7, 2013. The former indicates a cornering effect around Cape Dyer, which experienced moderate to strong north-northwest winds at 27 kt while Qikiqtarjuaq saw only light winds from the same direction. The surface analysis shows a quasi-stationary, low-pressure trough near the Greenland coast and most of the Baffin Island area affected by a high-pressure system, which generated mostly light flow.

Another scenario for northerly flow development occurs when an intense low develops over the Baffin Bay or Davis Strait areas. Mariners can find shelter from a strong northerly flow south of Cape Walsingham.

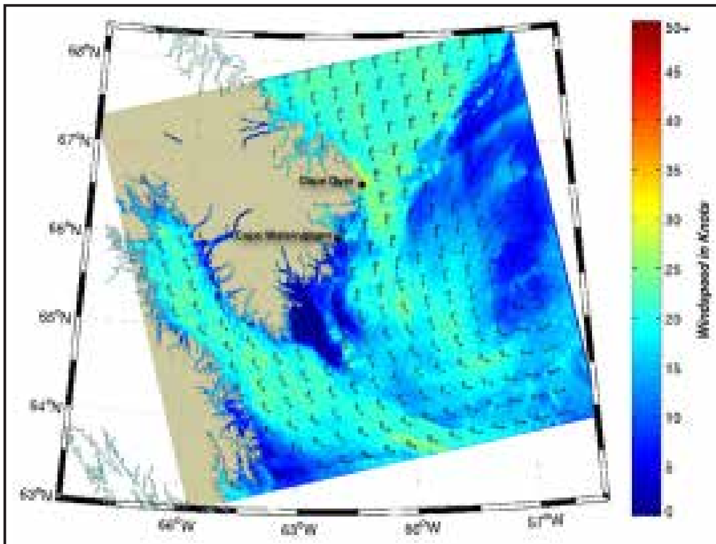


Figure 28: RADARSAT image from August 27, 2013.

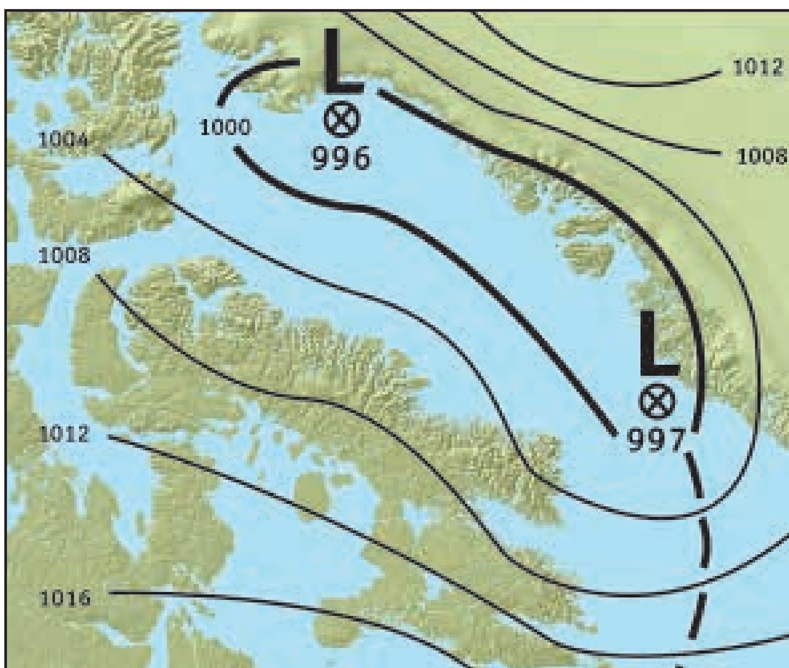


Figure 29: Surface analysis from August 27, 2013.

RADARSAT image (above) and surface analysis (below) from August 27, 2013. The former shows a band of stronger, cornering winds near Cape Dyer and an area of light winds in a strong northerly flow south of Cape Walsingham. Surface observations displayed north winds of 36 kt at Cape Dyer and only 20 kt at Qikiqtarjuaq.

11.2.1.3 Westerly Flow Pattern

Most of the fiords and inlets on the east coast of Baffin Island are geographically and topographically prone to channelling when a strong synoptic flow has a westerly component. Gap winds are also common in fiords when a strong pressure gradient develops along and parallel to the coastline.

Winds from westerly quadrants are the most common in fiords along the east coast of Cumberland Peninsula—in particular, in the Sunneshine, Exeter, and Ingnit fiords. Violent katabatic winds have been reported to funnel out of Exeter Fiord, causing gusty winds, while winds rise quickly and channel strongly in Sunneshine Fiord.

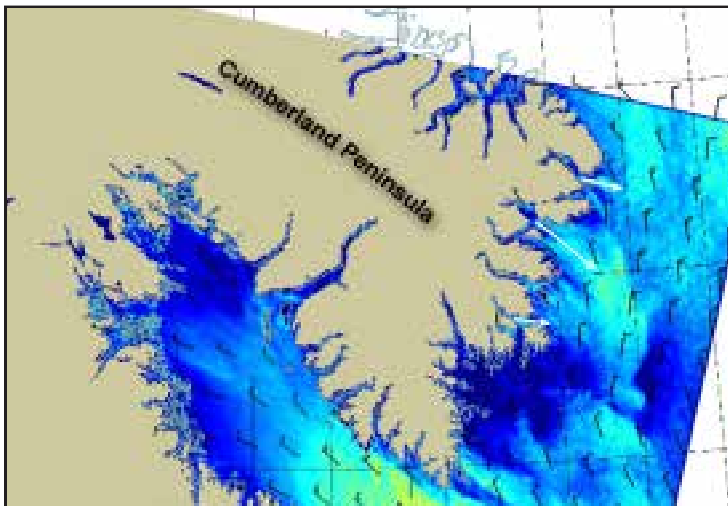


Figure 30: RADARSAT image from October 21, 2014, showing the westerly outflow winds from Cumberland Peninsula through the Exeter, Ingnit, and Sunneshine fiords.

Katabatic effects and westerly flow are responsible for the onset of west winds in Cape Hooper, where they are predominant and have been known to blow for days.

11.2.1.4 Southerly and Southwesterly Flow Pattern

A southerly or southwesterly flow usually occurs when storms move from Hudson Bay toward Baffin Island. Southerly winds can cause a cornering effect north of Cape Dyer.

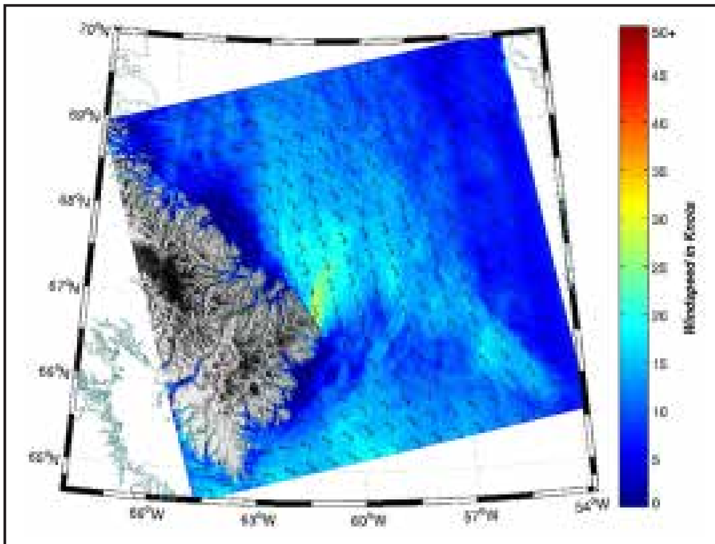


Figure 31: RADARSAT image from August 4, 2011.

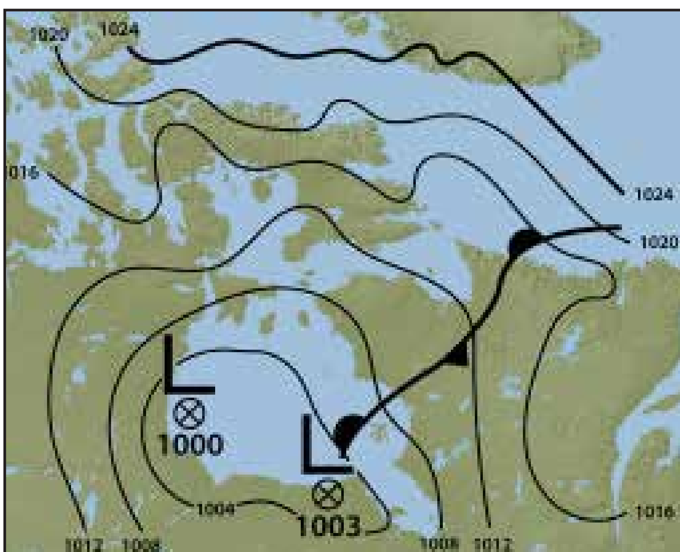


Figure 32: Surface analysis from August 4, 2011.

RADARSAT image (above) and surface analysis (below) from August 4, 2011 showing a cornering effect north of Cape Dyer in a southerly flow, where winds were reported at 23 kt in a relatively weak synoptic pattern.

11.2.2 Tides, Shoals, and Ice Conditions

11.2.2.1 Tides

Strong tidal streams are found along the shore from Cape Mercy to Cape Dyer. In Sunneshine Fiord, the incoming stream sets east and the outgoing stream, west, at 2 to 3 kt. As such, outflow winds sometimes oppose the tidal current.

Close to shore, off Cape Dyer, the tidal streams are very strong. At the mouth of Durban Harbour, both the incoming and outgoing streams reach a maximum rate of 4 kt, while the stream on the northern shore may set in the opposite direction to the main stream.

11.2.2.2 Shoals

Several shoals extend to nearly 20 km offshore of Cape Hooper. Shoals are also found at the southern and northern entrances to Broughton Channel, south of Broughton Island.

11.2.2.3 Ice Conditions

Coastal ice is usually heavy in July and early August but usually clears by the end of August or the beginning of September. Freeze-up occurs at the end of October. Icebergs can be found in the area at any time, many reported grounded in the shoal water off Cape Henry Kater in Home Bay.

11.2.3 Qikiqtarjuaq

Qikiqtarjuaq is located just off the east coast of Baffin Island, on the western shore of Broughton Island. The island is 12 km wide and 16 km long and is separated from the Baffin coast by Broughton Channel, which creates a corridor nearly 2 km wide.

11.2.3.1 Winds and Weather

South winds are likely stronger on the east side of Broughton Island, facing Davis Strait, and north winds are stronger in the bay in front of the community. The dominant wind directions in Qikiqtarjuaq are south to southwest and north to northeast, the latter increasing in speed in the fall. The most frequent are south winds. The topography of the east Baffin Coast, Broughton Island, and the area surrounding Qikiqtarjuaq, in particular, plays a role in the funneling of winds through Broughton Channel. North winds blow straight into the channel and are generally stronger; however, south winds can, in certain cases, be stronger than expected.

Freezing precipitation is uncommon but is known to occur in May and June and again in October and November.

11.2.3.2 Tides, Shoals, and Ice Conditions

The tides in Qikiqtarjuaq Harbour experience a modest rise and fall.

The maximum speed of the tidal stream in Broughton Channel is approximately 1 kt. Shoals are found near both entrances to the channel.

Break-up usually occurs by the middle of July to early August in Qikiqtarjuaq. During this time, boat travel is not possible on the fiords. In late July, August, and September, the fiords are normally free of ice, making it possible to travel all the way to the head of the fiord by boat. Freeze-up usually starts in early October.

Mariners' Tips:
According to local reports, a quick change in winds can cause a quick change in ice and travelling conditions in this area.

Arctic glacier. Photo courtesy of Nicolas Peissel.

11.3 Cumberland Sound Marine Region

Cumberland Sound is a large body of water located between Hall Peninsula and Cumberland Peninsula, on Baffin Island. The only settlement on the south shore of Cumberland Peninsula is Pangnirtung.

Figure 33: Local effects for the Cumberland Sound Marine Region.

11.3.1 Winds and Weather

11.3.1.1 Easterly and Southeasterly Flow Pattern

Easterly and southeasterly flows arise in this area when storms track north or northwest across northern Labrador toward southwestern Baffin Island. When they approach from the west, they produce a southeasterly flow over the sound.

Winds in this flow are strong due to channelling across Cumberland Strait. They blow down the Pangnirtung Fiord, Kingnait Fiord, and other smaller fiords on the southern coast of the

Cumberland Peninsula, causing bands of strong outflow winds to extend across the body of Cumberland Sound. Only the fiords at the head of the sound are oriented southeast to northwest, like the sound itself. All of the others stretch in a northeast to southwest direction.

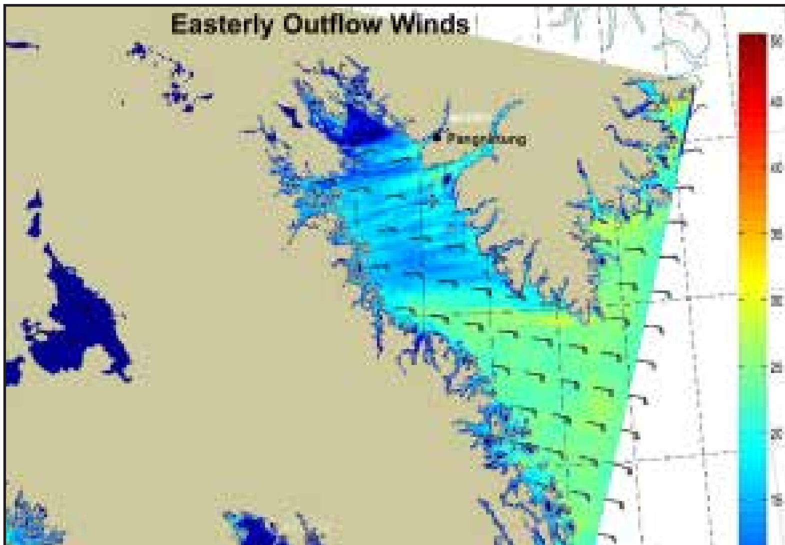


Figure 34: RADARSAT image from October 31, 2014

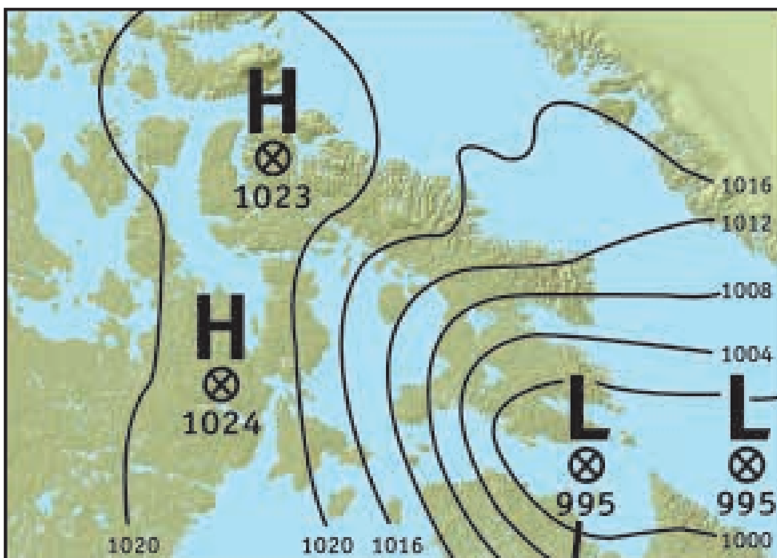


Figure 35: Surface analysis from October 31, 2014.

RADARSAT image (above) and surface analysis (below) from October 31, 2014, when winds were channelling over Cumberland Sound and its fiords. The Canadian Icebreaker Henry Larsen reported east winds of 24 kt at its location near Pangnirtung hamlet in the fiord of the same name. The Pangnirtung weather station also reported east winds, but at 10 kt lighter.

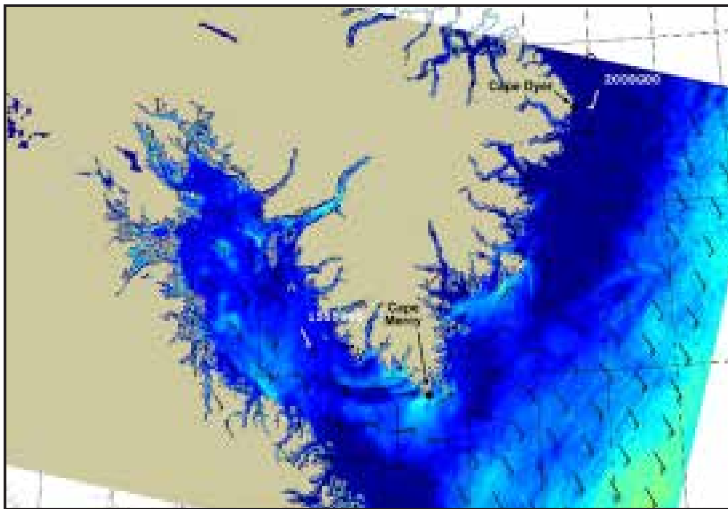


Figure 36: RADARSAT image from August 17, 2014, showing east winds cornering around Cape Mercy.

Southeasterly flow accelerates through the body of the sound. Stronger winds are observed at its head, reaching 25 kt even in a weak synoptic flow. Their acceleration can be reinforced by gap-wind effect with favorable synoptic set-up.

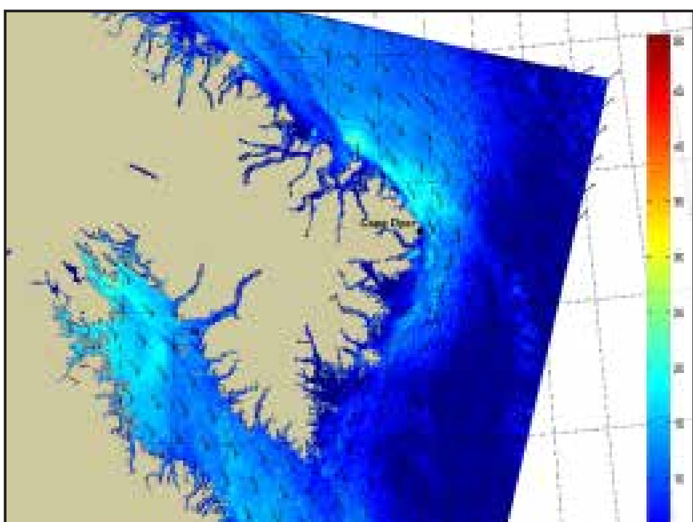


Figure 37: RADARSAT image from October 28, 2014.

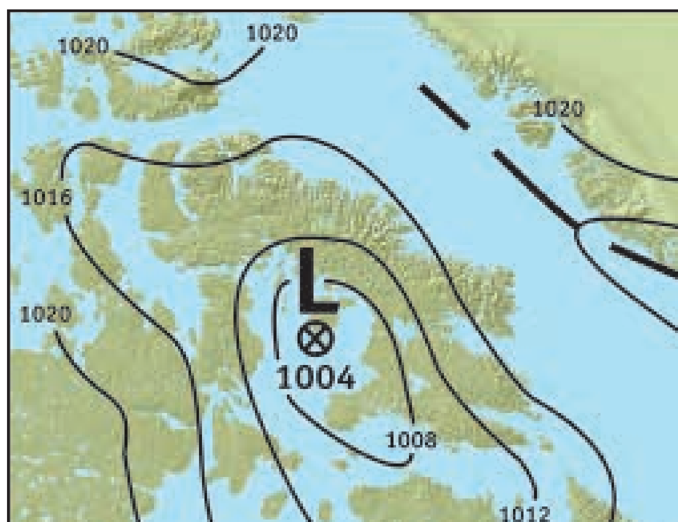


Figure 38: Surface analysis from October 28, 2014.

RADARSAT image and surface analysis from October 28, 2014. A low-pressure system moving north from Hudson Bay into Foxe Basin generated a southeasterly flow along the east coast of Baffin Island. The wind speed was likely accelerated by a gap-wind effect, given the favorable synoptic set up.

11.3.1.2 Northerly and Northwesterly Flow Pattern

A northerly or northwesterly flow over Cumberland Sound occurs primarily with a developing West Greenland trough or when a low-pressure system tracks northward over Davis Strait. Winds accelerate over Cumberland Sound due to channelling and gap-wind effects with this flow, as it is aligned northwest to southeast.

While most of the fiords and inlets in the area are protected from northwest winds by their northeast-to-southwest alignment, those at the head of the sound are as exposed as the sound itself, because they are aligned the same direction. Gap winds usually blow stronger at the exits or mouths of these fiords and inlets.

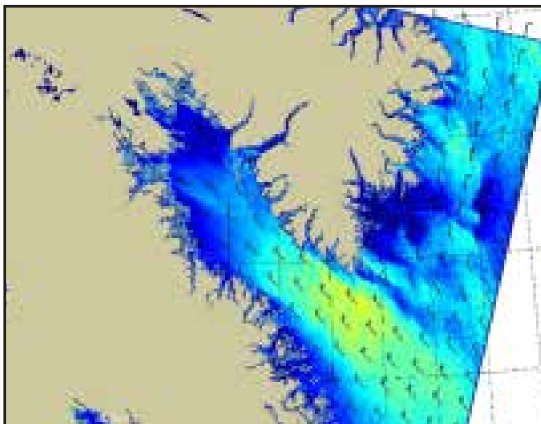


Figure 39: RADARSAT image from October 21, 2014.

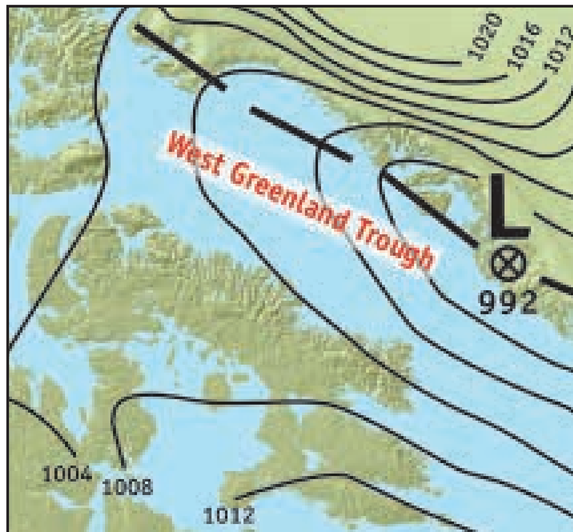


Figure 40: Surface analysis from October 21, 2014.

RADARSAT image and surface analysis from October 21, 2014. Fiords at the head of Cumberland Sound are exposed to the channeling of northwest/southeast winds in the same way as the sound itself is, with winds at its mouth capable of reaching gale force. This effect can be underestimated as, in this example, winds of only 25 kt were expected.

A northwesterly flow is responsible for the formation of lee waves near the mouth of Cumberland Sound and further south, along the coast of Hall Peninsula (West Brevoort Region).

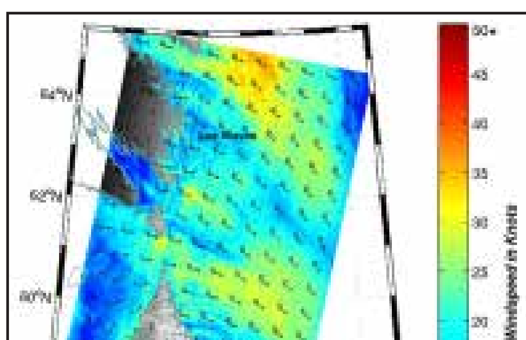


Figure 41: RADARSAT image showing the formation of lee waves in a northwesterly flow near the mouth of the Cumberland Sound and further south along the Hall Peninsula Coast, in the West Brevoort Marine Region.

11.3.2 Tides and Currents, Shoals, and Ice Conditions

11.3.2.1 Tides and Currents

The peak tidal range in Cumberland Sound is up to 5 m. There are strong tidal streams around Miliakdjuin Island and Nettilling Fiord and many violent eddies and tide rips along the route from Pangnirtung Fiord to Clearwater Fiord.

The southward-going Canadian Current sets into Cumberland Sound on the northeast side of the entrance and out of it on the southwestern side. Strong currents off Cape Mercy cause turbulence at the northern entrance to Cumberland Sound.

11.3.2.2 Shoals

There are extensive shoals near Queens Cape and reefs extending almost 2 km offshore of Saxe-Coburg Island.

11.3.2.3 Ice Conditions

In June, the larger and deeper fiords in Cumberland Sound are usually open and the ice in the exposed central area is beginning to disintegrate. Sheets of decaying fast-ice may persist until well into July in the shallower inlets and island-studded bays at the head of the sound and along its southwest shore.

Ice usually begins to form in late September and early October. While it sometimes freezes as a single sheet in the shallow bays and sheltered inlets, in most part of the sound, this early ice tends to be broken up by strong winds and tidal currents. Consolidated ice does not form until November or early December and can contain a mix of polar ice, pans of rafted local ice, and stranded icebergs—cemented together by new ice late in the season. Between the land-fast ice and this consolidated sheet, strong tidal currents create a formidable barrier of very rough ice. Off Cape Mercy, to the northeast, and in some of the deeper channels, strong currents usually keep the surface ice-free throughout the winter, providing a source of moisture for low clouds and fog.

Icebergs enter the sound and move northwestward toward Kekerten Island, then cross it and move southeastward along the shore. Some become grounded in the shallow waters near the Leybourne Islands and Hozier Islands.

11.3.3 Pangnirtung

Pangnirtung is a hamlet on the south shore of Pangnirtung Fiord. Nestled at the base of a range of snow-capped mountains on the shores of a narrow (3 km-wide) fiord, it is another area of the Baffin coast that is influenced by local topography.

11.3.3.1 Winds and Weather

Pangnirtung is located near a major track for storms moving north through Davis Strait from either northern Quebec or the Newfoundland area. It is sheltered from strong northerly winds by the mountains of the Cumberland Peninsula.

Pangnirtung has a clear tendency for strong flows, often from the west and west-southwest due to channelling through Pangnirtung Fiord. East or southeast winds are the strongest. The windiest situations occur with storms tracking north or northwest across the northernmost parts of Labrador, through Cumberland Sound, and across Baffin Island. These storms produce gusty east to east-northeast winds that increase in frequency in the fall and can sometimes reach damaging strengths. Strong and consistent easterly winds at Pangnirtung airport may be the result of outflow from the fiord, combined with downslope flow from the mountains.

Mariners' Tips:
Wind can be much localized in Pangnirtung. The head of Pangnirtung Fiord may be calm, while high winds are blowing in the community itself.

Another windy synoptic pattern results from a low approaching from the west that produces a southerly flow at Pangnirtung. On occasion, this flow produces strong southeast winds, likely the result of funneling in the valley to the southeast of the community.

Much of the snow at the lower elevations melts in the summer. Daytime heating accentuates the sea breeze effect, which can also be enhanced by channelling through Pangnirtung Fiord. In the summer, westerly winds often strengthen to 12 to 15 kt around 16:00 UTC and diminish to light by 21:00 UTC.

Significant Event: November 27, 2010
Strong wind gusts of about 70 kt flipped a truck, toppled oil tanks, and tore the roof off two housing complexes in Pangnirtung. Several buildings and a number of boats and vehicles were damaged, and power lines and broken windows were strewn about the area. Pangnirtung Airport reported sustained easterly winds of 49 kt, while Cape Dyer reported sustained southerlies of 42 kt.

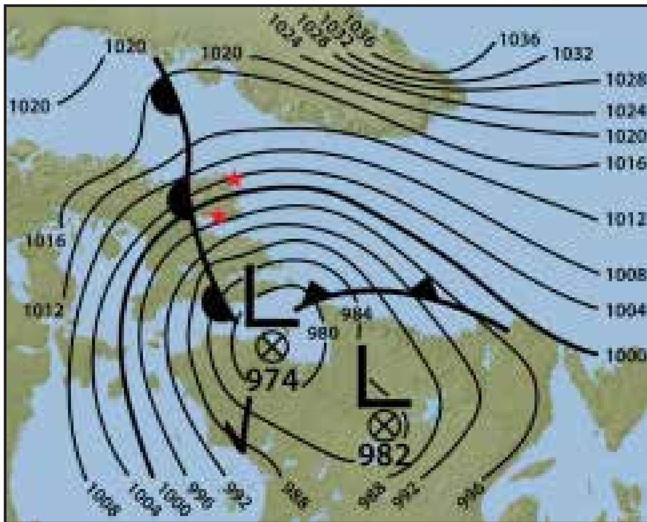


Figure 42: Surface analysis from November 27, 2010, at 12 UTC, when Pangnirtung and Cape Dyer experienced high, sustained winds from the east and south, respectively.

The strongest winds in both Pangnirtung and Kingnait Fiords occur with winds that blow down the fiord from the northeast. In Pangnirtung, strong downslope winds also occur as east to southeast winds come across the 1200 m high mountain peaks and descend to sea level. A quick and noticeable rise in temperature at Pangnirtung can mark the transition from winds that come from the northeast (down fiord) to east or southeast (downslope).

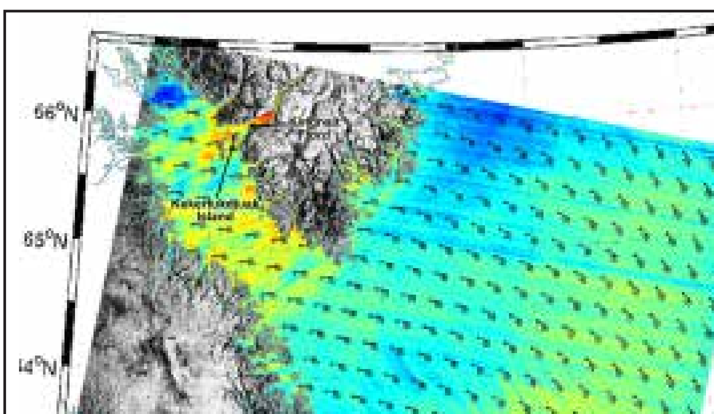


Figure 43: RADARSAT image from November 27, 2010, showing strong winds in Kingnait Fiord. Some of the strongest winds occur downstream of the high headland terrain on the north side of Cumberland Sound, as well as at Kekertukdjuak Island (700 m above sea level), at the mouth of Kingnait Fiord.

Mariners' Tips:
Sudden gales are frequent in Pangnirtung Fiord and others along this coast, especially in the vicinity of ice caps. In such cases, ships anchored in Pangnirtung may find better conditions in the open waters of Cumberland Sound.

The Penny Ice Cap can generate katabatic winds in Pangnirtung Fiord, especially at its head.

11.3.3.2 Tides and Ice Conditions

Due to the large tides experienced in the Pangnirtung region, boats can only arrive and depart the harbour within two hours on either side of high tide, which occurs twice every 24 hours. Tidal streams are around 2 kt.

Ice begins to break up in Pangnirtung Fiord in late June or early July. Pack ice can be expected to clear out around July 20, after which it seldom drifts back in appreciable quantities. Freeze-up occurs around the first or second week of November.

Numerous icebergs in distance. Photo courtesy of Nicolas Peissel.

11.4 West and Central Brevoort Marine Region

The West Brevoort Marine Region includes a small part of the Baffin Island coast, from the Lemieux Islands to Loks Land. Central Brevoort does not have any coastal borders, so the winds simply follow the synoptic flow in this region.

The major synoptic systems affecting this area include the West Greenland trough or storms moving north from the Labrador Sea, and storms moving northeast from Hudson Bay.

The Lemieux Islands face Davis Strait as high glaciated cliffs, pinnacles, and razor-backed ridges. Strong tidal streams are evident off their bold headlands and in the channels that separate them. Brevoort Island is high and rugged, with many glaciated valleys reaching the sea to form coves and inlets along much of its shoreline. Brevoort Harbour offers good shelter from all the winds except those from southwestern quadrants, which can raise the swell.

The approach to Cape Farrington is obstructed by shoals. Shallow water is found southwest of Allen Island and south of Brevoort Harbour, near Asiak Rock.

Careful navigation around iceberg. Photo courtesy of Nicolas Peissel.

11.5 Frobisher Bay Marine Region

Frobisher Bay is located on the southeastern corner of Baffin Island. Its funnel-like shape is formed by Hall Peninsula and Meta Incognita Peninsula.

Figure 44: Local effects for the Frobisher Bay Marine Region.

11.5.1 Winds and Weather

The climate in the region is strongly influenced by the local topography. The southeastern Baffin region tends to experience more cyclonic activity than the interior and northern parts of the island and is typically warmer by as much as 6°C. Studies indicate that the intensity and frequency of cyclonic activity around the North Atlantic has been steadily increasing and can be related to large-scale circulation patterns. As a result, more intense storms are anticipated in the Iqaluit region in the decades to come.

With the spring progression, storm tracks move closer to southern Baffin Island, with maximum intensity to the north and east of Frobisher Bay. During the summer, cyclones can track directly over Hudson Strait, increasing the southeasterly flow over southern Baffin Island. Channelling effects in Frobisher Bay maintains the high prevalence of northwesterly and southeasterly winds.

Southern Baffin Island is influenced by surges of warm and moist air from the Atlantic. Fog is fairly common in Frobisher Bay and most prevalent during September and October. It is less common near the head of the bay, and Koojesse Inlet itself is seldom foggy.

11.5.1.1 Southerly and Southeasterly Flow Pattern

Persistent south and southeast surface winds typically develop ahead of and behind the warm fronts of cyclones approaching from the west and southwest—in particular, when these systems stall temporarily near Cape Dorset or turn northward toward Foxe Basin. Southeasterly winds may be gustier and at least 5 kt stronger than expected due to channelling over Frobisher Bay. Shelter from southeasterly winds can found on the lee side of Edgell Island and Resolution Island.

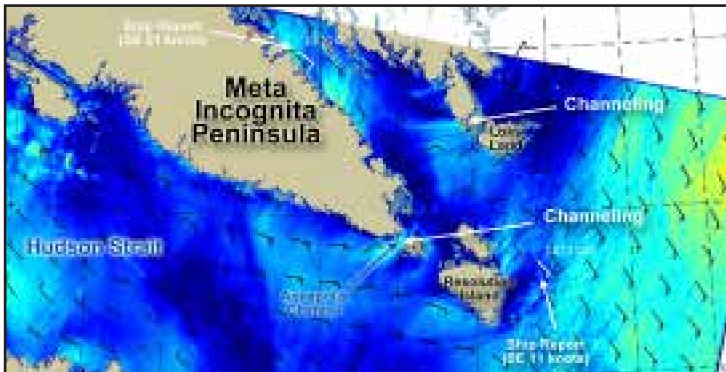


Figure 45: RADARSAT image from August 17, 2014.

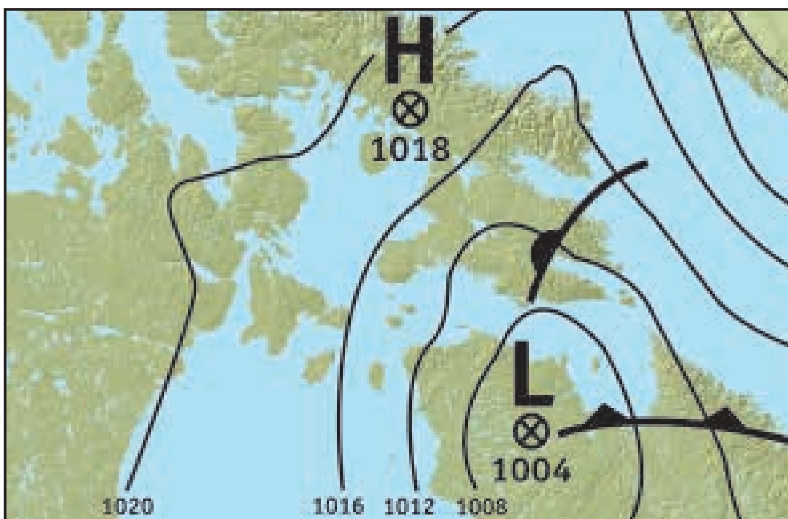


Figure 46: Surface analysis from August 17, 2014.

RADARSAT image (above) and surface analysis (below) from August 17, 2014. A fairly weak southerly flow produced moderate to strong southeast winds over Frobisher Bay, according to ship reports. Funneling outflow winds can be seen between Loks Land and the Blunt Peninsula, including Lefferts Island.

Southeasterly or southerly gales often develop in Leach Bay from the flow coming down over the mountains, creating a moderate sea.

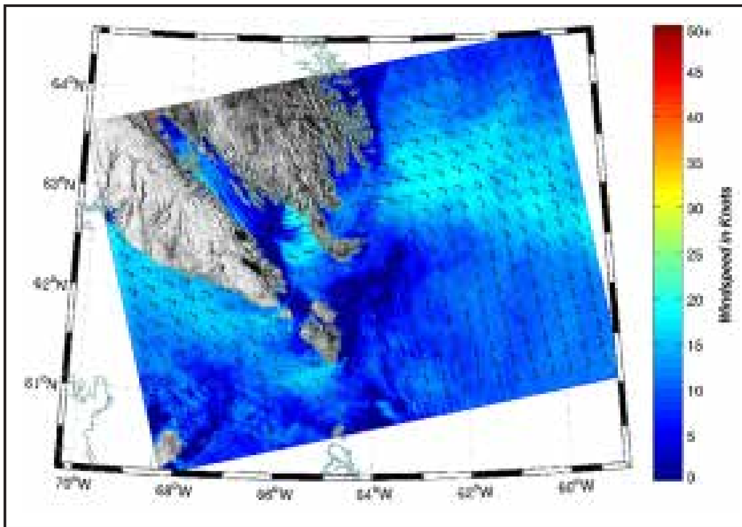


Figure 47: RADARSAT image from September 21, 2012.

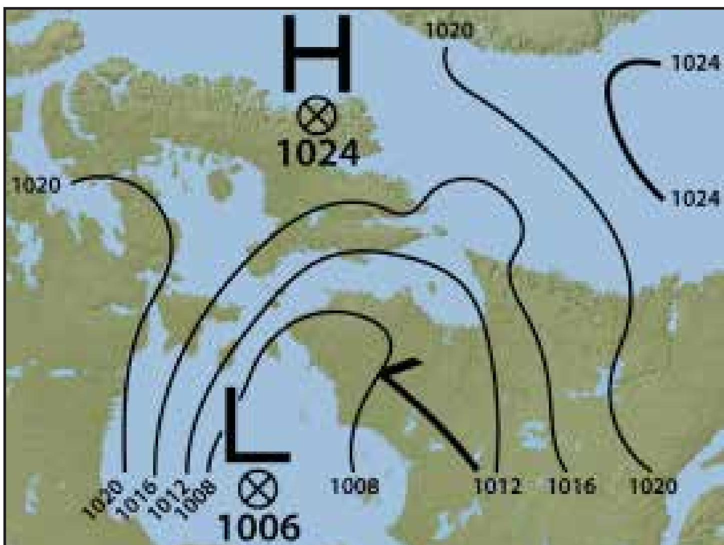


Figure 48: Surface analysis from September 22, 2012.

RADARSAT image (above) and surface analysis (below) from September 21 and 22, 2012, respectively. Moderate to strong east winds generated by a southeasterly flow were observed from Loks Land to the Blunt Peninsula and to the Hall Peninsula Coast, near the Countess of Warwick Sound. Funneling between the narrow passes likely accelerated the wind speed.

11.5.1.2 Northerly and Northwesterly Flow Pattern

Extended periods of northwest winds in Frobisher Bay most frequently occur in the wake of a cold front located south and east of the bay, when rapid wind shifts can occur between the southeast and northwest. The winds channel through the body of Frobisher Bay due to steep mountain ranges along the coast of the Hall and Meta Incognita peninsulas. The gap-wind effect is a reinforcing factor if a high-pressure center is to the north or northwest of Frobisher Bay, strengthening winds at the mouth of the bay. Violent northwest winds also funnel down into Eggleston Bay from mountains that rise to over 600 m a short distance inland. Shelter from strong northwesterlies can be found near Noble Inlet (which affords shelter from all wind directions) and the Lower Savage Islands.

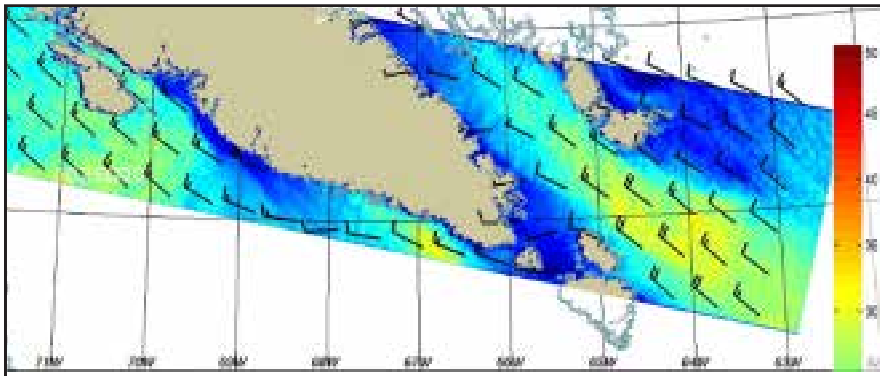


Figure 49: RADARSAT image from October 21, 2014.

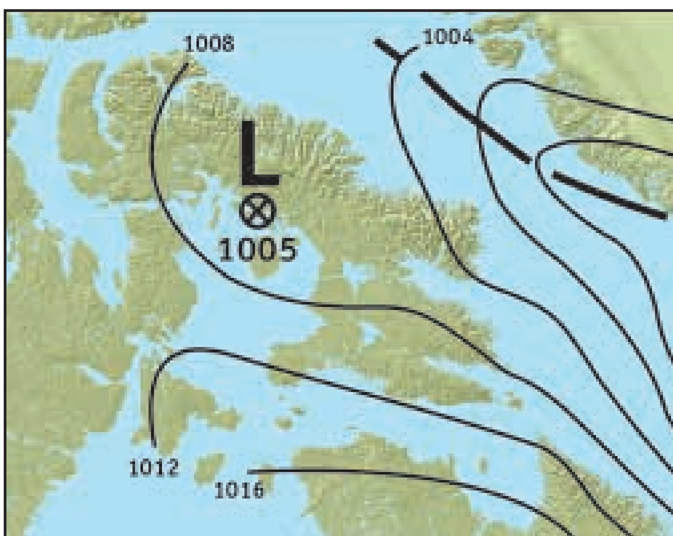


Figure 50: Surface analysis from October 21, 2014.

RADARSAT image (above) and surface analysis (below) from October 21, 2014, when there were northwesterly gap winds in Frobisher Bay. Winds can be as strong as 30 kt at the mouth of the bay, even in a fairly weak northwesterly synoptic flow.

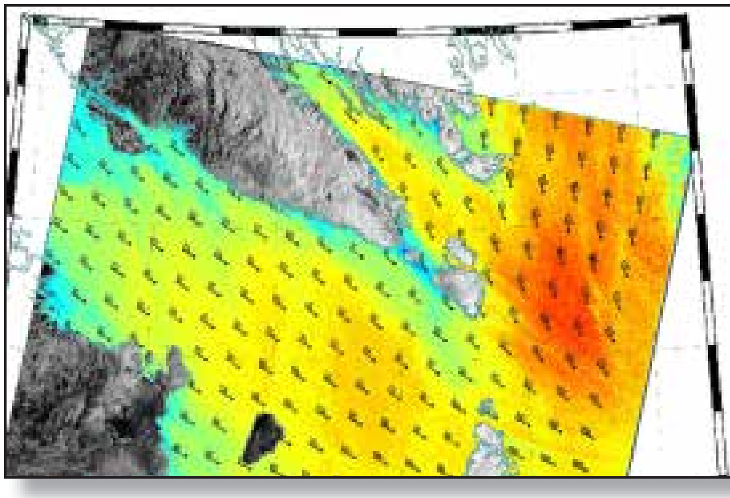


Figure 51: RADARSAT image from September 20, 2012.

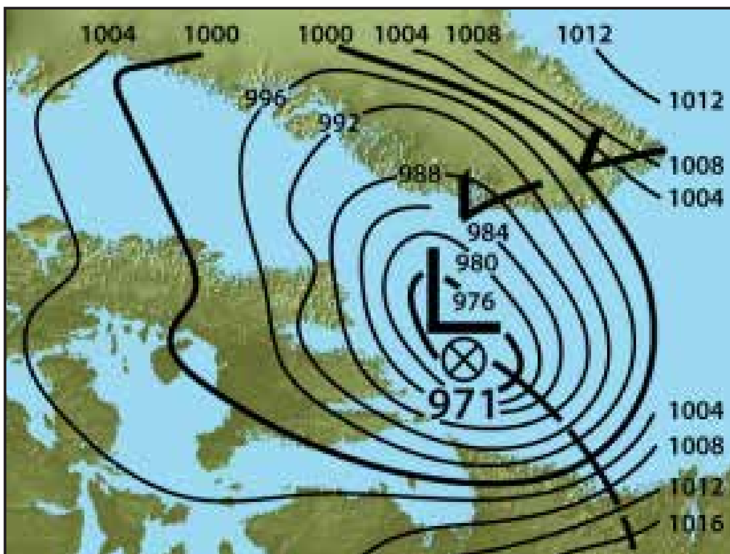


Figure 52: Surface analysis from September 20, 2012.

RADARSAT image (above) and surface analysis (below) from September 20, 2012, when an intense storm moved northeastward across Davis Strait, generating northwesterly gales in Frobisher Bay. The Iqaluit observing station reported northwesterlies of 22 kt. In this flow, winds at the mouth of the bay can be up to 10 to 15 kt stronger than they are at its head.

11.5.1.3 Northeasterly and Easterly Flow Pattern

As low-pressure systems approach southern Baffin Island from the Labrador Sea, the resulting wind flow over Frobisher Bay can be quite complex. A general northeast wind-flow pattern can simultaneously manifest itself as downslope northeast winds coming over the lee slopes of mountain ridges on Hall Peninsula and channelling northwest winds between the Hall and Meta Incognita peninsulas. Strong northeast winds can transform into strong northwest winds, sometimes in less than an hour. A northeast flow pattern can either be blocked by the steep orography of the Meta Incognita Peninsula or transformed into a northwesterly barrier jet along its shores.

Mariners' Tip:
During a strong northeasterly flow across Frobisher Bay, mariners may experience contrasting bands of stronger and lighter winds due to a lee-wave effect.

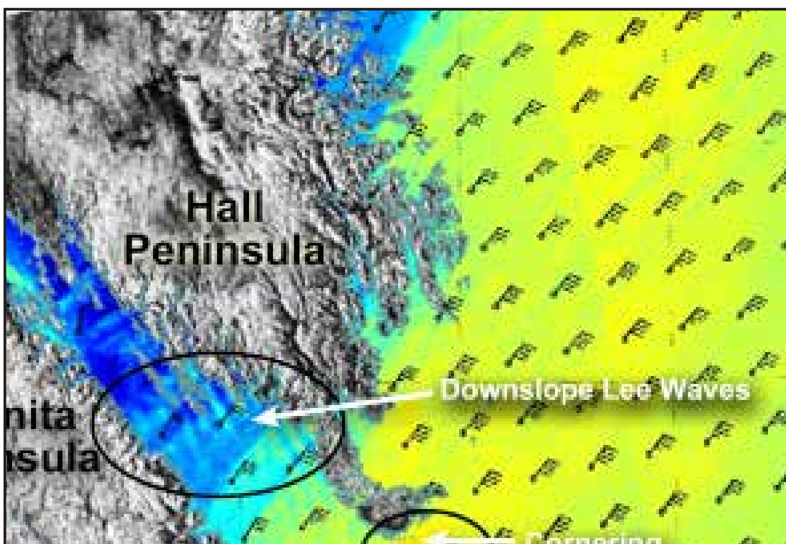


Figure 53: RADARSAT image showing northeasterly winds intensifying over the lee slopes of Hall Peninsula in the form of downslope winds.

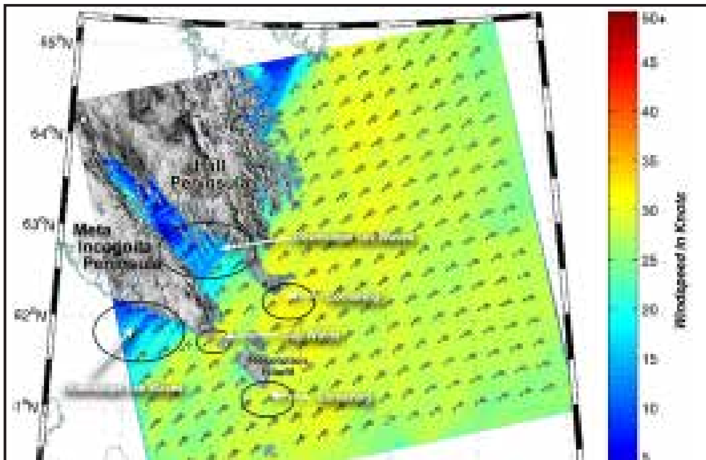


Figure 54: RADARSAT image from October 22, 2012.

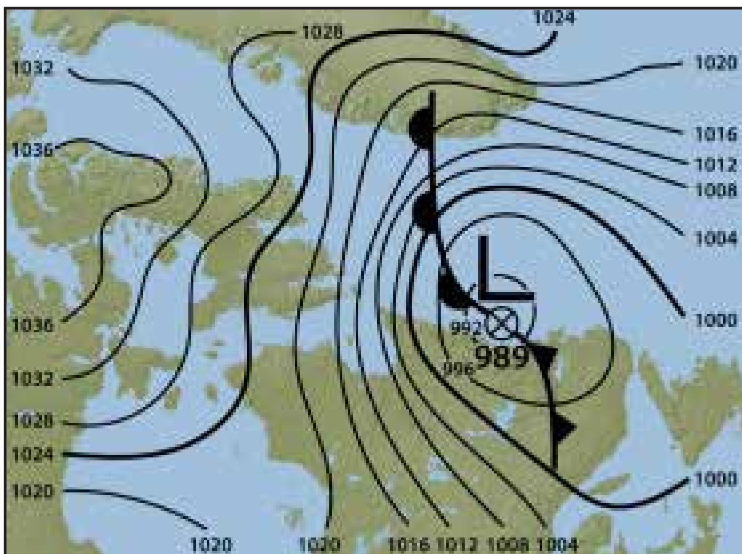


Figure 55: Surface analysis from October 23, 2012.

RADARSAT image (above) from October 22, 2012, and surface analysis (below) from October 23, 2012.
A northeasterly flow produced bands of downslope lee-wave winds over the southern parts of Frobisher Bay and on the western side of Meta Incognita Peninsula, on the coast of Hudson Strait.

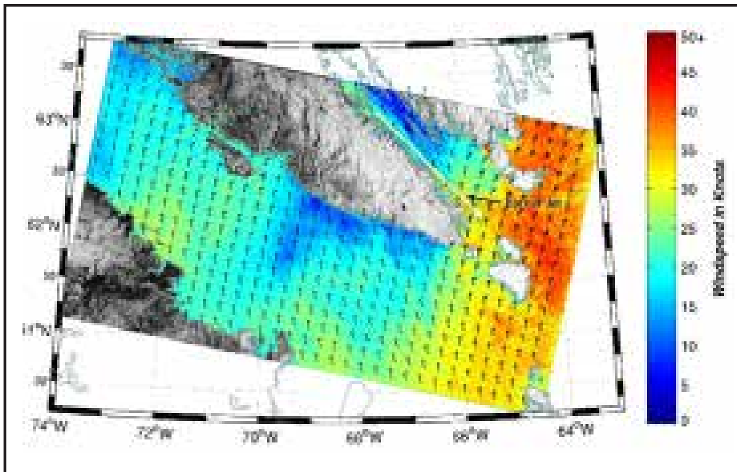


Figure 56: RADARSAT image from October 24, 2012.

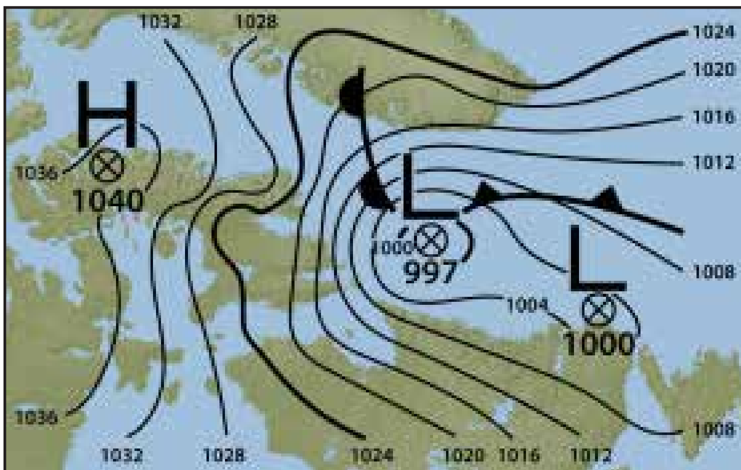


Figure 57: Surface analysis from October 24, 2012.

RADARSAT image (above) and surface analysis (below) from October 24, 2012, when a barrier jet had formed on the heels of the storm described in the previous pair of images. The Iqaluit weather station reported northwest winds of 15 to 20 kt for several days, while a ship in the area reported them at as high as 24 kt.

11.5.2 Waves, Tides and Currents, Shoals, and Ice Conditions

11.5.2.1 Waves

Storms may lead to wave generation when strong winds blow up the bay from the southeast. Wave energy is constrained by the available open-water fetch which, in turn, is dependent on the absence of sea ice in the bay. Most of the high-wind events from the southeast occur in the fall, extending the ice-free season. The warming of the sea-surface temperature may increase the probability of future open-water storms with large waves.

A large sandbar extends along the length of the western coast of Blunt Peninsula, not far from shore. The outgoing tide in this area—in conjunction with westerly winds—causes a dangerous undertow and huge waves that break several kilometres offshore. Uncharted reefs may also lie within this area.

11.5.2.2 Tides and Currents

The tides in Frobisher Bay are the second most active in the world, the head of the bay experiencing a twice-daily tidal range with variations from 7 to 11 m. Mariners must wait until high tide to get in or out of Iqaluit.

Fast and sometimes erratic tidal streams run strongly at the entrance to the bay and through the passages between the islands. Beare Sound is also characterized by such streams, which create numerous eddies and tidal rips in Lupton Channel. A line of breakers forms across the channel's northeastern entrance when its northeastward-going stream meets rough seas from Davis Strait.

In the vicinity of the islands and islets southeast of Chase Island, the tidal streams run strongly, forming eddies and rips. Tidal streams of 5 to 7 kt are found in the narrow channels of upper Frobisher Bay—including Bartlett Narrows Channel, Algerine Passage, and Deep Passage—which should be navigated within an hour on either side of high water, when the tide is slack or the stream weak. The range of tidal streams in Pike-Resor Channel is 2 to 5 kt, while Cincinnati Press Channel is navigable during the high-water tide. Tidal rips occur west of Pike Island/Agitator Reef.

Ocean currents flow in Frobisher Bay similarly to those in Cumberland Sound. The southward-going Canadian Current enters the bay and heads northwestward along the northern shores, then turns the opposite direction along the southern shores of Frobisher Bay. It then merges again with the southward-going current from Baffin Bay and the eastward outflow current from Hudson Strait.

11.5.2.3 Shoals

Shoal waters are found in the following areas:

- west of Blunt Peninsula and near the approach to the Countess of Warwick Sound
- south of Gabriel Island
- Ward Inlet including Cornelia Channel
- northwest of the Crowell and Pike islands, between the Crowell and Anchorage islands
- in the middle portions of Cincinnati Press Channel
- northwest of Pink Lady Island, which is north of the Deep Passage
- northwest of Agitator Reef which is south of Pike Island
- in Koojesse Inlet
- Aiguille Shoal, southeast of Pike Island towards Cape Poillon, which is sometimes marked by a tidal rip or grounded ice

Reefs have been reported in the following areas:

- southeast and east of Fletcher Island, breakers have been observed between these reefs.
- northwest of Fletcher Island
- northwest of Culbertson Island (Scylla Reef)
- northwest of Scylla Reef (Charybdis Reef)
- west of Charybis Reef (Theron Reefs)
- in Burton Bay, where shoals are also found
- west of Lamb Point (Deception Reef), where shoals are also found
- south of Monument Island and west of Deception Reef (Shagstone Reef)

11.5.2.4 Ice Conditions

Frobisher Bay tends to be virtually ice free from mid-July through late September. Southeasterly winds can push ice into the bay at the beginning of the open-water season, delaying navigation. On the other hand, strong northwesterlies can have the opposite effect and clear the bay in just a few days. Pike-Resor Channel is free of ice before any of the other channels or passages into upper Frobisher Bay.

The entrance to Frobisher Bay is typically frozen by the beginning of November, however, southerly and southeasterly prevailing winds can delay this process until the middle of December.

Icebergs enter the bay from Davis Strait and continue northwestward, with the current, along the northern shore. They cross the bay in the vicinity of Chase Island and then move southeastward along the shore. Icebergs do not penetrate upper Frobisher Bay.

11.5.3 Iqaluit

Iqaluit is the largest city and territorial capital of Nunavut. It is located at the head of Frobisher Bay in Koojesse Inlet.

11.5.3.1 Winds and Weather

Iqaluit is located near a major west-to-east path for storms travelling along Hudson Strait. Low-pressure systems also track north from Newfoundland or Quebec and can pass over a wide area, from Davis Strait in the east to Foxe Basin in the west. The systems affecting the bay are the same as those affecting the community.

The most frequent and stronger wind directions in Iqaluit are from the northwest and southeast due to the effect of channelling over the body of Frobisher Bay. Winds from these directions tend to be stronger in the fall than summer, and a rapid wind shift between southeast and northwest has been noted in the area. Although local winds can exceed 54 kt, these are fairly rare events. More typical winds from these low-pressure systems, which average 25 occurrences per year, reach about 33 kt from these dominant directions.

Fog is often observed at Iqaluit when low-level moisture arrives with an onshore flow. It can persist for days and break up, only briefly, in the afternoon hours if the light onshore flow is persistent. Freezing rain is often observed in the fall with weather systems moving from the south.

Northwest Winds

Northwest winds develop in Iqaluit after a storm has moved north from the Labrador Sea to Davis Strait, usually after the passage of a cold front. Cold air draining from the mainland into Frobisher Bay, combined with the steady stream of lows that pass to the south, result in a high frequency of northwest winds at Iqaluit during the colder seasons.

Southeast Winds

Strong southeast winds usually develop ahead of a warm front approaching from the west, especially when it has stalled over northern Hudson Bay or the Foxe Basin.

Given Iqaluit's location near the coast in a valley that slopes gently upward to the northwest, a reinforcement of southeasterly anabatic winds in Sylvia Grinnell Valley by onshore sea breezes can be expected during an otherwise calm, clear summer day. This is consistent with the increased occurrence of moderate and strong southeasterly winds after sunrise in the summer.

In the summer, moderate and strong southeasterly winds at Iqaluit may often be the result of the combined orientation of the topography and the difference between the temperature over the land and the water.

Continental, northwesterly offshore winds are associated with the warmest temperatures in summer, whereas weak and strong southeasterly winds have consistently higher values of relative humidity throughout the year. Except in summer, weak and especially strong east-northeast surface winds are significantly warmer than those from the northwest.

Northeast Winds

Strong northeast winds are less frequent in Iqaluit and are associated with strong downslope winds from higher terrain. In the summer, east-northeast winds are significantly warmer than those from the northwest, due to a chinook effect.

Cyclones tracking over the Labrador Sea sufficiently close to southern Baffin Island can simultaneously generate both the pressure gradients conducive to wind channelling over Frobisher Bay and strong downslope winds over the lee slopes of the mountain ridge on Hall Peninsula. Strong northeast winds do not occur regularly, but when they do, they can have a major impact on the community and its surrounding marine environment. In certain synoptic settings, there is sharp transition (less than one hour) from strong northeast downslope winds to strong, channelling northwest winds. When strong northeast winds deflect off the sharply rising terrain to the southeast and generate northwesterlies, the wind created is very turbulent.

11.5.3.2 Waves, Tides, and Ice Conditions

Waves in Koojesse Inlet are generally low energy and range from localized chop to short-duration, wind-forced waves during high wind events from the southeast. Strong southeast winds can sometimes build large swells in the inlet, especially with high-tide events.

The daily tidal variance in Iqaluit is approximately 7 to 11 m.

Koojesse Inlet is open for navigation from late July to the middle of October, with an ice-breaking service usually available to assist ships in July.

ARCTIC REGIONAL GUIDE PART 8: GREAT SLAVE LAKE AND MACKENZIE RIVER

12. Great Slave Lake and Mackenzie River Marine Areas

This chapter covers the nine marine regions in the FQCN13 CWNT Great Slave Lake and Mackenzie River Marine Areas: three in the former, and six in the latter.

Great Slave Lake includes the East Arm, North Arm, and Basin marine regions. Mackenzie River is divided along its length into the Wrigley Harbour mile 0 to Axe Point mile 91; Axe Point mile 91 to Camsell Bend mile 290; Camsell Bend mile 290 to Tulita mile 512; Tulita mile 512 to Fort Good Hope mile 684; Fort Good Hope mile 684 to Point Separation mile 913; and Point Separation mile 913 to Kittigazuit Bay mile 1081 marine regions.

Figure 1: The Great Slave Lake and Mackenzie River Marine Areas and its marine regions.

Low-pressure systems in this area tend to develop, redevelop, or strengthen due to the presence of the Mackenzie Mountains, which lie to the west of the Mackenzie River. Low-pressure disturbances that originate over the Pacific Ocean are often broken up by the coastal mountain ranges and then re-form on its lee side. During the long, warm summer, areas within the treeline see an increase in short-lived, low-pressure systems—in particular, over the higher mountains and eastern-slope foothills. These disturbances often spawn thunderstorms that drift eastward from the mountains later in the afternoon or evening.

Mariners' Tips:
Even a small difference in the track of a low can be significant for a mariner in terms of wind direction, speed, and weather.

Easterly and southeasterly winds and generally fair skies to the east of the developing low-pressure system evolve into cloudy skies and areas of precipitation in the vicinity of the low. As the low moves off (generally to the east), brisk northwest winds give cloudy skies with either showers or flurries. Strong east to southeast winds typically occur over the region with the approach of a storm from the west. These winds often shift rapidly to strong, gusty northwest or north winds after the low passes (often, after the passage of a cold front).

Some of the driest and sunniest skies are found in the area of Great Slave Lake and the Mackenzie River. Summer temperatures often reach 25°C or more as, once the ice melts, the long hours of sunlight quickly heat up the water and surrounding land.

Much of the precipitation in the Great Slave Lake-Mackenzie River basin comes from convective summer storms. Although the mean flow over the basin is still westerly during the warm season, the moisture feeding the most significant summer precipitation events often comes from the southern continental regions or the Gulf of Mexico. Thunderstorms can suddenly generate winds of 45 kt and wave heights of up to 3 m over Great Slave Lake.

There are fairly distinct patterns related to the time of day and time of year when mariners are most likely to encounter lightning in this area; however, there can be considerable variability from year to year. It is important to watch the skies for signs of potential of thunderstorms, as lightning can occur at any time, under the right conditions.

In the Great Slave Lake area, lightning activity is generally low in May and September, typically peaking in July and dropping off around mid-August. The early part of the season sees the greatest activity in the area of Fort Simpson and Fort Smith. Lightning activity then moves northward, toward the Mackenzie Delta, in June.

Thunderstorms in the Great Slave Lake region are strongly driven by solar heating. Lightning activity typically peaks around 1800 (local time); however, nocturnal activity between 2200 and 0600 is not uncommon. Storms can move more quickly than the speed of a boat and may be accompanied by strong gusty winds, which often begin ahead of the thunderstorm itself. Fog often forms after thunderstorms pass.

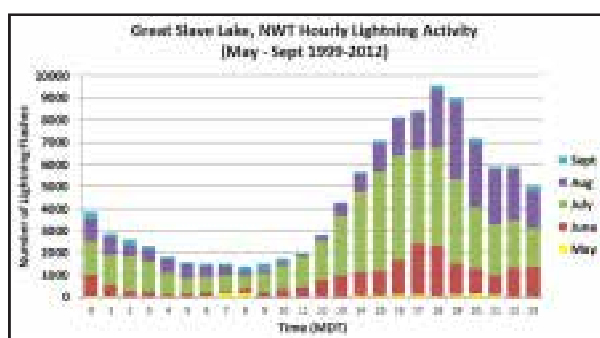


Figure 2: Hourly lightning activity over Great Slave Lake from May to September (1999 to 2012).

12.1 Great Slave Lake Marine Area

Great Slave Lake is the deepest lake in North America and the 10th-largest lake in the world, at nearly 500 km in length. The average depth of the lake is 41 m, with the waters at its western end having a mean depth of 32.2 m and a maximum depth of 187.7 m. Waters in its eastern section are deeper, Christie Bay boasting the lake's maximum recorded depth of 614 m.

The lake's primary inflows are Hay River and Slave River, while its primary outflow is the Mackenzie River. Towns situated on the lake include Yellowknife, Hay River, Behchoko, Fort Resolution, Lutsel K'e, Hay River Reserve, Delta, and N'Dilo.

The lake is divided into three marine regions: Great Slave Lake–East Arm, Great Slave Lake–Basin and Great Slave Lake–North Arm. These regions have very similar wind regimes and offer relatively fair sailing in the summer. September, however, typically heralds an increase in storm frequency and the onset of some of the most intense storms of the year. Great Slave Lake can be a ferocious body of water in the fall, when northwesterlies blow down from the Arctic prior to freeze-up.

Figure 3: The three marine regions of the Great Slave Lake Marine Area.

Figure 4: Satellite image of the Great Slave Lake Marine Area.

Mariners' Tips:
Great Slave Lake is prone to sudden and violent storms. Within minutes, high winds and waves can create extremely dangerous conditions, while sand reefs and shallows can make it difficult for those caught in such storms to reach shore.

As temperatures become colder and until the ice re-forms, the relatively warm waters of the lake provide ideal conditions for the development of lake-effect snow squalls or snow streamers. Late in the shipping season, snow streamers can develop, producing large quantities of precipitation over and to the lee of the lake. West to southwest winds can bring precipitation to the East Arm; southerly winds, to the North Arm; and northerly winds, to the south shore.

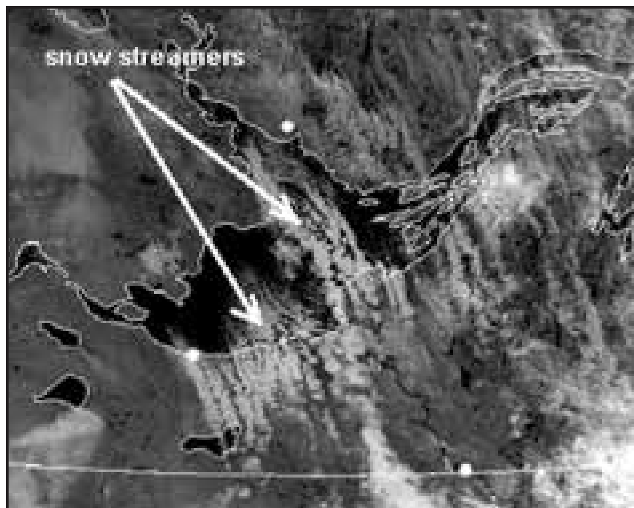


Figure 5: Satellite image from October 8, 2009.

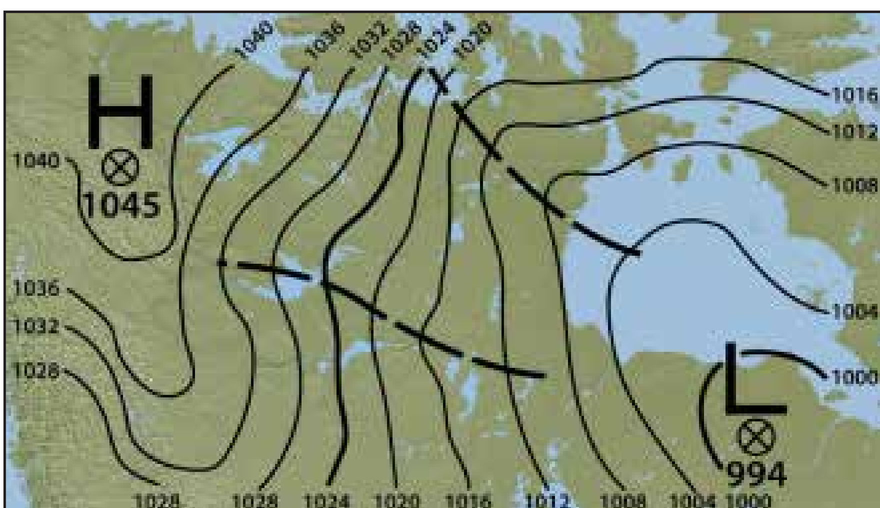


Figure 6: Surface analysis from October 8, 2009.

Satellite image (above) and surface analysis (below) from October 8, 2009, when snow streamers developed over Great Slave Lake in a northerly flow. More intense streamers can be identified over the middle portion of the lake, where the longest fetch is available.

Most seiches on the lake are generated by northeast winds (typically of 10 to 15 kt) at Fort Resolution and set down by southeast winds. Seiche set-up at Yellowknife Bay is characterized mostly by southeast winds and set-down primarily forced by northwest winds around 15 kt.

Ice sometimes covers the lake until late June, with the ice in the upper part of the North Arm usually melting much earlier than it does elsewhere. The navigation season typically starts in June and ends in October, with break-up starting earlier and freeze-up later in recent years. The water-surface temperature increases rapidly after the ice melt and attains a lake-wide mean temperature of nearly 15°C from late July to early August. Strong winds in September and October are associated with a progressive decrease in lake heat as the surface water cools.

12.1.1 East Arm Marine Region

The East Arm of the lake, which lies about 70 km from Yellowknife, is a popular destination for mariners due to its topography, numerous islands, and peninsulas—all of which offer shelter from the wind. It is much deeper than its other parts. The vertical cliffs of Redcliff Island soar high above the water, which plunges into subterranean canyons hundreds of metres deep. The steep, northern shore of McLeod Bay, the easternmost bay in the arm, rises nearly 300 m above the lake. Nearby Gibraltar Point is exposed to strong winds.

The spectacular rock formations along its shores and its numerous islands and peninsulas (which offer shelter from the wind) make the East Arm quite different from its western reaches. Although it is a popular destination for kayakers, its cliffs, waves, and icy waters can make for daunting conditions on the water. The East Arm is home to the community of Lutsel K'e.

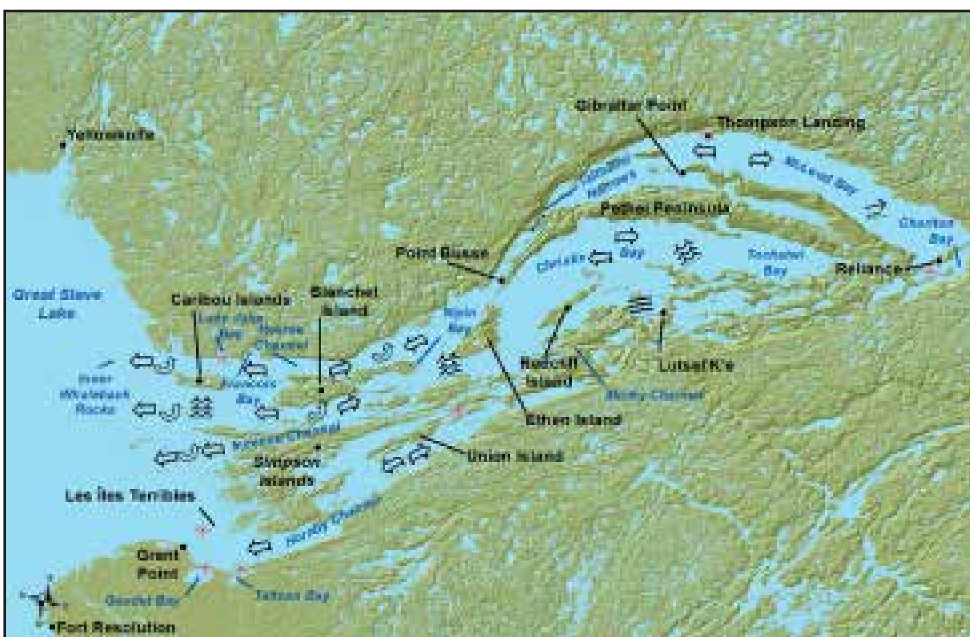


Figure 7: Local effects for the Great Slave Lake—East Arm Marine Region.

12.1.1.1 Winds and Weather

The East Arm's east-northeast to west-southwest geographical orientation makes winds from these same directions prevailing and subject to channelling through Hearne, Hornby, and Inconnu channels. These flows develop ahead of low-pressure systems tracking toward Great Slave Lake from the northwest, west, or southwest and can be quite strong when these systems are intense. Winds can also be enhanced by a gap-wind effect, if a high-pressure centre or ridge is located just east of the arm.

According to some mariners' reports, northeast and east winds are the most frequent in the East Arm, although northwest winds are also common—especially in its easternmost reaches. Hearne Channel, the banks of which rise to about 250 m above sea level, sees mostly winds from the east. Mariners should be careful when passing near the entrances to these channels in easterly events, as strong easterly outflow winds may cause them to be swept westward, toward the middle of the lake.

Francois Bay, Nipin Bay (on the north side of the east end of Blanchet Island), Scott's Arm (east of Point Busse), and Thompson Landing offer sheltered anchorage in Hearne Channel and McLeod Bay. Redcliff Island (bounded by a narrow channel on its southeast side and Murky Channel on its southwest side) offers sheltered anchorage for small craft in Christie Bay.

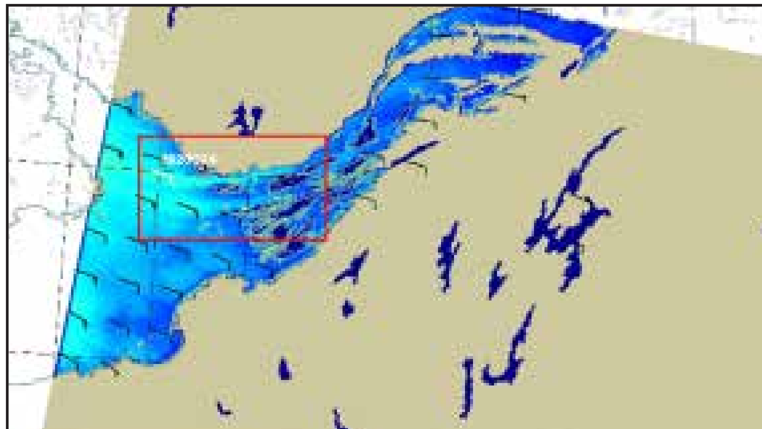


Figure 8: RADARSAT image from August 18, 2014.

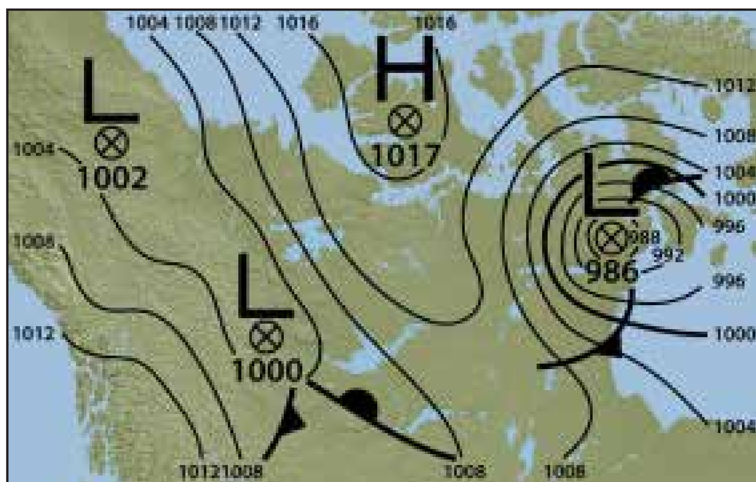


Figure 9: Surface analysis from August 18, 2014.

RADARSAT image (above) and surface analysis (below) from August 18, 2014, when channelling occurred with a southeasterly flow over the western parts of Hearne Channel, around the Caribou Islands. Strong outflow winds into Great Slave Lake Basin are also visible on the satellite image. The Inner Whaleback Rock weather station reported east winds of 22 kt, gusting to 25 kt.

12.1.1.2 Waves, Currents, Shoals, and Ice Conditions

Waves

Choppy seas develop in the East Arm when the winds change direction.

Currents

Taltheilei Narrows separates the mainland from Pethei Peninsula—and connects Hearne Channel to McLeod Bay. Its relatively shallow waters usually flow southward; however, the current can quickly shift direction, generating a strong current through the narrows. This depends largely on the wind direction and quantity of snow melt.

Shoals

Grant Point Reef is found northeast of Grant Point, near Les Îles Terribles. There are shoals in Lady Jane Bay, at the entrance to Gaudet Bay, in Taltson Bay, northeast of Union Island, at the west entrance to Thompson Landing, and in Charlton Bay. For more detailed information on shoals in the area, consult *Sailing Directions: Great Slave Lake and Mackenzie River* (hereafter *Sailing Directions*).

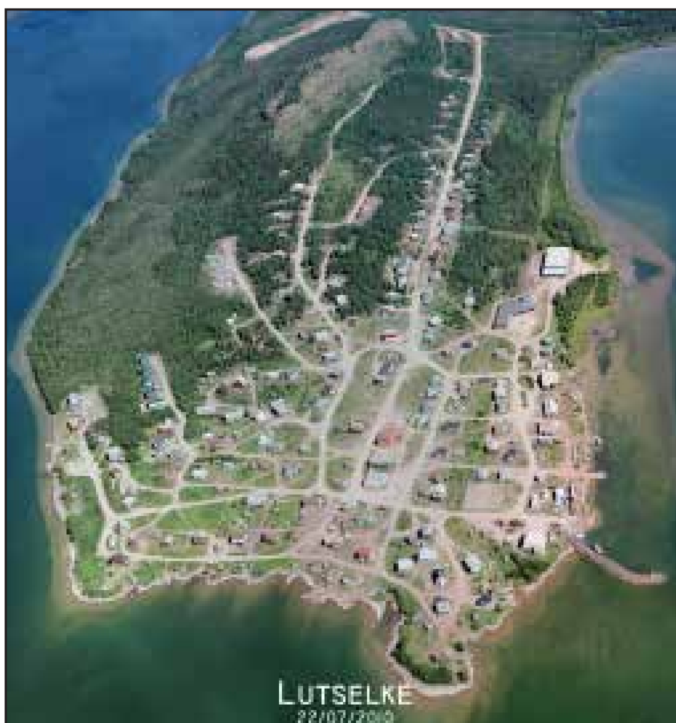
Ice Conditions

McLeod Bay breaks up from the west to east in the spring. Often, its western parts are open to boat passage while its eastern tip is still ice bound.

12.1.1.3 Lutsel K'e

Lutsel K'e is located on a peninsula on the south shore of the East Arm, near the mouth of the Snowdrift River (after which it was formerly named). Summers at Lutsel K'e are usually cold and wet, with no dry season.

Winds at Lutsel K'e usually blow from the east-northeast or west and rarely from other directions, with the strongest summer winds routinely from the northeast. The area does not have a dry season: summers are cold and typically wet, while fog and freezing drizzle often occur in the fall.



The community of Lutsel K'e. Photo courtesy of the Government of the Northwest Territories.

12.1.2 North Arm Marine Region

As its name suggests, the North Arm lies at the north end of Great Slave Lake. It is connected, at its northernmost tip, to Marian Lake and Russell Lake by the Frank Channel. The body of the North Arm stretches northwest to southeast and forms the dividing line between the Canadian Shield, to the east, and the Mackenzie Lowlands, to the west. It is home to the city of Yellowknife, capital of the Northwest Territories.

Figure 10: Local effects for the Great Slave Lake—North Arm Marine Region.

12.1.2.1 Winds and Weather

Due to its geographical orientation, the prevailing winds over the North Arm are north-northwest and south-southeast. The North Arm is relatively shallow, causing waves to pick up quickly with strong winds from any direction. A small bay on the north side of Devils Channel (close to its western entrance) offers shelter for small craft.

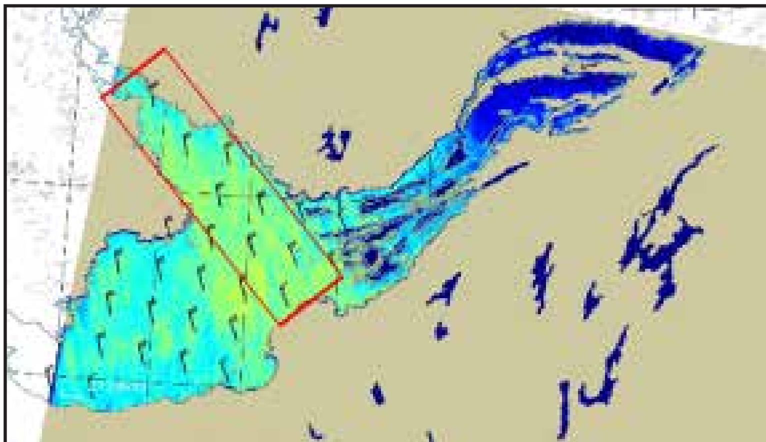


Figure 11: RADARSAT image from September 4, 2014.

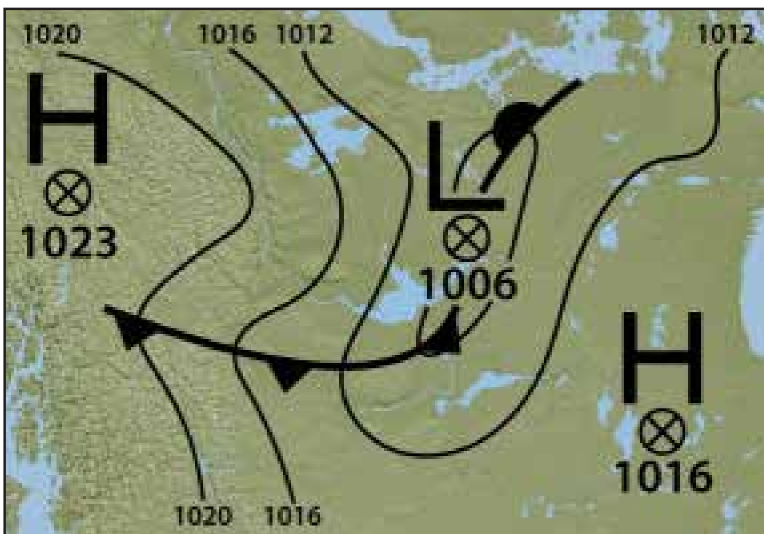


Figure 12: Surface analysis from September 4, 2014.

RADARSAT image (above) and surface analysis (below) from September 4, 2014, when strong north winds occurred over both the North Arm and eastern parts of the Basin. The Inner Whaleback Rock weather station reported north winds of 27 kt, gusting to 32 kt. A buoy deployed approximately 15 km to the east of the station reported northwest winds of 23 kt, while one located northeast of Hay River reported moderate west winds. These observations support the idea of northerly winds channelling through the North Arm.

12.1.2.2 Waves, Currents, Shoals, and Ice Conditions

Waves

With strong southerly winds, waves could be up to 3 m in the southern portion of North Arm due to the more than 150 km of open-water fetch south of Whitebeach Point. With southerly events, waves in this area can be just as high, but they diminish significantly north of the point.

Currents

There is a strong current in Frank Channel with strong southerly winds, which push water up the channel.

Shoals

There are numerous shoals in the North Arm and Yellowknife Bay, a detailed list of which is available in *Sailing Directions*. A few locations to watch for include the following:

- northeast of Gypsum Point
- in Gypsum Bay
- near Mirage Point
- between the West Mirage Islands and East Mirage Islands
- northeast of Anderson Point
- northeast of Foam Point
- around Baker Island
- around Post Island (Yellowknife Bay Reef also lies west of the island)
- north and south of Inner Island
- west of Horseshoe Island
- southwest of the Pilot Islands
- near Burnt Island
- near the Cabin Islands
- inside the entrance to Devils Channel

12.1.2.3 Yellowknife

The capital city of the Northwest Territories sits on the west shore of Yellowknife Bay, on the east side of the North Arm of Great Slave Lake. The bay juts northward from the lake and is surrounded by numerous lakes and marshes.

The city of Yellowknife. Photo courtesy of the Government of the Northwest Territories.

The dominant winds in Yellowknife are from the east, with lesser components coming from the northwest and south-southeast. Lake breezes that develop during the warmer months bring southeasterly flow from Yellowknife Bay; otherwise, winds from the east are mainly due to weather systems passing from west to east, south of the lake. In the fall, northwest winds become stronger and more frequent.

Thunderstorms from the south and southwest rarely reach Yellowknife because they tend to dissipate as they move over the colder waters of Great Slave Lake. Those moving eastward from Horn Plateau (to the west) are more likely to affect the area.

Stratus and fog are rare in the summer, as increased surface-heating often makes the air too dry for them to form. Fog is most common in September and freezing precipitation, in November. Snow squalls off Great Slave Lake can occur in the fall until the lake freezes over, although they are less common than on the south side of the lake, since the prevailing winds at that time of year are north to northwest.

12.1.3 Basin Marine Region

The Basin Marine Region is considered the wildest section of Great Slave Lake. The southern, Hay River portion of its coast is characterized by sandy, exposed shores and few islands. It includes the communities of Hay River and Fort Resolution.

Figure 13: Local effects for the Great Slave Lake—Basin Marine Region.

12.1.3.1 Winds and Weather

Easterly and northeasterly flow is generated over Great Slave Lake by low-pressure systems moving just south of the lake, over northern Alberta. Northeast winds may also shift to northerly as a result of being redirected by the coastal topography of the North Arm.

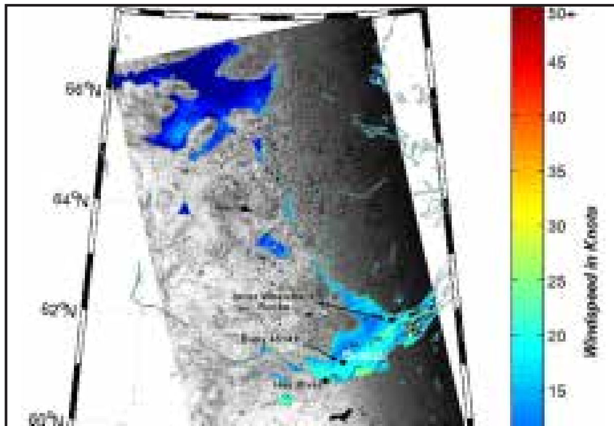


Figure 14: RADARSAT derived winds from July 16, 2011.

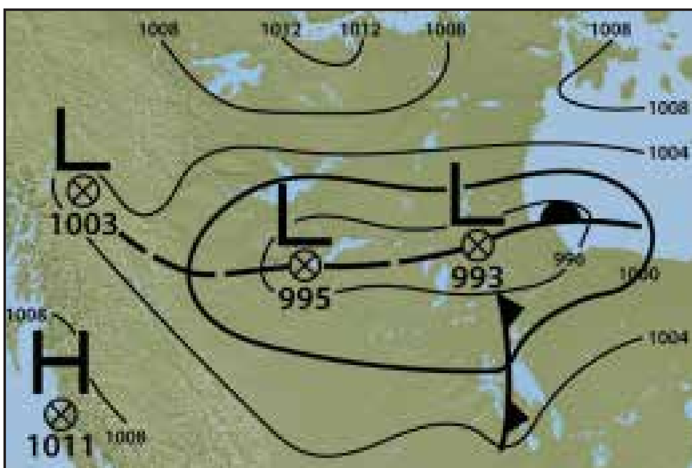


Figure 15: Surface analysis from July 16, 2011.

RADARSAT image (above) and surface analysis (below) from July 16, 2011. Strong east-northeast outflow winds out of East Arm extended throughout the southern parts of the basin. Inner Whaleback Island, near the entrance to Hearne Channel (East Arm), reported northeast winds of 20 kt, while a buoy deployed in the water nearer the southern shore of the basin (approximately 40 km northeast of Hay River) reported north winds of 20 kt. At the Hay River weather station, winds were north at 13 kt.

The south shore of Great Slave Lake is exposed to winds from the northwest through the northeast. Northwest and west winds channel along the shore, toward Hay River, in the western part of the Basin. Sudden shifts in wind direction make Slave Bay a dangerous place to be trapped. Southeast winds blow into Deep Bay, north of Big Island, but its muddy bottom make it a good fair-weather anchorage. Swan Point is exposed to east winds, but Moraine Bay and Sulfur Cove both offer good shelter—the latter, only for small craft.

Fog has been reported to set in with little warning over the waters between Hay River and Pointe de Roche.

Mariners' Tips:
The Annual Commissioner's Cup sailing race takes place from Yellowknife to Hay River and back over the August long weekend. Sailors cross both the North Arm and Basin of Great Slave Lake during the race, which takes three to five days. The weather at that time of year can turn bad in a matter of minutes, with racers often encountering high winds (30 kt or more) and large waves as a result of sudden thunderstorms.

12.1.3.2 Water Levels, Waves, Currents, Shoals, and Ice Conditions

Water Levels
Seiches can cause water levels in this part of the lake to fluctuate by as much as 0.3 m over the course of a day.

Waves
When winds are northwesterly, waves and seas can become rough on the south shore of the basin due to the large fetch available. Waves in these waters can reach as high as 4 m. In a strong, consistent wind, ocean-sized waves build up over the lake, suddenly increasing in height when they strike the shallow waters off the sandy shores of Hay River—the approach to which has been the site of many accidents over the years.

Currents
In the west end of Great Slave Lake, a westward-going current is caused by the inflow of lake water into the Mackenzie River.

Shoals
There are numerous shoals on the west shore of the lake, a more detailed list of which can be found in *Sailing Directions*. Some to look out for include the following:

- at the entrance to the South Channel
- in the North Channel
- around Big Island
- between Green Island and Burnt Island
- northwest of Mission Island
- along the shore from Buffalo River to Hay River
- near Slave Point (where there are also rocks)
- in Slave Bay
- east of Horncastle Point
- around the Cranberry Islands
- northeast of Jones Point

- north of Caribou Point
- south of Moraine Point
- east and north of Northwest Point
- west and north of Lonely Point
- northeast of Long Island
- east of Hardisty Island
- near May Point

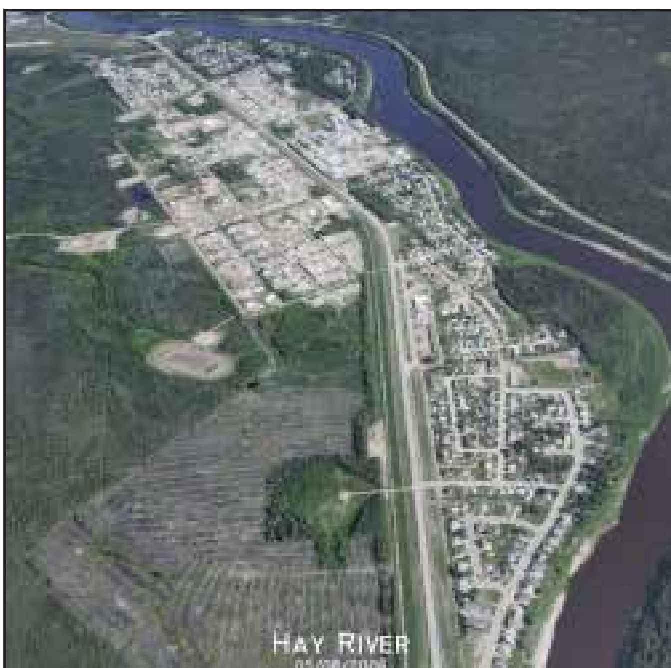
Gull Reef lies southwest of Egg Island and Pilot Reef, northeast of Green Island.

Ice Conditions

Ice begins to form in the smaller bays around mid-October, ending navigation on the lake. By the first week of June, open water begins to appear along the shores; by mid-June, the main body of water is clear of ice.

12.1.3.3 Hay River

The town of Hay River is located on Vale Island, in the Hay River delta. The island's generally flat terrain is dotted with marshland and slopes off gently toward the north, well exposed to Great Slave Lake. The town lies directly within the Aurora Borealis viewing belt, so spectacular displays of the Northern Lights are commonplace between late August and October.



The community of Hay River. Photo courtesy of the Government of the Northwest Territories.

Winds at Hay River usually blow from the northeast in the summer and, to a lesser extent, from the northwest and southeast. In the fall, southeast winds become more frequent, as do stronger northwesterly winds. A northeast lake breeze dominates in this area.

Cold air sweeps across the lake in the fall and early winter, creating favourable conditions for strong, gusty winds and snow showers or squalls. The Caribou Mountains and, to a lesser extent, the Cameron Hills (south of Hay River) are favoured areas for thunderstorm development as a result of daytime heating.

Hay River's proximity to the lake, as well as the prevailing northerly wind flowing off the colder lake water, tends to keep the air temperature slightly cooler than it is when winds blow overland (southerly flows). Fog can occur at Hay River throughout the summer but is most frequent in August. Freezing precipitation is most common in late October and into November.

12.1.3.4 Fort Resolution

Fort Resolution is a hamlet on the south shore of Great Slave Lake, at the mouth of the Slave River. It is the oldest community in the Northwest Territories and was a key link in the fur trade's water route north. The area surrounding the community is generally flat, rising to a maximum of about 10 m above lake level.

At Fort Resolution, the prevailing winds are from the west-northwest and the east-southeast, flowing approximately parallel to the main shoreline of Resolution Bay. The strongest and most predominant are from the west and north off Great Slave Lake, although winds are common from all quadrants. In the fall, northwesterlies often push low cloud off the lake toward the hamlet—at times generating snow streamers late in the season. Fall is also a common time for freezing drizzle.

12.2 Mackenzie River Marine Area

The Mackenzie River is the longest and largest river in Canada and one of the longest in the world—at 1,738 km in length and averaging approximately 2 km in width. Its discharge into the Beaufort Sea represents more than 10 percent of the total river flow into the Arctic Ocean. The mixing of this large volume of warmer, freshwater with the colder saltwater of the Arctic Ocean has an important influence on the Arctic climate.

Detailed information is provided for the six marine regions that represent different segments of the Mackenzie River: Wrigley Harbour mile 0 to Axe Point mile 91; Axe Point mile 91 to Camsell Bend mile 290; Camsell Bend mile 290 to Tulita mile 512; Tulita mile 512 to Fort Good Hope mile 684; Fort Good Hope mile 684 to Point Separation mile 913; and Point Separation mile 913 to Kittigazuit Bay mile 1081. The mile system, which is used as a reference for mariners, begins at the outlet of Great Slave Lake and ends at Kittigazuit Bay.

Did You Know?
The Mackenzie River was named after Scottish explorer Alexander Mackenzie, who started his expedition from Fort Chipewyan (Lake Athabasca) on June 3, 1789, in the hopes of finding a water route to the Pacific Ocean. On July 14, after following the large river that flowed west from Great Slave Lake, he and his team were disappointed to see pieces of ice floating in the salty waters—indicating that the river did not empty into the Pacific but the Arctic Ocean.

12.2.1 Winds and Weather

The Mackenzie is an important transportation route for both commercial and local interests and offers generally flatwater conditions, except for the presence of the Providence, Green Island, Sans Sault, and Ramparts rapids. Strong winds, however, can quickly turn the wide expanse of water into dangerous whitecaps.

Mariners' Tips:
There are several danger zones on the Mackenzie River. They are described in detail in *Sailing Directions*.

Air flow in the Mackenzie Valley is largely influenced by topography. Winds are channeled along the valleys, causing localized wind patterns that often differ from the prevailing winds in the region. Wind speed and direction in each valley is determined by its orientation to the prevailing winds, as well as its length, width, depth, and straightness. Diurnal katabatic and anabatic winds and lake breezes also introduce variations in the wind flow. Daytime heating often creates a thermal gradient that reinforces the channelling of winds along the western side of the Mackenzie Valley. Those in excess of 35 kt, however, rarely persist for more than four hours.

In the southern reaches of the Mackenzie River, the average daily maximum temperature in July is approximately 21°C; with minimums of about 10°C at night. Average temperatures in the northern regions are about three to eight degrees cooler. Rainfall is slightly lower near the Arctic Coast than in the southern reaches, averaging not more than 60 mm.

Storm activity in the region reaches a peak in July and August, with the area around Norman Wells often affected. In August and September, the Beaufort Sea coast and lower Mackenzie Delta area receive precipitation from storms that develop north of Alaska and travel along the coast. As the maritime air penetrates the Mackenzie Valley, rapid surface heating causes it to become more unstable, resulting in more frequent precipitation in the lower Mackenzie Valley and Delta areas.

From May to July, the Beaufort Sea coast and the lower Mackenzie Valley receive precipitation from frontal lows that originate in northern Alaska, track through the northern Yukon, and then head southeastward. In addition, the upper part of the valley is affected by frontal lows that come eastward from the Gulf of Alaska through the southern Yukon. Outbreaks of Arctic air become progressively colder and more frequent during the fall, penetrating further south along the Mackenzie Valley. As freeze-up starts, moisture introduced into the atmosphere by the relatively warm bodies of water causes cloudy skies and frequent snow.

12.2.2 Waves, Shoals, and Ice Conditions

12.2.2.1 Waves

Large standing waves develop on the Mackenzie River with strong, persistent north winds in sections where the river has a north-south orientation.

12.2.2.2 Shoals

Most of the navigation difficulties on the Mackenzie occur in shallow, fast-flowing areas—in general, upstream of Fort Simpson. Shoals are found at McGern Island, near Blackwater River, above Saline River, at Saline Island, below Smith Creek, at Norman Wells (harbor access only), at Rader Island, at Camsell Bend, at Barrel Crossing, and at Hume River Crossing. The Sans Sault Rapids and Ramparts Rapids are also hazardous.

12.2.2.3 Ice Conditions

Spring break-up on the Mackenzie River usually starts east of Fort Simpson and gradually moves both upstream and downstream—likely due to the input of heat and water from the break-up of the nearby Liard River. The southern end of the river begins to break up in mid-May and the northern end in early June. Freeze-up generally begins in November. The navigation season, therefore, runs from June to late September, which is slightly longer than it is on most northern rivers.

When the Mackenzie River is ice-free, the Northern Transportation Company Limited provides a commercial barge service from Hay River, on Great Slave Lake, to the regional terminal in Inuvik, making stops all along the Mackenzie River. The annual sealift moves supplies as far east as Taloyoak, Nunavut, and west to Barrow, Alaska.

Mariners' Tips:
When wind funnels down a canyon or river valley, maximum speeds are reached at constrictions (such as sharp bends), where the wind is compressed. Strong winds create large, standing waves when they blow against the current.

12.2.3 Wrigley Harbour Mile 0 to Axe Point Mile 91 Marine Region

At the outlet of Great Slave Lake, Big Island divides the flow between the South Channel (which receives the majority of the water) and the shallow North Channel. The Mackenzie River widens significantly downstream of Big Island through Beaver Lake, where it is joined by the Kakisa River. Just downstream of this confluence, the Mackenzie gradually decreases in width through Burnt Point to Providence Narrows (upstream of Meridian Island). At this point its flow splits among numerous islands. This region includes the hamlet of Fort Providence.

Figure 16: Local effects for the Wrigley Harbour to Axe Point Marine Region.

12.2.3.1 Winds and Weather

This part of the river has a primarily northwesterly course, so winds are subject to funneling and barrier effects. As a result, northwest and southeast winds are more frequent and stronger than those from other directions.

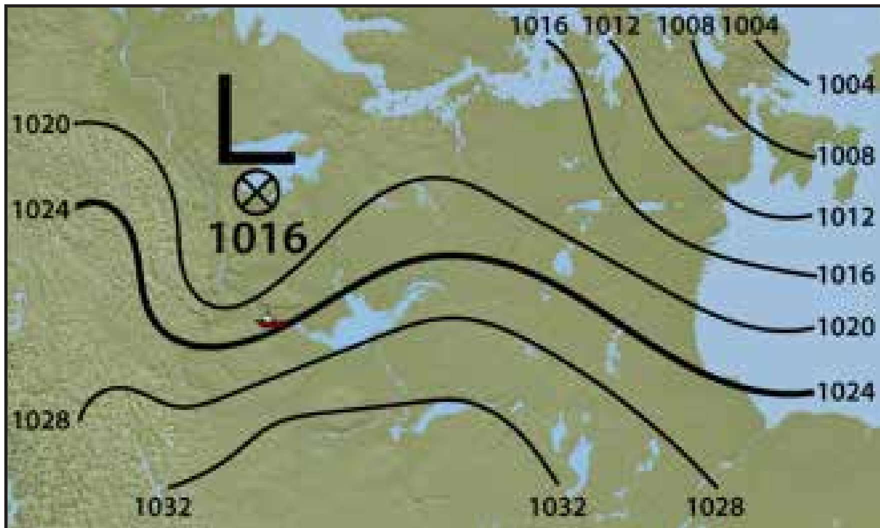


Figure 17: Surface analysis from September 11, 2014, when the synoptic pattern indicated winds from the southwest in the vicinity of the pusher tug *Kelly Ovayuak* but the ship itself reported southeast winds of up to 23 kt. The winds backed to east winds after the tug passed Mills Lake and the river's course shifted to westerly.

Wrigley Harbour, on the northwest side of Brabant Island, provides shelter from the river's swift current but is unsafe for small boats during northwest gales. Beaver Lake is very shallow and features a narrow, dredged channel (marked by buoys) that runs parallel to its south shore. When the winds are strong, mariners are advised to head for the south shore. Just past the Deh Cho Bridge, the river deepens, creating strong and unpredictable currents. The Providence Rapids, located a few kilometres upstream of Fort Providence, renders the river channel to only 100 m wide in some places.

Mills Lake is a shallow broadening of the Mackenzie River northwest of the hamlet of Fort Providence that has a reputation for dangerous waters, even in moderate winds. At the mouth of the lake, the winds are noticeably stronger and can cause large seas. Mariners are advised to stick to the south shore of the river; smaller vessels can find shelter in the weed beds that extend from shore.

12.2.3.2 Water Levels, Waves, Currents, and Shoals

Water Levels

The long fetch length of the river at Beaver Lake enables significant wind-induced waves to develop. The length of the fetch upstream of the Deh Cho Bridge (about 12 km south of Fort Providence) can be as much as 45 km for winds blowing east-southeast. Winds of 32 kt from this direction can produce waves 0.9 m in height and, if blowing with or against the current, can decrease or increase the water level, respectively, by as much as 0.4 m.

Waves
Beaver Lake and Mills Lake are prone to waves from all directions due to their shallowness.

Currents
Providence Rapids are swift but smooth, with currents up to 10 kt and strong eddies and whirlpools. Currents of up to 4 kt occur in the South Channel (south of Big Island) and up to 2 kt through Beaver Lake.

Shoals
Shoals are found along the northeast side of Big Island, in the South Channel (south of Big Island), 800 m offshore of Burnt Point, and in Mills Lake. The Big Snye, south of Meridian Island, is a shallow and unnavigable side-channel.

12.2.3.3 Fort Providence

The hamlet of Fort Providence is located downstream of Providence Narrows, on the north bank of the main channel. It has a humid, sub-arctic continental climate with cool summers and no dry season. Fort Providence generally experiences winds from all directions, but fewer from the southwest and northeast. The strongest blows come from the west and northwest.

Fort Providence. Photo courtesy of the Government of the Northwest Territories

12.2.4 Axe Point Mile 91 to Camsell Bend Mile 290 Marine Region

Near Mills Lake, the river is several kilometres wide. It starts to narrow past Small Axe Creek (south of Axe Point) as it flows through low, wet swampland. By the time it changes to a more northerly course at Jean Marie River, it is only about 1 km in width. It continues in this direction for about 25 km, then starts to turn west at the mouth of the Rabbitskin River. The river continues its westerly course down to Camsell Bend, where it once again turns north. This region includes the communities of Jean Marie River and Fort Simpson.

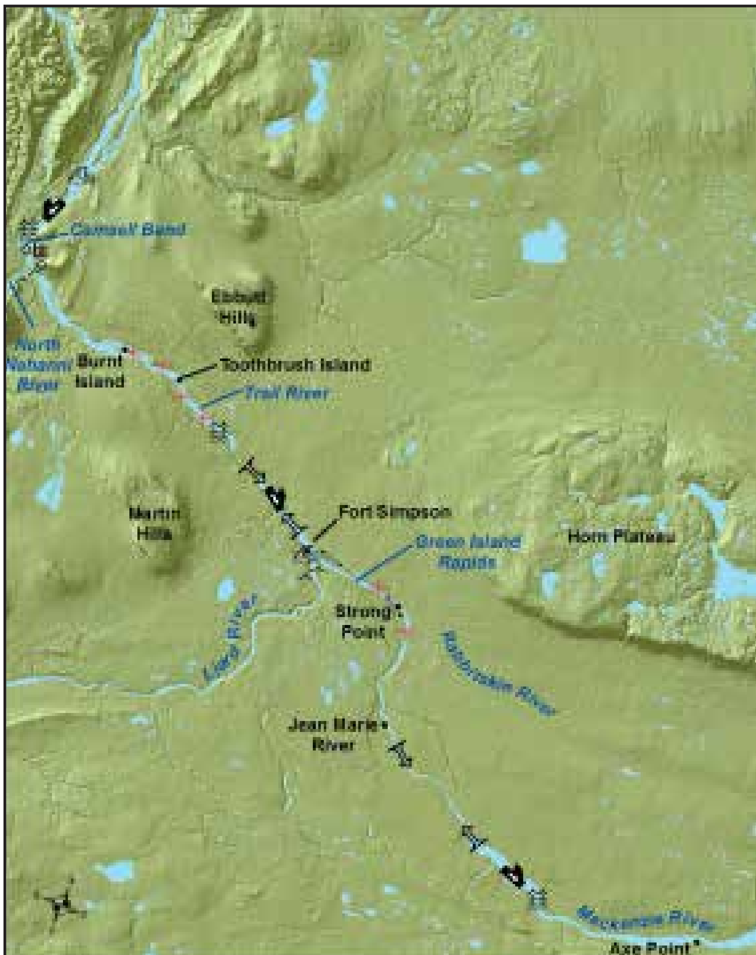


Figure 18: The Axe Point to Camsell Bend Marine Region.

12.2.4.1 Winds and Weather

The river valley in this section is oriented from northwest to southeast. As such, winds from these directions are most frequent and strong, due to a funneling effect.

12.2.4.2 Water Levels, Waves, Currents, and Shoals

Water Levels

During the navigation season, flash floods or freshets from Mackenzie River tributaries such as the Liard and Nahanni rivers have been reported to raise the water level of the Mackenzie by 1.5 m or more over a period of three or four days.

Waves

Large or choppy seas can occur on this section of the river when winds are northerly or northwesterly (against the river current). Prolonged northerly events can create standing waves up to 1.5 m in height at the junction of the Liard and Mackenzie rivers.

Currents

The current between the junction of the Rabbitskin and Mackenzie rivers and Green Island Rapids ranges from 2.5 to 5 kt, with the current running at up to 5.5 kt through the rapids. These rapids can produce very turbulent water; boats are advised to stay within the marked channel, as this is generally where the water is deepest. The water current also increases dramatically at Strong Point, at the approach to the junction between the Mackenzie and Liard rivers, and near the junction of the Mackenzie and North Nahanni rivers (up to 5 kt), where large whirlpools and dangerous eddy lines form. An eddy also forms after Camsell Bend, along the west shoreline.

Shoals

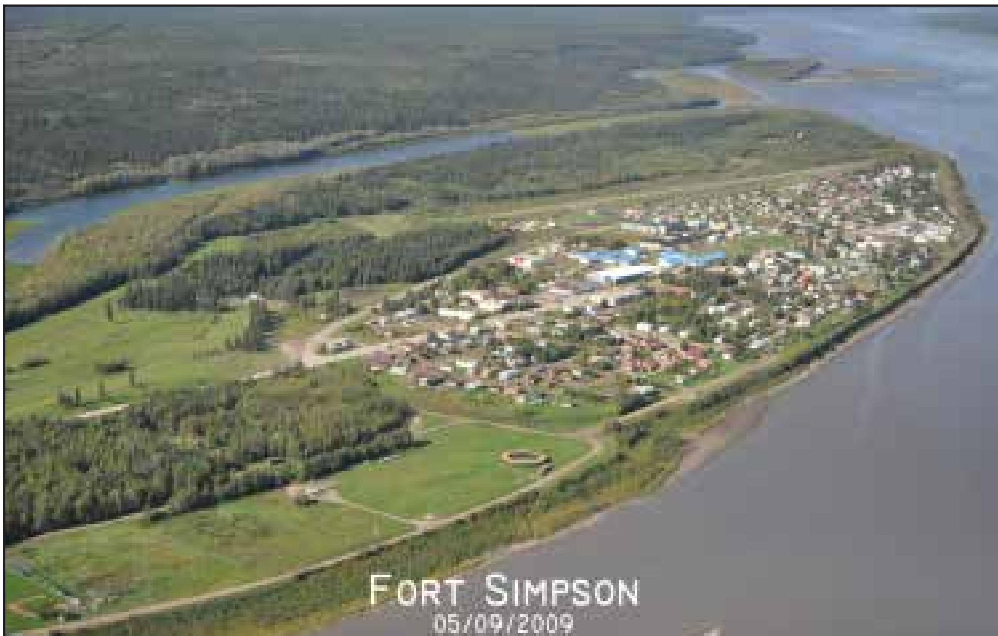
There are shoals at the confluence of the Rabbitskin and Mackenzie rivers; on the west bank, northwest of Gifford Island; extending across the Mackenzie River, beginning just upstream of Trail River; extending nearly 0.5 km upstream and 1.8 km downstream of Toothbrush Island; and south of Burnt Island.

12.2.4.3 Jean Marie River

Jean Marie River is a small Dene community located at the south side of the junction of the Jean Marie and Mackenzie rivers. Generally speaking, winter in the area is long and very cold, spring is short and cool, summer is short and hot, and fall is short. The average wind speed at Jean Marie River is 3.8 kt.

12.2.4.4 Fort Simpson

Fort Simpson is located on an island near where the Liard River empties into the Mackenzie River. The island is separated from the west bank of the Mackenzie by a narrow, shallow channel and joined to the mainland by a causeway at its east end. The terrain in the area slopes gently upward, toward the Mackenzie Mountains to the west-southwest. Closer to the mountains, the land rises more steeply.



The community of Fort Simpson. Photo courtesy of the Government of the Northwest Territories.

The village of Fort Simpson has a subarctic climate with long, cold winters, short, warm summers, and short transition seasons. Most of the precipitation falls during the summer months. On average, July and August receive about 61 mm of rain. The most common wind directions at Fort Simpson are northwest and southeast.

The Martin Hills, to the southwest, can instigate summer thunderstorms, which drift over the area in the afternoon and evening. Daytime heating also causes a buildup of thunderstorms over the Ebbutt Hills, to the northwest. June and July are the most common months for lightning activity in the Fort Simpson area. The storms are strongly driven by sunshine, so most frequently occur in the mid- to late afternoon and evening.

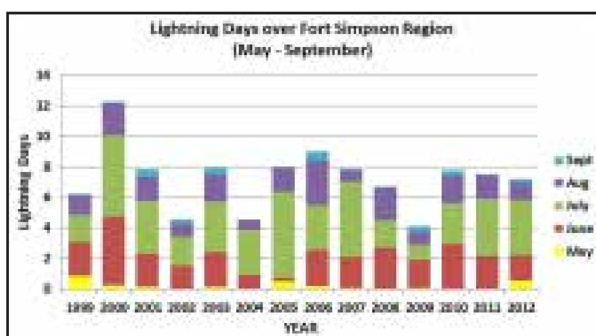


Figure 19: Lightning days over the Fort Simpson area from May to September (1999 to 2012).

Fog can occur during the spring, summer, and fall, but is somewhat less frequent in July. During the spring—and especially the fall—it can form over open parts of the Liard and Mackenzie rivers, sometimes lingering all morning. On occasion, southeast winds can bring low clouds and precipitation to the area. While freezing precipitation is not common, it can occur in October and early November.

12.2.5 Camsell Bend Mile 290 to Tulita Mile 512 Marine Region

At Camsell Bend, the Mackenzie River turns sharply north, entering a very mountainous region north of the mouth of Willowlake River. Rising out of the lowlands to the east are the Bell Range and the Franklin Mountains, which run parallel to its right bank for nearly 320 km. On the left bank, the river is flanked by the high-ridged Camsell Range, beyond which the land raises gradually to the Mackenzie Mountains. Just past the mouth of the River Between Two Mountains, the Mackenzie narrows, causing its current to increase near Old Fort Island.

Past Camsell Bend, the Mackenzie Mountains provide a spectacular backdrop to the wide, wooded river valley and its abundance of sandbars and islands. Below the bend, the river slows and widens markedly, with banks 3 to 5 km apart. Several channels appear at this point, created by the numerous low-lying islands in the area.

The Ochre River—so named for the bright red colour it turns in early summer—empties into the Mackenzie from the east along this stretch. At the mouth of the Blackwater River, about 80 km downstream, the river flows in a north-northwest direction at a fairly swift rate. Three kilometres below the Blackwater, the Mackenzie turns abruptly to the west for 6.4 km before resuming its northerly course. The current becomes swifter, and the river winds through islands and sandbars as it descends toward Tulita.

This region includes the communities of Wrigley and Tulita.

Figure 20: Local effects for the Camsell Bend to Tulita Marine Region.

12.2.5.1 Winds and Weather

Winds from northerly and southerly directions can channel in this part of the river due to the mountainous terrain, which also make the weather in this region unpredictable. Moisture-fueled air masses from the Pacific collide with the Mackenzie Mountains throughout the summer, generating heavy rainstorms. Summer temperatures can rise to some 25°C during the day and sometimes drop to near freezing at night. On cooler days, snow and hail are possible.

12.2.5.2 Waves, Currents, and Shoals

Waves

Large whirlpools and dangerous eddies occur where the North Nahanni River meets the Mackenzie. Large, rough seas occur when winds are northerly (oppose the current) at the confluence of the Nahanni and Mackenzie rivers, while choppy seas also occur near Wrigley with brisk north and northwest winds.

Currents

An eddy forms downstream of Camsell Bend, along the west shoreline. Approximately 30 km south of Wrigley (just past the mouth of the River Between Two Mountains), the Mackenzie's current increases to 5 to 6 kt. A fast, turbulent current of 5 to 7 kt is found between Blackwater River and Old Fort Point, reaching its maximum rates at the bend near Saline Island and 10 km downstream of the island. The current then slows to between 1.5 and 3.5 kt between Old Fort Point and Tulita.

Shoals

There are shoals west of the Berry and McGern islands, at the downstream end of Round Island, at the mouth of Root River, between Wrigley and the shallow mouth of the River Between Two Mountains, between Wrigley and Blackwater River, near the upstream side of Birch Island, and across the river between Blackwater River and Old Fort Point. For more detailed information on shoals, consult *Sailing Directions*.

12.2.5.3 Wrigley

The community of Wrigley is located on the east bank of the Mackenzie River, just below its confluence with the Wrigley River. Winds in the area most frequently blow from the southeast and northwest and tend to be stronger in the fall. Although generally less than 12 kt, they reach speeds of 12 to 20 kt less than five percent of the time. Winds from the southwest or northeast are rare. On average, July is the wettest month, with 64 mm of precipitation; August receives nearly 50 mm. In July, the average high is 23°C and the average low 10°C.

The community of Wrigley. Photo courtesy of the Government of the Northwest Territories.

12.2.5.4 Tulita

The hamlet of Tulita is located on the east bank of the Mackenzie River, just south of its confluence with the Great Bear River. Winds in the area can blow from almost any direction but are most frequent from the northwest and southeast in the summer. In the fall, winds usually blow from the northeast and only occasionally from more westerly directions.

The community of Tulita. Photo courtesy of the Government of the Northwest Territories.

12.2.6 Tulita Mile 512 to Fort Good Hope Mile 684 Marine Region

The Mackenzie River flows northwest from Tulita between clay banks up to 12 m high, before sharply shifting its course to the northeast, just upstream of Spruce Island. It stays the course for the next 25 km, to Fort Good Hope, before once again heading northwest.

The Sans Sault Rapids are located where Mountain River joins the Mackenzie from the west. They are considered to be the most dangerous and difficult section of the river, which drops some 6 m over just a few kilometres. Shaped like the bow of a ship, these large rapids span a tight turn in the river, raging ferociously on its inside corner, where the waves can be over a metre high. Its outside corner, while shallow and less turbulent, can still cause navigation problems in the summer, when numerous eddies are present. It is suggested that small craft stick to the outside corner to avoid capsizing. There is ample depth for shallow-draft barges in July; however, shallow water can sometimes be a navigation problem in late summer.

Upstream of Fort Good Hope, the river enters Ramparts Rapids, a 12-km-long, vertically walled limestone canyon that narrows to about 400 m wide. The canyon's cliffs provide some of the most spectacular scenery found along the Mackenzie. When the water level is high, the rapids are submerged and the greatest challenge is a strong cross-current. When it is low, there is a distinct drop over a short distance.

This marine region includes the communities of Norman Wells and Fort Good Hope.

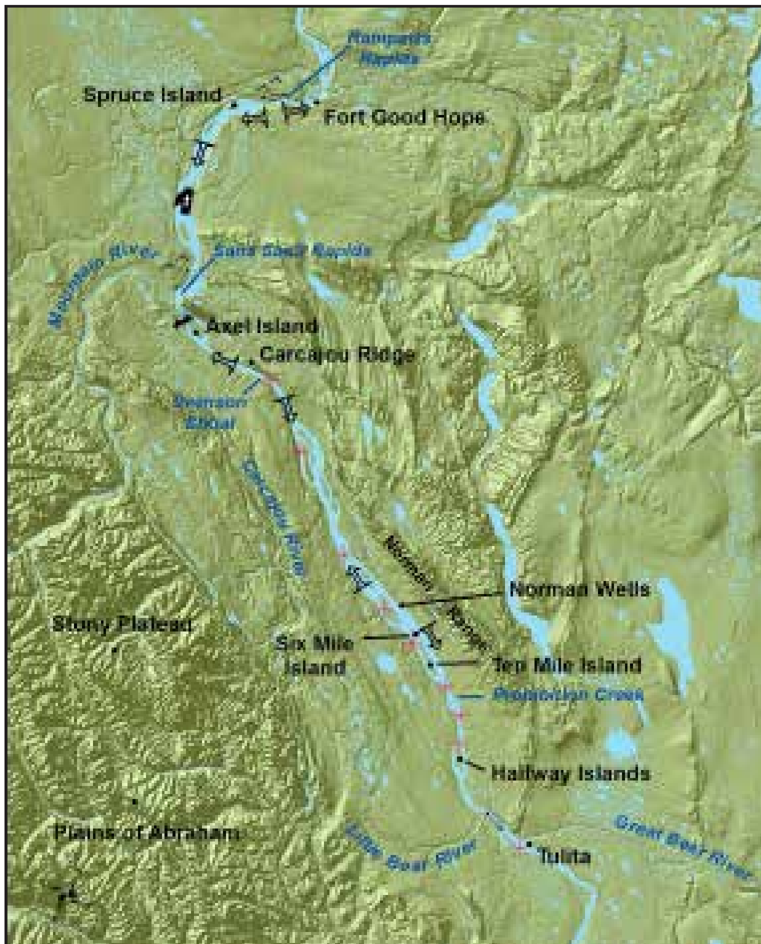


Figure 21: Local effects for the Tulita to Fort Good Hope Marine Region.

12.2.6.1 Winds and Weather

The presence of the Carcajou and Norman mountain ranges supports the channelling effect along this stretch of the river, which flows in a northwest direction from Tulita to Ramparts Rapids. Northwesterly and southeasterly winds are the most frequent and strongest on this part of the river. Winds funnel as they blow through the Ramparts Rapids Canyon.

12.2.6.2 Water Levels, Waves, Currents, and Shoals

Water Levels

The limestone ledges that confine the Ramparts Rapids are submerged when the water level is high; however, at low water (usually toward the end of the navigation season) a distinct drop in water level and an increase in water velocity (up to 6.5 kt) can occur within a length of approximately 460 m.

Waves

The river is shallow most of the way from the Sans Sault Rapids to Fort Good Hope. As such, waves quickly build up when a strong wind is blowing against the current.

Currents

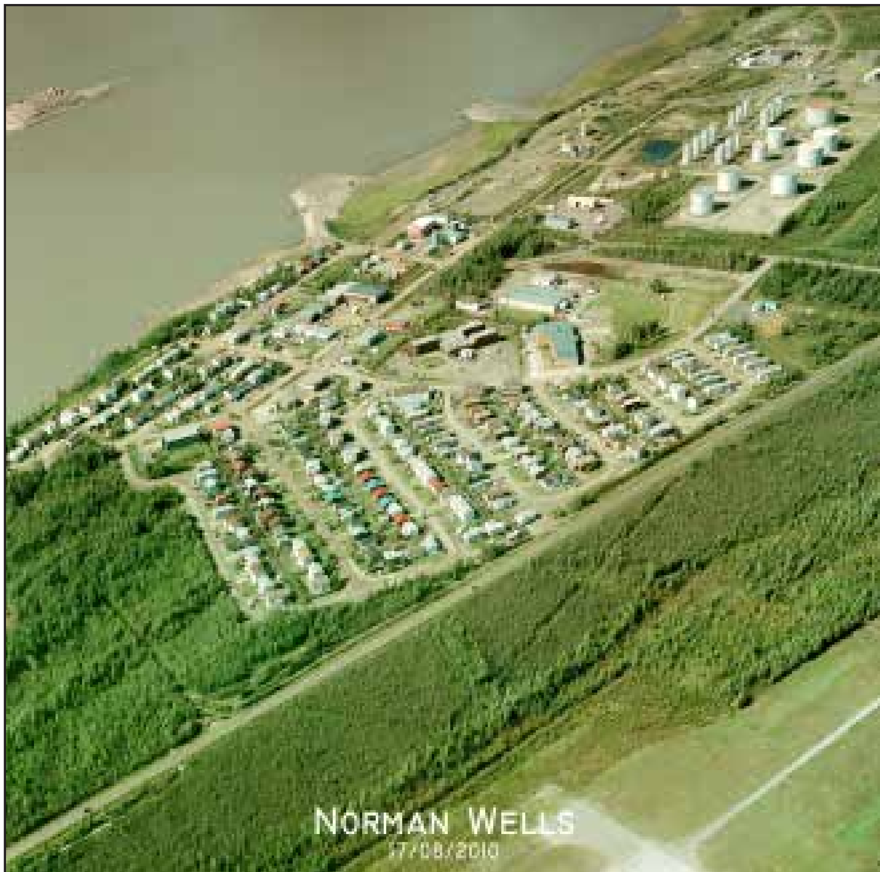
Downstream of Tulita, the current varies from 3.5 to 7 kt. It is stronger along the west bank down to Little Bear River, reaching 5 to 7 kt at its mouth. The current is reported at 3 to 4 kt between Norman Wells and Carcajou Ridge and in the channel that runs east and north of Axel Island. At Ramparts Rapids, it increases to 5.5 to 6 kt—maintaining that speed for a distance of about 2 km downstream before it decreases to 3 to 3.5 kt for another few kilometres.

Shoals

Shoal waters are found in the channel where the Great Bear River enters the Mackenzie; extending from the east bank of the river, northeast of the Halfway Islands; on the east side, upstream of Prohibition Creek; around Six Mile Island and Ten Mile Island; and between Norman Wells and Carcajou Ridge (Svenson Shoal).

12.2.6.3 Norman Wells

The town of Norman Wells is located on the eastern bank of the Mackenzie River valley, bordered to the east by the Norman Range of the Franklin Mountains and to the west by the Carcajou Range of the Mackenzie Mountains. Norman Wells has a subarctic climate, with summer lasting about three months. Rainfall averages 171.7 mm and snowfall, 161.5 cm.



The community of Norman Wells. Photo courtesy of the Government of the Northwest Territories.

The winds in Norman Wells blow along the river valley. Funneling between the two ranges causes gusty west to northwest winds and less frequent southeast winds. Very strong northwesterly winds often blow up the valley with the passage of a cold front.

In the summer, thunderstorms develop along the mountain slopes and often drift over the community. Fog often forms over the river in the spring and fall—especially in September, as cold air masses move over the warmer waters. Freezing precipitation is most frequent in October.

12.2.6.4 Fort Good Hope

Fort Good Hope is located on a peninsula between Jackfish Creek and the east bank of the Mackenzie River. On average, July is the wettest month with 41.3 mm of rain, followed by August with nearly 40 mm. The average high in July is 22°C and the average low, 10.9°C. Winds in the area tend to blow from the west-northwest or east-northeast in the summer, likely due to funnelling through the river valley, which takes an easterly turn upstream of the community. In the fall, while winds continue to blow from the east-northeast, westerly winds become stronger and more frequent.

The community of Fort Good Hope. Photo courtesy of the Government of the Northwest Territories.

12.2.7 Fort Good Hope Mile 684 to Point Separation Mile 913 Marine Region

From Fort Good Hope to about 160 km downstream, the Mackenzie River flows in a generally northwesterly direction around numerous islands and constantly shifting sandbars. The current is moderate but picks up in constricted sections, around islands and where the river narrows between the limestone cliffs. Below Thunder River, the Mackenzie turns sharply west, continuing that direction for nearly 96 km to Travaillant River, where it takes a more northwesterly course. During periods of low water (usually in late summer and early fall), the numerous islands, sand flats, and shoals along this stretch can pose a challenge—even to paddlers.

Beyond the mouth of Pierre Creek, the Mackenzie heads north, entering a long horseshoe-shaped bend above the settlement of Tsiigehtchic. This section, known as the Lower Ramparts, features a 13-km-long canyon with walls up to 90 m high. While the river narrows here to as little as 800 m, the current remains moderate (4 kt) and should not cause any problems for boaters.

There is one settlement in this marine region. Tsiigehtchic is a small Gwich'in community situated at the confluence of the Mackenzie River and the Arctic Red River. A former trading post, its population increased with the construction of the Dempster Highway, which crosses the Mackenzie River by ferry in the summer and by ice road in the winter.

Figure 22: Local effects for the Fort Good Hope to Point Separation Marine Region.

12.2.7.1 Winds and Weather

Northerly winds are strengthened by funneling along the river valley from Fort Good Hope to the mouth of Thunder River; however, shelter can be found at the mouth of the Ontaratue River. Northerly headwinds can be so strong downstream of Fort Good Hope that canoes and other small craft can be pushed upstream by their force. Conditions can be particularly bad after the passage of a cold front.

Mariners' Tips:
A possible indication of a coming storm is the appearance of dark blue rings or a halo around the sun or moon.

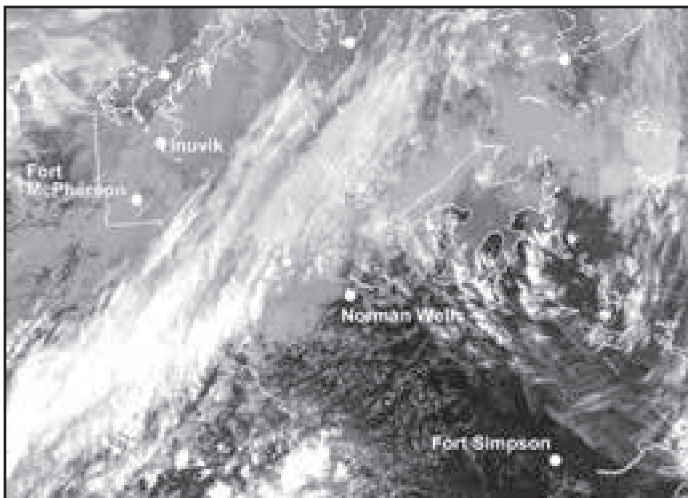


Figure 23: Satellite image from August 1, 2004

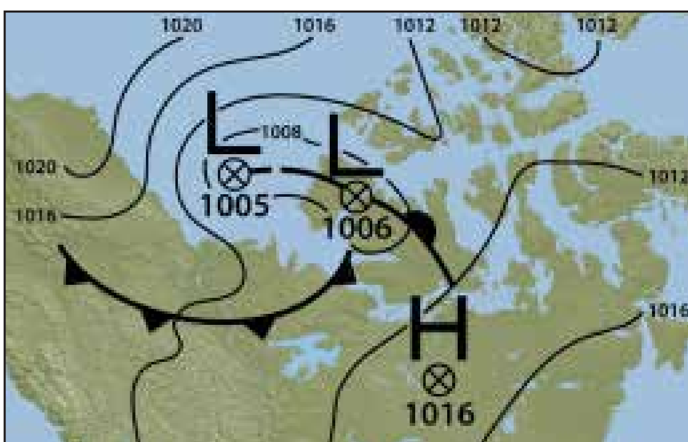


Figure 24: Surface analysis from August 1, 2004.

Satellite image (above) and surface analysis (below) from August 1, 2004, when a storm generated strong headwinds along the river downstream of Fort Good Hope, all the way to Andersons Landing.

12.2.7.2 Currents and Shoals

The current reaches 4 kt at Lower Ramparts and 3.5 kt between the mouth of the Arctic Red River and Point Separation.

Shoals extend for 1.5 km near the west bank of the Mackenzie River, beginning 4 km downstream of Lower Ramparts. Numerous shoals are also found between Adam Cabin Creek and Cony Bay.

12.2.8 Point Separation Mile 913 to Kittigazuit Bay Mile 1081 Marine Region

Point Separation (24 km downstream of the confluence of the Arctic Red and Mackenzie rivers) refers to the place where the Mackenzie River separates into several channels that flow through the Mackenzie Delta. The delta, which is about 160 km across at its widest point, is a myriad of lakes, swamps, river channels, and land masses that extends from its head at Point Separation to the Beaufort Sea, about 250 km north.

Three main channels of the Mackenzie River flow through the delta. The East Channel (the entrance to which is hidden by an island but found about 16 km north of Point Separation) goes past the town of Inuvik. North of Inuvik, the channel heads north-northwest, then shifts to northeast at Tununuk Point, maintaining this course all the way to Kittigazuit Bay. The Middle Channel is the main discharge into the Beaufort Sea, while the Peel Channel flows past the town of Aklavik.

Figure 25: Local effects for the Point Separation to Kittigazuit Marine Region.

The main shipping route for barges heading from Point Separation to Tuktoyaktuk is via the wider Middle Channel to the Oniak Channel, which leads into the East Channel. Since the shipping lanes within these river channels are continuously changing due to silting and erosion, vessels in these waters may be exposed to danger at any time. In the summer, this wide expanse of water is exposed to high winds that cause large waves, making travel by boat even more treacherous.

This marine region includes the communities of Fort McPherson, Aklavik, and Inuvik.

12.2.8.1 Winds and Weather

Winds from the northwest to southeast funnel through the East Channel north of Inuvik—strengthened by the presence of the Caribou Hills (to the east) and the Middle Channel (to the west)—until the waterway turns northeast, near Tununuk Point. Winds from the northeast to southwest likely funnel from Tununuk Point to Kittigazuit Bay. In general, northwesterlies are the strongest winds along this section of the river. They usually occur behind a low-pressure system tracking eastward or southeastward from the Beaufort Sea or along the northern coast of the mainland.

12.2.8.2 Water Levels, Waves, Currents, and Shoals

Water Levels

During the late summer and fall, Beaufort Sea storm surges can cause flooding in the Mackenzie Delta area, when the pack of ice retreats 100 km or more from the shore. Fluctuations in water levels occur in the Middle and East channels as far as Tununuk Point. Persistent onshore winds will raise the water level in these areas, while persistent offshore winds will lower it.

Waves

Northwest winds in the Middle Channel are reported to cause high waves in the vicinity of Marcus Channel and Lewis Channel. In the summer, the wide expanse of water at Point Separation is subject to high winds that cause large waves and make boat travel through the area treacherous.

Currents

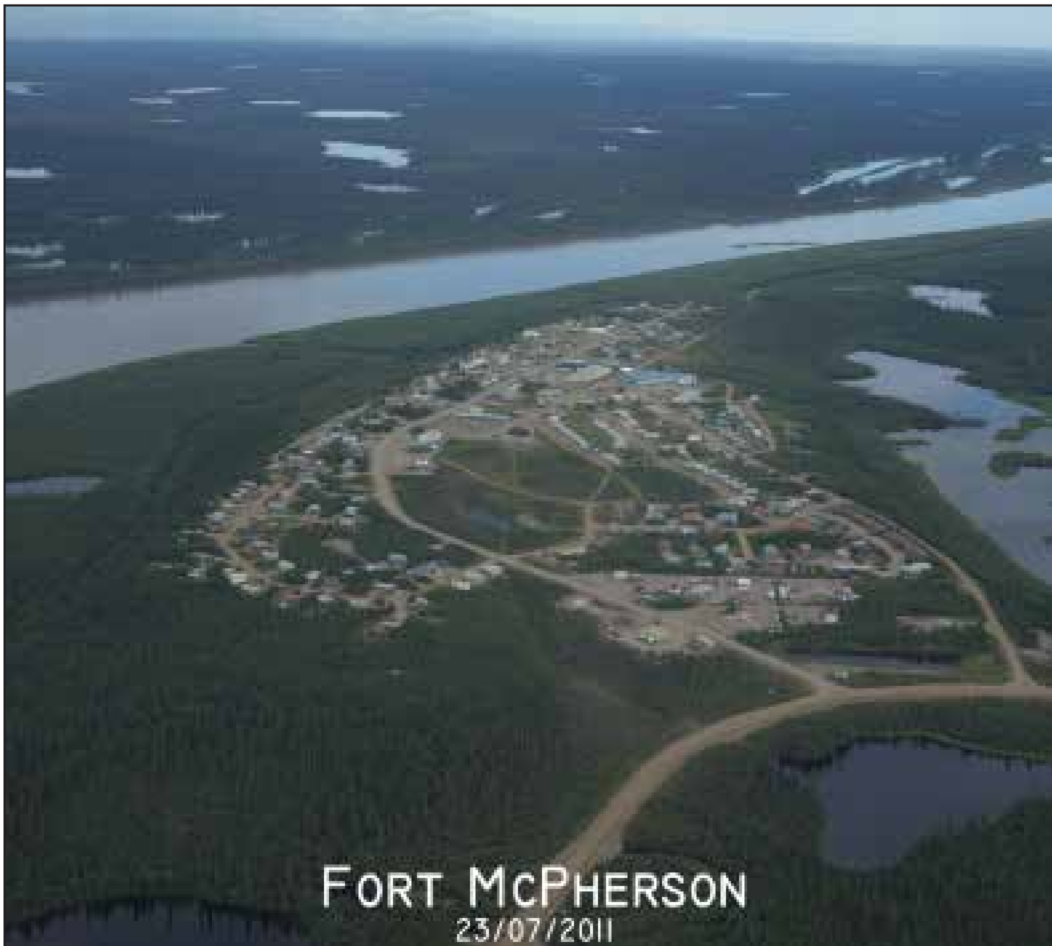
The flow in the channels of the Mackenzie Delta fluctuates with the prevailing meteorological conditions, tides in the lower delta, and the outflow of the rivers. The current in the Middle Channel varies from 3 to 3.5 kt, while currents near 2 kt have been registered in the other channels. There is a strong current off the west shore of the Middle Channel, near the entrance to Aklavik Channel. Next to the entrance to Neklek Channel, part of the Middle Channel's flow reverses direction and flows south around a large drying flat into Reindeer Channel. The flow downstream of Tununuk Point is reportedly much greater than that at Inuvik.

Shoals

Middle Channel has a wide but shallow mouth. Kittigazuit Bay is also very shallow.

12.2.8.3 Fort McPherson

The hamlet of Fort McPherson is located on the east bank of Peel River, about 37 km from its junction with the Mackenzie River, on rolling land between the Richardson Mountains and the Mackenzie River Delta. The average rainfall amount in Fort McPherson is 145.9 mm and the average snowfall is 152.5 cm, with August being the wettest month.



The community of Fort McPherson. Photo courtesy of the Government of the Northwest Territories.

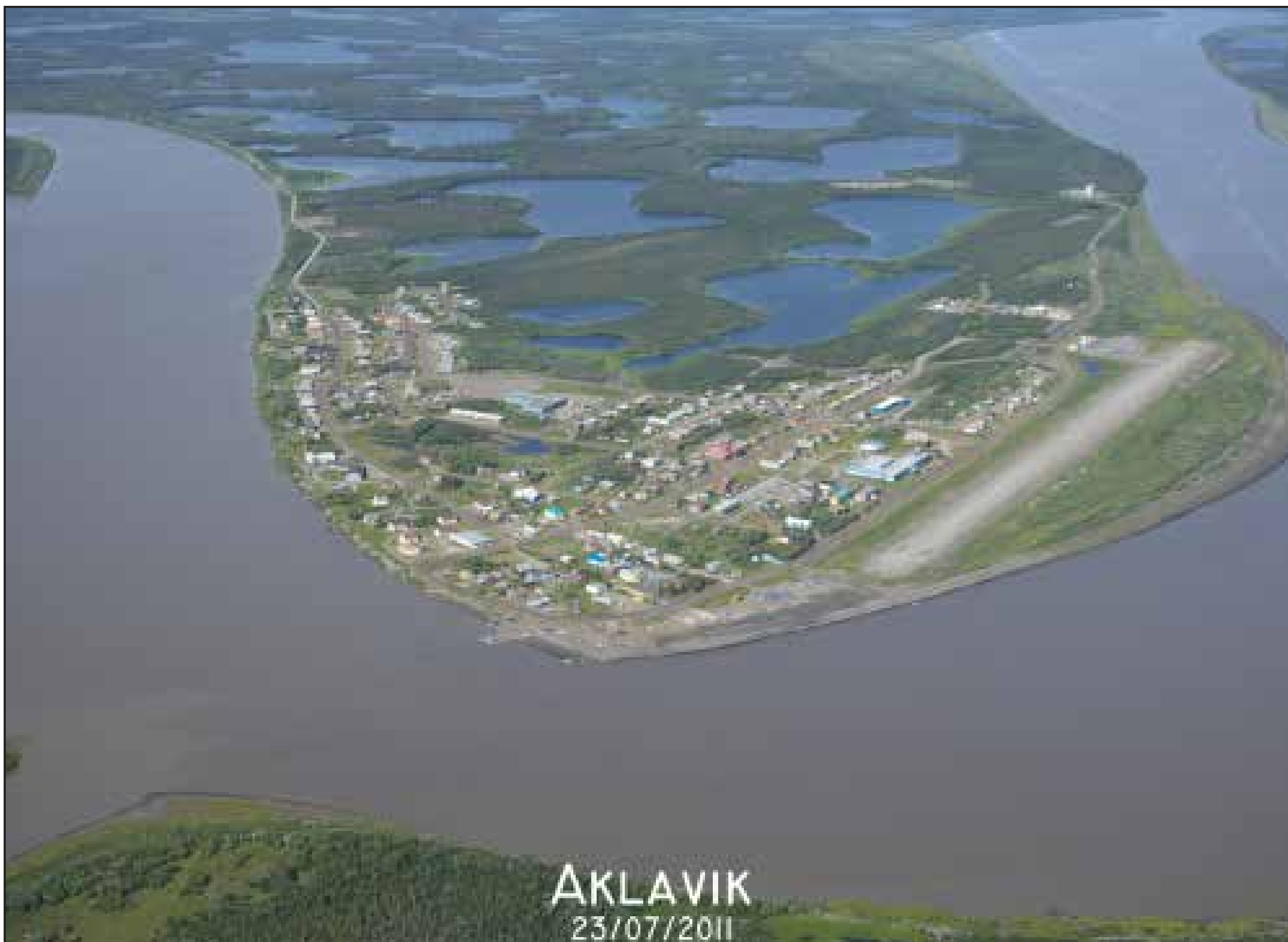
Winds at Fort McPherson are strongly influenced by its geographic location. To the west lie the Richardson Mountains, which tend to deflect winds in a northerly or southerly direction. On occasion, downslope winds flow off the mountains toward the town. These winds, however, are much stronger near the mountains than they are by the time they reach Fort McPherson.

Summer winds blow mostly from the north and northwest, as well as from south and southeast. Northerly summer winds can bring weather from the Beaufort Sea, such as fog, low cloud, and precipitation. Low cloud and low visibility are rare in all seasons with southeast, south, southwest, and west winds. Lightning activity in this area is short, but can be quite intense, with a strong peak in July.

The navigation channel in Peel River shifts due to erosion and silting, so local knowledge is needed to navigate it safely. Between the Mackenzie River and Fort McPherson, the Peel River ranges from 300 to 800 m in width and has a current of approximately 2 kt. The river's navigation season runs from June to September.

12.2.8.4 Aklavik

Aklavik is a hamlet situated on the west bank of the Peel Channel, in the Mackenzie Delta, not far upstream of its junction with the Aklavik Channel. The Peel Channel was subject to flooding and its banks were being washed away, so the Federal Government built a new community at Inuvik with the intention of closing Aklavik. Many residents persevered, and the community survives today.



The community of Aklavik. Photo courtesy of the Government of the Northwest Territories.

Northwest and southeast are the most common wind directions at Aklavik and are strongest in the summer. The most severe winds and storms are from the northwest.

Significant Event: September 22, 1993

On September 22, 1993, a severe storm with northwest winds up to 50 kt generated a storm surge that raised water levels to 2.2 m higher than what was indicated on the navigational charts. These elevated water levels, combined with large waves, resulted in flooding in Aklavik and Tuktoyaktuk.

12.2.8.5 Inuvik

Inuvik is located approximately 120 km south of the Beaufort Sea, on the east bank of the East Channel of the Mackenzie River. Inuvik has a subarctic climate. Its summers are typically wet and cool, although temperatures vary wildly due to its location near the cold Arctic Ocean. July has a mean high of 19.5°C and a mean low of 8.6°C. Summers warm up quickly due to the continuous daylight. Winters are long and extremely frigid, with a mean high of -22.8°C and a mean low of -31.0°C in January. Freezing temperatures can occur any month of the year. Due to its northern location, Inuvik experiences an average of 56 days of continuous sunlight every summer and 30 days of polar night every winter.

The community of Inuvik. Photo courtesy of the Government of the Northwest Territories.

East and east-northeast winds dominate in this area in all seasons. When a surface ridge is east of the weather station, winds tend to be from the east. Northwest and north winds are also frequent—in particular, when it comes to strong winds. Even moderate north and northwest winds can generate large waves downstream of the last bend in the East Channel (upstream of Inuvik).

When low-pressure systems develop or move eastward across Mackenzie Bay or the Mackenzie Delta, a strong northwesterly or westerly flow will occur over coastal areas in the low's wake and then spill inland. The more intense the cold front and the deeper the cold air behind it, the stronger this flow tends to be—although it is generally of short duration. Strong cold fronts from the coast often weaken when they reach the delta, so don't make it as far inland as Inuvik.

Mariners' Tips:
If there is the potential of a cold front moving through this area, mariners should be aware of the presence of wind shifts, strong pressure-tendency rises, and sharp temperature drops at upstream stations in Alaska and the Yukon.

During the open water season, northwest winds routinely bring low cloud and fog to Inuvik, the former often persisting all day. When winds shift to the west or southwest, these clouds tend to lift and the temperature can rise dramatically. Fog is most frequent in Inuvik during the fall, usually developing overnight and persisting through the morning and into the afternoon.

Thunderstorms and lightning are not common in Inuvik, but sometimes develop over the Richardson Mountains, arriving in the community in the late afternoon or early evening—most often, in June and July. Freezing precipitation can occur in May and October, during times of break-up and freeze-up.

ARCTIC REGIONAL GUIDE PART 9: HUDSON BAY AND JAMES BAY

13. Hudson Bay and James Bay Marine Area

The Hudson Bay and James Bay Marine Area comprises 13 marine forecast regions, including nine coastal areas (Roes Welcome, Rankin, Arviat, Churchill, York, South Hudson, James Bay, Belcher, and Puvirnituq), three open-water areas (Coats, Central, and South-Central Hudson); and an inland lake (Baker Lake).

This section provides information on local wind, weather, sea state, and ice conditions for 11 of these regions, each of which is affected by differences in its coastal topography, temperature, and other local factors. Since the Central and South-Central Hudson regions are far from shore and affected only by weather systems passing over these areas of open water, they are not covered. Information on Roes Welcome is featured in Part 5: Foxe Basin Marine Area.

Figure 1: Map of the Hudson Bay and James Bay Marine regions.

Hudson Bay is a large, shallow, inland sea in the Canadian Arctic that is 830 km across at its widest point and 1500 km long. Although it has an average depth of 125 m, it is less than 80 m deep from 20 to 100 km from its coast. James Bay, at its southernmost tip, generally ranges from about 36 to 54 m deep in the middle; however, much of it is quite shallow, with drying mud flats extending from its shores.

Hudson Bay is landlocked on all sides except the north, where it is bordered by islands that separate three main entrances to the bay. The most important of these is the channel between Nottingham Island and Ungava Peninsula, which leads from the bay directly into Hudson Strait, and, from there, to the Atlantic Ocean. This deep-water route is the only one of significance to oceangoing vessels and, while ice can sometimes block the strait in winter, it is typically navigable from mid-July to mid-October. The other two entrances lead north into Foxe Basin, which provides access to the Arctic Ocean via Fury and Hecla Strait.

The main body of Hudson Bay is quite open, with its western side almost completely devoid of islands aside from some small ones at its northern end. Its northeastern and eastern portions, however, feature a number of large islands and groups of smaller ones—as does James Bay.

Many large, shallow rivers feed into the bay, including (from west to east) the Thelon and Dubawnt (which flow through Chesterfield Inlet); the Hayes, Nelson, and Churchill; the Severn and Winisk; the Attawapiskat, Albany, Moose, Harricana, Nottaway, Rupert, Eastmain, Abitibi, and La Grande (which flow into James Bay); and the Grande rivière de la Baleine, Petite rivière de la Baleine, and Nastapoka.

Shorelines in the north and east are typical of the Canadian Shield: low (generally 60 to 90 m in elevation), rough, rocky, and indented with bays and inlets. Well-developed coastal cliffs and headlands reaching 500 m in height occur along parts of the Quebec coast and the Nastapoka arc—a large semicircular bight in the southeast coastline across from the Belcher Islands. The Hopewell-Nastapoka-Long Island complex—which stretches for approximately 600 km along this section of coastline—is the longest chain of islands in the country.

In contrast, Hudson Bay's western and southwestern coasts (Hudson Bay Lowlands), the southwestern coasts of the Southampton, Coats, and Mansel islands, and the larger islands of James Bay feature vast expanses of low-lying and often marshy land. Tidal flats up to 9 km wide extend several kilometres from the mainland, making water access difficult and coastal travel in small craft dangerous when winds are high. Eskers, moraine, and raised beaches are common.

The communities of Churchill (the bay's principal port) and Moosonee are terminals on the continental railway system, located on the Churchill and Moose rivers, respectively. Other settlements with small harbours or anchorages, often centred around Hudson's Bay Company stores, are scattered along the coast.

13.1 Winds and Weather

13.1.1 Winds

Hudson Bay experiences strong winds during all but the summer months. Winds from between the north and west are more common on the western side of the bay; on the eastern side, no one direction predominates. In summer, the wind direction is variable, except for onshore sea breezes.

Since much of the surrounding land is composed of tidal flats and sparse vegetation, winds observed at land-based coastal weather stations are usually fairly representative of those encountered in the marine environment. In the summer, however, offshore winds tend to be stronger and gustier over land than they are over the cooler, more stable water.

During the late summer and early fall, cool air and warm waters generate greater instability, causing the formation of convective clouds that can produce showers or flurries. Wind speeds also increase, rising noticeably by late September. Gales are most frequent over the bay from October to December, as the water begins to freeze, and least frequent from May to September. Although gales are common throughout the winter, the bay is usually frozen over by then and closed to shipping.

While local wind effects are few, west-northwest winds may be slightly stronger across the entrance to James Bay and Cape Henrietta Maria. Since larger vessels tend to travel through the deeper channels in the middle of the bay, these gusty offshore winds only affect coastal boat traffic.

13.1.2 Weather

Even in the summer months, Hudson Bay is a very active area in terms of well-organized, longer lasting storms moving through the area, as mean storm tracks cross the bay all year round. In the fall, it is one of the most active storm regions in the country.

In spring the cold, partially ice-covered marine water has a stabilizing effect on the air. This reduces vertical convection (and, therefore, wind stress and evaporation) and increases the heat flux into the water.

The primary storm tracks that occur during summer do not tend to carry deep, low centres and often move eastward across central Hudson Bay from the west or southwest. Thunderstorms are common on the Belcher Islands at this time of year.

From September through November, intense storms often curve through the bay in a more southwest to northeast direction. The relatively warm waters have a destabilizing effect on the cooler air. West-to-east storm tracks move southward across James Bay.

In winter, secondary tracks moving across Hudson Bay are usually at the centre of an occluded depression and apt to create strong winds but little snowfall. There is a general flow of cold Arctic air from the northwest or west over the western half of the bay and from the west or southwest over its eastern parts and James Bay. Low-pressure areas generally pass south of James Bay but can induce strong surface winds from the north or northwest as they recurve northward over Davis Strait.

13.1.2.1 Precipitation

In early summer, water temperatures are colder than those of the surrounding land. As a result, drizzle and fog often form over the bay, especially where sea ice lingers. While convective clouds moving from over the land to the water tend to dissipate a short distance offshore, showers and thunderstorms that formed along fronts usually last longer—and thunderstorms can cross James Bay without dissipating. Moosonee experiences thunderstorms three days per month, on average, from June through August.

In fall and early winter, low-pressure systems moving from the cooler land to the warmer water often intensify, producing thick cumulus clouds and frequent and often heavy rain or snow. Along the east coast, average monthly precipitation peaks in September as increasingly cold-air masses pass eastward and southeastward across the open waters of Hudson Bay. The highest monthly average snowfall occurs from October to January but is concentrated in November and December.

13.1.2.2 Fog

Fog is most frequent in June, July, and August as warm air cools over the colder water or the surface of melting sea ice. As open water increases, the cold surface increases the likelihood of fog formation. By early July, rapidly warming water temperatures in the south decrease the frequency of fog; however, lingering ice cover in the north keep it high into August. Coastal observations indicate that Moosonee experiences 3-4 days of fog per month during this period, while more northerly Inukjuak averages 12. Incidences are lower in the northwest part of Hudson Bay, with Chesterfield Inlet seeing an average of four days. Fog at coastal stations is also tied to onshore flows: westerly winds bring fog to the eastern shore, while easterlies do the same to the western shore. During the early spring and late fall, Arctic sea smoke also develops from the shore leads, as the cold air moves over the warmer waters.

13.1.2.3 Vessel Icing

The main cause of vessel icing in Hudson Bay is freezing spray, which can cause ice accretions exceeding 20 cm in thickness. Conditions for freezing spray usually occur when large, intense cyclones with strong west-northwest flows of cold Arctic air produce snow showers and squalls over warmer, open water. During freezing spray events in Hudson Bay, the air temperature is typically -6°C with 25 kt northwesterly winds and waves of 2-3 m.

Although the potential for freezing spray in Hudson Bay exists from October to May, heavy ice-cover restricts vessel speed and wave growth for most of the winter. As such, vessel icing from spray is most frequent in October and November, when temperatures are dropping but ice cover has not yet advanced significantly.

Vessel icing from super-cooled fog and freezing precipitation is less frequent and is generally responsible for accretions of 1-2 cm. Arctic sea smoke can accompany spray icing if air temperatures are very cold. In Hudson Bay, freezing precipitation is most likely in the spring and fall, while super-cooled fog occurs most often in the fall.

13.2 Waves, Tides and Currents, and Ice Conditions

13.2.1 Waves

Data on wave heights and periods in Hudson Bay and James Bay are scant. Median wave heights in August and September are 1-2 m with periods of 5-6 seconds. In northern Hudson Bay, wave heights over 3 m occur about 10 percent of the time during the open-water season, with most of the largest originating from the northwest; wave heights of 8 m with periods of 10 seconds have been recorded in September.

Strong storm surges sometimes occur in southern James Bay, usually during the early spring (April to June) or late fall (September to December). They pose a significant hazard to travellers who may be unprepared for a tide that can extend for kilometres inland, well beyond the normal high-water mark.

Storm surges are greatest when winds blow along the north-south axis of James Bay. Strong autumn winds have caused surges of at least 1.2 m, while sustained winds of 90 km/h have caused surges of 6 m along the south shore of the bay. Strong or prolonged south winds can lower the water level in the south part of James Bay.

13.2.2 Tides and Currents

Powerful tides surge twice daily into Hudson Bay from Hudson Strait, following the contour of the shoreline in a roughly circular manner. At the entrance to the bay, the average height of the tide above chart datum is 3 m. As it heads southward along the west shore, it increases to 3.7 m and as much as 4 m at Churchill Harbour before turning northward up the east shore, where it drops to as little as 0.5 m at Inukjuak.

The maximum tidal currents are observed at the entrance to Hudson Bay, where they reach velocities of 90 cm s^{-1} (average 45 cm s^{-1}). Smaller maximum values of 30 cm s^{-1} (average 20 cm s^{-1}) occur within the bay. During the winter, ice cover dampens the tidal currents and their heights and advances their arrival times. At the shallow entrance to James Bay, tidal currents increase to 50 cm s^{-1} (average 22 and 29 cm s^{-1}).

Currents are strongly affected by influxes of fresh water from rivers and, during the open-water season, by wind stress. In summer, surface water circulates counter-clockwise around Hudson Bay. Deeper water moves in the same general direction but is influenced by bottom topography. Cold saline water from Foxe Basin enters Hudson Bay via Roes Welcome Sound. As it flows eastward along the southern coast of the bay, some enters James Bay and the remainder is deflected northward and into Hudson Strait. A westward, wind-driven return flow across the top of Hudson Bay has been predicted by modelling studies and there is a small, perhaps intermittent intrusion of Atlantic water from Hudson Strait at the northeast corner of Hudson Bay.

Figure 2: Summer circulation of water in the Hudson Bay complex.
Source: Arctic Monitoring and Assessment Programme.

13.2.3 Ice Conditions

Hudson Bay and James Bay are the largest bodies of water in the world that freeze over each winter and become ice-free each summer. Ice formation in the bay usually begins in late October in the coastal inlets in the northwestern sector. As the weather grows progressively colder, the ice thickens and spreads southward along the shore more rapidly than it extends seaward, due to the prevailing winds. Hudson Bay is normally covered with thickening first-year ice by mid-December.

Polynyas are found predominantly along the northwest and east coasts of Hudson Bay, the coasts of James Bay, and near the Belcher Islands. In James Bay, strong prevailing winds keep leads along the inner shores open all winter. During the winter, a belt of shore-fast ice 10-15 km in width develops along most of the Hudson Bay coastline and, in many years, a distinctive area of consolidated ice forms between the Belcher Islands and the Quebec coast. Beyond the shore-fast ice, the bay is covered with pack ice that moves in response to the wind and the slow, counter-clockwise current.

As temperatures rise in May and June, flaw leads in the northwest portion of the bay become persistent. Normal clearing of the pack ice progresses southward from the Chesterfield Inlet–Southampton Island area and westward from the Quebec side of the bay. Associated ice melt is a slow process that accelerates in July. An open-water shipping route to Churchill forms by the end of the month, and the pack often breaks into several large patches before melting completely by the middle of August.

The waters of James Bay are the last to freeze over in winter and the first to thaw in summer. The ice in the south part of the bay begins to melt in late April, breaks up in June, and is usually gone by mid-July. Complete clearing normally occurs in early August, although the northwest portion of the bay can still receive intrusions of ice from Hudson Bay until late August. Access to James Bay, which depends on ice conditions in Hudson Bay and Hudson Strait, can usually be gained by late July. Freeze-up begins in the west in mid- to late November, and the bay is typically ice-covered by early December. In light or severe seasons, the timing of break-up and freeze-up may shift two weeks in either direction. Old ice and icebergs are rare in Hudson Bay and rare or absent in James Bay.

13.3 Coats Marine Region

The Coats Marine Region is bounded by Southampton Island to the northwest, Hudson Strait to the northeast, Mansel Island to the east, and the open waters of Hudson Bay to the south.

Figure 3: Local effects for the Coats Marine Region.

Southampton Island, the largest island in the region, lies at the entrance to Hudson Bay at Foxe Basin and is separated from the Melville Peninsula by Frozen Strait. Other waterways surrounding the island include Roes Welcome Sound, Bay of Gods Mercy, Fisher Strait, Evans Strait, and Foxe Channel.

The north and northeast parts of Southampton Island consist of undulating highlands of Precambrian Shield rock that terminate in steep cliffs at Foxe Channel. In contrast, its south and southwest reaches are made up of gently sloping, flat-lying Palaeozoic rocks that form limestone plains and plateaus of low relief. Mathiasen Mountain is the island's highest peak, at 625 m. The only settlement on the island is Coral Harbour.

Coats Island, located 75 km south of Southampton Island, is the only other large piece of land in the area.

13.3.1 Reefs, Shoals, and Anchorages

Shoals or shoal water can be found at the entrance to Coral Harbour, in South Bay near Prairie Point and Native Point, along the east and south shores of the Bell Peninsula, in Fisher Strait (81 km southeast and 85 km south-southeast of Cape Low), off Mansel Island south of Cape Acadia, and off Coats Island at Santianna Point, Cape Southampton, and south-southeast of Cape Pembroke.

On the west and south shores of the island, boats landing at high tide must remain until the tide rises again. Both sides of Native Point offer good places to land, with the lagoon on the south side of the point a particularly safe anchorage.

13.3.2 Coral Harbour

Coral Harbour is a small Inuit community located along the north shore of South Bay, on the southern coast of Southampton Island.

Hamlet of Coral Harbour. Photo courtesy of Nunavut Tourism.

13.3.2.1 Winds and Weather

Coral Harbour has a dry and windy climate caused by downslope winds from the higher terrain to its north and northwest. Summer temperatures range from 8°C to 24°C, with average rainfall amounting to 163 mm per year—most of it falling in August, which averages 58.9 mm. The sea ice freezes over in November and breaks up in early July. On rare occasions in late summer, drift ice enters the harbour.

Although the open waters of Hudson Bay lie 250 km south of Coral Harbour, low-pressure systems crossing the bay cause strong easterly winds and bring low cloud to the community. During the fall, rain changes to snow as these systems pass.

Northwest winds dominate both in frequency and strength and are strongest in the colder months. Winds from the east through north-northeast are much less frequent but more likely than winds from other directions to be strong.

Winds off the bay bring stratus cloud and fog, especially in the spring and fall, with fog most common in August and September. In contrast, a northerly subsidence flow off the terrain to the north may cause clear skies around Coral Harbour while the rest of the island is encircled in low cloud. October and, to a lesser degree, May are prime months for freezing drizzle.

13.4 Rankin Marine Region

The Rankin Marine Region extends along the Kivalliq coast from Maguse River, in the south, to Whale Point, in the north, and southeastward to 45 km east of Cape Low. It includes waters up to 200 km offshore from the mainland and Bay of Gods Mercy, off Southampton Island. The coastline between Chesterfield Inlet and Whale Cove is relatively low lying, with relief rarely exceeding 30 m in height. The navigation season in this region normally extends from July to October.

Figure 4: Local effects for the Rankin Marine Region.

13.4.1 Currents and Shoals

There are few places within 8 km of the west and south shores of Southampton Island for a vessel to stand in. The waters south of Cape Kendall are dangerous even 16 km from shore, and a 5-km-long reef lies about 38 km north of the cape at a latitude of 64° 17'. Although the water becomes deep at a distance of about 3-5 km from the reef, on either side, this is a very dangerous area, as the reef can only be seen at low tide. A strong current sweeps past Cape Kendall, striking across the reef north of Whale Point and south of Cape Fullerton.

Between Chesterfield Inlet and Rankin Inlet are several small islands interspersed with shallow bays and surrounded by shoal water.

The entire coastline between Rankin Inlet and Whale Cove is fronted by rocks and shoals, some of which extend up to 13 km offshore. Shoals extend 16 km east-southeast from Dunne Foxe Island, the largest in a group of islands outside Pistol Bay.

The passage between Marble Island and the mainland to the north and northwest is obstructed by numerous detached shoals. Patches of shoal water also exist 5 km south of the west end of the island; however, there is deep water between them.

13.4.2 Chesterfield Inlet

Chesterfield Inlet is the easternmost section of the Thelon River and empties into Hudson Bay. In addition to several islands, it includes Cross Bay—a large widening in the inlet that occurs 30 km east of the lake. The Inuit hamlet of Chesterfield Inlet is situated near the mouth of the waterway, at the head of Chesterfield Anchorage, on a low and narrow strip of coastline.

The Hamlet of Chesterfield Inlet. Photo courtesy of the Government of Nunavut.

13.4.2.1 Winds and Weather

Northwest winds dominate in strength and direction year round. In summer, they occur about 14 percent of the time—one in six events blowing at 20 kt or stronger. North-northwest and south-southeast winds compete for second place in terms of directional dominance in the summer. West-northwest winds tend to funnel down the inlet.

The mean high in July is 15.2°C, while the mean low is 5.9°C. Low stratus cloud and fog often occur in the onshore flows off Hudson Bay, especially during the spring and fall, although not as often as they do in Rankin Inlet and Arviat. Freezing drizzle can sometimes fall in May, October, and November. Chesterfield Anchorage freezes over in mid-November and clears in early to late July, although timing can vary by two to four weeks.

13.4.2.2 Tides, Shoals, and Anchorages

Chesterfield Anchorage lies in a bay between the northern entrance to Fish Bay and low-lying Finger Point, 2 km to the northeast. Depths off its eastern shore range from 10 to 20 m, while its western and northern shores are rocky, strewn with boulders, and fronted by wide tidal flats. Shoal water extends 1.5 km southeast of Finger Point, which has also been known to experience tidal rips at spring tide.

13.4.3 Rankin Inlet

Rankin Inlet is an Inuit hamlet on the Kudlulik Peninsula, approximately 19 km west of Hudson Bay. Located at the end of its namesake waterway, it is the seat of government and the business and transportation hub for the administrative region of Kivalliq. The waterway itself is home to dozens of islands.

13.4.3.1 Winds and Weather

Northwest winds dominate in both strength and frequency throughout the year. They are driven by the combination of a recurring and persistent ridge of high pressure that extends from the Arctic Basin southwest across the western Northwest Territories and low-pressure systems over Hudson Bay, Foxe Basin, and Davis Strait/Baffin Bay. Calm winds are rare.

Onshore winds from Hudson Bay can draw in stratus or fog along the coast that persists for extended periods. As the ice breaks up from May through July, the addition of moisture to the lower atmosphere creates large areas of low cloud and fog over the bay and coastline. Freezing drizzle is common in May and October. During the brief summer, thunderstorms can move in from the west and southwest, usually along an advancing trough or cold front.

13.4.3.2 Tides, Shoals, and Anchorages

Water depths in Rankin Inlet are highly irregular, and there are many islands, islets, rocks, and shoals that make it hazardous to vessels. At low water, Marble Island and nearby Quartzite Island become one. Entry to the inlet is between Papik Point and Scarab Point, about 27 km northeast.

The tidal stream sets strongly across the approach to Rankin Inlet from Marble Island, especially on the in-going tide and usually in a southwest direction at about 1 kt—although a set in the opposite direction can occur. Tidal rips have also been observed.

Dinghies are used to access local boats anchored in the small craft harbour in Johnston's Cove, where tides are approximately 4 m high. Anchorage for larger vessels can be found in Horseshoe Deep, where water depths are 33 m and a tidal stream of 2-3 kt has been reported. Horseshoe Deep is located 2 km east-southeast of Kresik Island, outside the entrance to Prairie Bay, between Thomson Island and the north end of Guillemot Bank. Anchorage can also be found 740 m east of Esker Island, in waters 13 m deep.

13.4.4 Whale Cove

Whale Cove is located 72 km south of Rankin Inlet, between the peninsula that forms the east side of Wilson Bay and Term Point—a prominent, rocky point about 5 m high that marks the southeast extremity of an offshore island. The cove's namesake settlement is located at its head.

13.4.4.1 Winds and Weather

Weather conditions are similar to those experienced in Rankin Inlet, although winds tend to be slightly weaker. In summer, northwesterly winds become less frequent than southerly winds, but remain stronger.

13.4.3.2 Anchorages

Whale Cove is exposed to all but north winds. While anchorage is available at its entrance, 4 km west-northwest of Term Point, depths vary from 20 to 68 m, and the bottom is rocky. Anchorage for small craft can be found in the northeast bay of the cove.

13.5 Arviat Marine Region

The Arviat Marine Region extends from latitude 60°N (the Manitoba/Nunavut border) to Maguse River, and 217-267 km offshore. Unlike the Rankin Marine Region, the Arviat Marine Region has a regularly shaped coast that is generally devoid of outlying islands. Expanses of flat tundra dominate the landscape, which is marked by glaciated eskers, gravel ridges, patches of sand, long tidal flats, and many small, shallow lakes.

Figure 5: Local effects for the Arviat Marine Regions.

13.5.1 Winds and Weather

As in the Rankin Marine region, moderate to strong northwest winds dominate, especially in the colder months. On occasion, intense low-pressure systems approaching from the southern Northwest Territories or northern Prairies cause very strong and gusty south to southeast winds. A sudden shift to northwesterly winds typically occurs with the passage of a low-pressure system or cold front. Easterly winds off Hudson Bay bring stratus and fog during the open-water season. Freezing drizzle can occur in the spring and fall, and thunderstorms can advect from the west and southwest—peaking, in occurrence, in July.

13.5.2 Arviat

The hamlet of Arviat, formerly known as Eskimo Point, is situated 90 km north of the tree line, on the west coast of Hudson Bay. It is the most southerly mainland community in Nunavut.

13.5.2.1 Winds and Weather

During July and August, daytime temperatures in Arviat average 15-20°C. The first snowfall occurs in mid- to late October.

13.6 Churchill Marine Region

The Churchill Marine Region extends from the Manitoba/Nunavut border (60°N) to just south of Thompson Point, and up to 267 km offshore. The coast of the Churchill Marine Region is similar to that of the Arviat Marine Region. It is fronted by shoal banks, the inner parts of which dry up, that extend up to 20 km offshore.

Figure 6: Local effects for the Churchill and York Marine Regions.

13.6.1 Churchill

The town of Churchill, located at the mouth of the Churchill River on the Hudson Bay coast, is the only deep-water ocean port in the Prairies, with four deep-sea berths that can accommodate Panamax class vessels with a capacity of approximately 70,000 tonnes.

Town of Churchill. Photo courtesy of Shannon Badzinki.

3.6.1.1 Winds and Weather

The winds are seldom calm at Churchill. The combination of a ridge of high pressure to the west and low-pressure systems over Hudson Bay cause them to favour the northwest; however, winds from any direction are possible, at least part of the time. The strongest generally blow onshore from the northwest to north. The only gales that affect Churchill Harbour come from the northeast, raising choppy seas for a short distance inside its entrance.

When the bay is open in the summer, it is usually partially covered in low cloud. Northeast to east winds eventually move this cloud inland and can create areas of freezing drizzle. Although the shipping season is usually from July to November, open water can be found near the coast at other times of the year, as well. Snow streamers are possible in an onshore flow during the colder months, when open water is present. Fog can occur any time the flow is off the bay but is more likely in August.

13.6.1.2 Tides and Shoals

An extensive area of shoal water, called Churchill Shoals, with numerous drying patches can extend up to 15 km offshore, midway between Cape Churchill and Churchill Harbour.

During spring tides, rips and eddies may be found near and to the north of buoy at the Merry Rock light. During strong northeast and east winds, steep waves develop at the mouths of the Churchill and Nelson rivers with the outgoing tide.

13.7 York Marine Region

The York Marine Region extends from Thompson Point in Manitoba to an unnamed point approximately 40 km northwest of Severn River. The Hayes and Nelson rivers flow into the head of a coastal bay located between Cape Tatnum and Rupert Creek. The shores of the bay—which opens to the northeast—are low, swampy, and punctuated by numerous creeks. At high water, the peninsula separating the two rivers is nearly submerged for 16 km from its easternmost extremity at Marsh Point (marked by a beacon). York Factory and Port Nelson are abandoned settlements at the head of the bay.

13.7.1 Winds and Weather

Weather and sea conditions in the York Marine Region are similar to those encountered in the Churchill Marine Region.

13.7.2 Shoals and Anchorages

Extensive, drying shoals lie at both entrances to the bay: Tatnum Shoal is located about 6.5 km north-northeast of Cape Tatnum; Nelson Shoal, about 14 km east-northeast of Rupert Creek, is covered at spring tide. The channel through Hayes River is open only to small craft, as it is very shallow and bounded by extensive mud banks.

York Roads is an open anchorage off the entrances to the Nelson and Hayes rivers, although it is exposed to northeast gales, which are frequent during the navigation season. An anchorage for small vessels is charted off Port Nelson; however, constant silting within the narrow channel makes passage difficult.

13.8 South Hudson Marine Region

The South Hudson Marine Region stretches approximately 375 km along the Ontario coast, from 40 km northwest of Severn River to Cape Henrietta Maria, and up to 370 km offshore. The coast of the South Hudson Marine Region is similar to that of the Arviat and Churchill marine regions in terms of its regular shape and lack of islands. Well-drained, raised beaches and grass-covered tidal flats line much of the coast. The two main communities in the area are Fort Severn and Peawanuck.

Figure 7: Local effects for the South Hudson Marine Region.

13.8.1 Winds and Weather

Prevailing winds across the region are generally from the northwest. During the summer, fog banks and low stratus are common over the cold water.

13.8.2 Shoals and Anchorages

The coast should be given a wide birth, as offshore waters are shallow and uncharted. The large, shallow rivers that flow into Hudson Bay discharge large quantities of sand and clay, forming sand bars and shoal waters that extend up to 28 km offshore. The whole coast is open to northerly winds, and there are no anchorages.

The mouth of the Severn River is obstructed by mud bars and rapids. Vessels with a draught of 2.4 m can navigate the northwest channel (west side of Partridge Island) as far as the settlement of Fort Severn.

Winisk River is wide but shallow and encumbered by islands. A broad sand bar extends across the river entrance, allowing only shallow-draught craft to navigate the river up to Peawanuck. Unsheltered anchorage may be obtained 9 km north-northeast of Oman Point.

13.9 Puvirnituq Marine Region

The Puvirnituq Marine Region extends along Quebec's Ungava Peninsula, from Cape Wolstenholme to Promontoire Portland. The three main communities in the region are Ivujivik, Akulivik, and Puvirnituq. This region is generally split into north and south sections.

Figure 8: Local effects for the Puvirnituq Marine Region.

13.9.1 Puvirnituq–Northern Half

The northern half of the Puvirnituq Marine Region extends from Mansel Island to Cape Wolstenholme, southward to just south of Akulivik, and westward to about 100 km offshore.

13.9.1.1 Winds and Weather

South to southwest winds can interact with the coast and generate a barrier jet wind, especially in stable conditions. Strong northerlies are less likely to cause similar coastal accelerations, as they tend to be associated with more unstable conditions. In such cases, winds are most often uniformly strong over the whole domain.

Downslope windstorms can be triggered near the coast by mountain waves developing in strong and stable southeasterly flows, especially where the land-sea interface is relatively steep (i.e., around Ivujivik and Akulivik). Such downslope winds are more likely to affect coastal areas in a localized fashion and do not extend very far offshore. In certain conditions, they occasionally reach storm force.

13.9.1.2 Ivujivik

Ivujivik is located 28 km southwest of Cape Wolstenholme, the northernmost tip of the Ungava Peninsula, near Digges Sound. The village is located on a small, sandy cove between imposing cliffs that drop steeply into the sound, where the strong currents from Hudson Bay and Hudson Strait clash. Directly across the sound are the West and East Digges islands, while the Nottingham and Salisbury islands are found further north, in Hudson Strait.

Winds and Weather

The most common winds at Ivujivik are southwesterly and northeasterly. In summer, northeast winds are the most frequent, due to low-pressure systems moving across southern or central Hudson Bay. They can remain quite strong into the fall, when southerly and northerly winds can also occur. As in winter, summer winds at Inujivik can blow strong from all directions—including northwesterlies after a cold front and south to southeast winds when troughs or lows come from the west or southwest. In summer, wind speeds of 20 kt or more occur 25 percent of the time when south winds blow and 20 percent of the time when winds are south-southwest. The anchorage at Ivujivik is exposed to north winds and violent squalls from the south. Nuvuk Harbour, located southwest of Ivujivik, offers shelter from most winds. The area is ice-free for 20 working days a year, during which it is prone to fog.

13.9.1.3 Akulivik

Akulivik takes its name from the surrounding geography, as it is situated on a peninsula that resembles a “kakivak”—a traditional, trident-shaped spear used for fishing. To the south of the village is the mouth of the Illukotat River; to its north is a deep bay that forms a natural port and protects the area from strong winds.

Winds and Weather

In summer, close to half the winds come from the north through west-northwest and can, at times, be strong. East and east-southeast winds are much less frequent in summer than in winter; however, they still tend to blow strong, with 20 percent of them reaching 20 kt or more. Stratus ceilings are common in summer, while fall storms can bring bouts of strong winds and snow. Ice starts to form in late September and stays until late July, when the bay becomes navigable. Ice around the peninsula tends to break up early in the spring.

13.9.2 Puvirnituq–Southern Half

The southern half of the Puvirnituq Marine Region extends from just south of Akulivik and Cape Smith to Promontoire Portland, and westward up to 150 km offshore. It includes the hamlet of Puvirnituq. The area between Cape Smith and Promontoire Portland is indented with numerous islands and islets.

13.9.2.1 Winds and Weather

As in the northern half of the region, south to southwest winds can interact with the coast and generate a barrier jet, especially in stable, low-level conditions when the contrast between coastal and offshore wind regimes can be significant. Strong northerlies are less likely to cause similar coastal accelerations, as they tend to be associated with more unstable conditions. In such cases, winds are most often uniformly strong over the whole domain. Downslope windstorms are not as common here because the coastal cliffs do not rise as steeply as they do in the northern half of the region. Individual peaks close to the coast could, however, trigger some very localized, southeasterly downslope winds.

13.9.2.2. Shoals

Shoal waters extend for a considerable distance offshore and the bottom is uneven, posing a hazard even to small craft.

13.9.2.3 Puvirnituq

The hamlet of Puvirnituq (formerly Povungnituk) is located approximately 4 km from the head of Povungnituq Bay, on the north shore of the river of the same name. It is surrounded by a flat, expansive plateau.

Winds and Weather

In the summer, westerly (southwest through northwest) winds are dominant. Winds of 30 kt or more are most likely to be from the east, east-southeast, west-southwest, or west-northwest. In the fall, the winds become primarily southwest or northwest. Stratus cloud is common, especially in the spring.

Tides, Currents, and Shoals

There is little tide and no marine currents in the area. Coastal waters are not very deep, so light signals are used to help boats navigate to the village.

13.10 Belcher Marine Region

The Belcher Marine Region extends from near Inukjuak to the northern edge of James Bay and includes the hamlets of Inukjuak, Umiujaq, Sanikiluaq, Kuujjuarapik, and the Belcher Islands. It also encompasses waters out to approximately 300 km offshore.

The coast between Promontoire Portland (north of Inukjuak) and Pointe Louis-XIV is backed by land that rises to elevations of 300-600 m. Several island chains, including the Hopewell Islands and the Nastapoka Islands, form the seaward side of an almost continuous and sheltered shipping channel. Further south, the Manitounuk Islands and Long Island also provide navigable channels.

Figure 9: Local effects for the Belcher Marine Region.

The two central islands in the Nastopoka Islands group, Gillies and Clarke, are 19 km and 5.6 km long, respectively, while the smallest are sea-swept reefs. The 65 islands form a chain that spans 193 km and lies an average of about 6.5 km from the mainland. Their eastern shoreline is broken into a series of cliffs that rise up to 107 m above sea level.

Nastapoka Sound, the protected passage between the Nastapoka Islands and the mainland, is about 190 km long and averages just over 3 km wide. The sound extends from Cotter Island south to Flint Island, with depths of 12.8-20 m charted in its middle section. Between Curran Island and Luttit Island, mid-channel depths are 46-92 m. The land backing the sound is high and rugged, with elevations of 305-457 m.

From the north, the sound may be entered between Cotter Island and the mainland or through the channel between Davieau Island and Christie Island. Channels also exist between several of the other islands.

The Belcher Island Archipelago is a group of about 1500 islands located on southeastern Hudson Bay. Spread out over almost 3000 km^2 in a north-south direction, these low-lying, striated Precambrian outcrops peak at 155 m above sea level, with cliffs of up to 50-70 m. The north coast of Flaherty Island is home to the hamlet of Sanikiluaq. Kugong, Tukarak, and Innetalling are the other main islands in the group.

Did You Know?

Flaherty Island, the only island in the Belcher Island Archipelago with a permanent settlement, was named after Robert Flaherty, who mapped the islands on expeditions in 1914 and 1916. Flaherty went on to produce the film *Nanook of the North*.

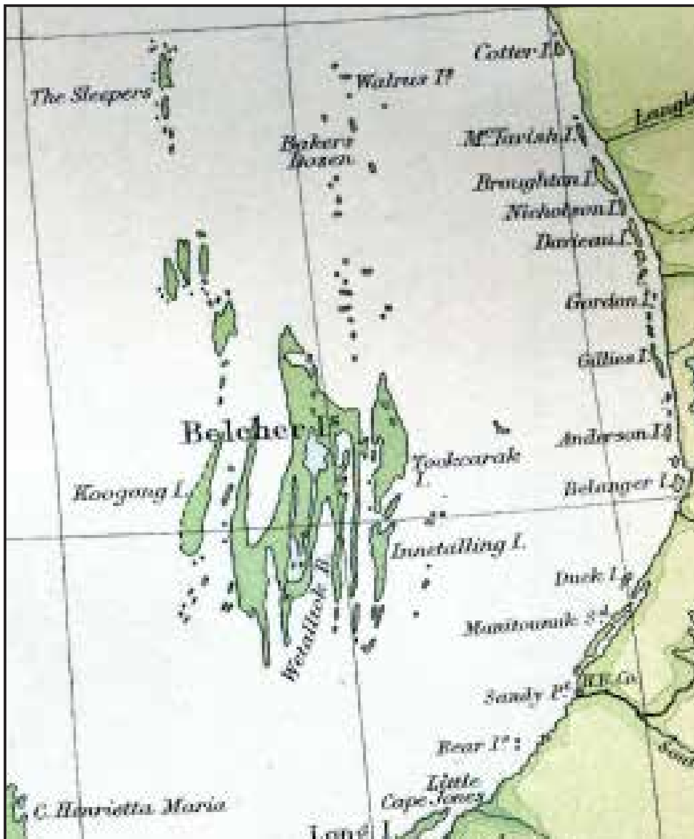


Figure 10: The Belcher Islands Archipelago and the Nastapoka Islands chain along the mainland.

13.10.1 Winds and Weather

Local downslope windstorms can occur in the Umiujaq area (and to its north and south) with strong and stable easterly flows. The associated mountain waves generate oscillations that cause bands of strong winds that extend up to 50 km offshore.

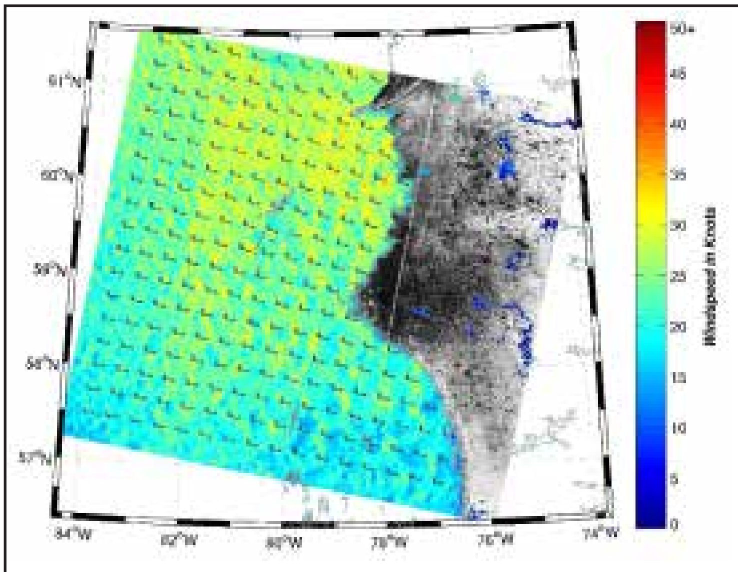


Figure 11: RADARSAT image from November 14, 2012 at 11:37 UTC. The airport at Puvirnituq reported west-northwest winds of 15-25 kt, with gusts to 32 kt, and reduced visibility due to snow.

Freeze-up usually begins between November 10 and 20, although freezing occurs around the Belcher Islands later than it does on the mainland. This is due to the influence of the bay and the salinity of the surrounding waters, as the fresh water flowing into the bay from rivers and streams freezes much faster and at warmer temperatures than salt water. A solid ice bridge usually forms between the Belcher Islands and the mainland during February and March. Break-up starts around the end of May, with the area generally clear of ice by the first week of June.

13.10.2 Shoals and Anchorages

The west sides of the Nastapoka Islands slope gradually to the sea, with shoal water and reefs extending some distance offshore. Only the channels between the larger, higher islands are navigable, as the others have shoals.

The mainland coast along the east side of Hudson Bay offers many anchorages, mainly on the inner sides of the coastal islands. Among the outlying islands, only the Ottawa and Belcher islands afford anchorage.

13.10.3 Inukjuak

Inukjuak is a village located on the north bank, at the mouth of the Innuksuak River. The surrounding land is marked by gently rolling hills and open spaces.

13.10.3.1 Winds and Weather

Inukjuak has a polar climate, with average temperatures of 9.4°C in July. In the fall, winds blow from most directions, although less frequently from the northeast to southeast, and can be strong from any of them. Fog banks and stratus are common when the wind comes from anywhere between the south and the west.

13.10.4 Umiujaq

Umiujaq is a small community at the mouth of the Little Whale River. The preferred passage through the islands to Umiujaq is by way of a channel between Clarke Island and Luttit Island that is nearly 3 km wide and at least 19.5 m deep.

Lac Guillaume-Delisle is a large, triangular-shaped inland lake, the northern tip of which lies 15 km east of the village. It is joined to Hudson Bay by a rocky, glacier-polished gulch called Le Goulet (French for “bottleneck”). This canyon-like passage is 5 km long, 300-600 m wide, and flanked by cliffs 200 m high. Since water levels vary by about 0.5 m with the rise and fall of the tides, the passage does not freeze in the winter.

The western shoreline of the lake is guarded by steep ramparts of sedimentary rock, called the Hudsonian Cuestas, that rise abruptly out of the brackish waters. The eastern shore rises more gradually and is largely rocky, Canadian Shield. Several large rivers enter the lake in boisterous rapids or sheer falls.

13.10.4.1 Winds and Weather

Westerly, onshore winds produce low stratus cloud and fog in the area.

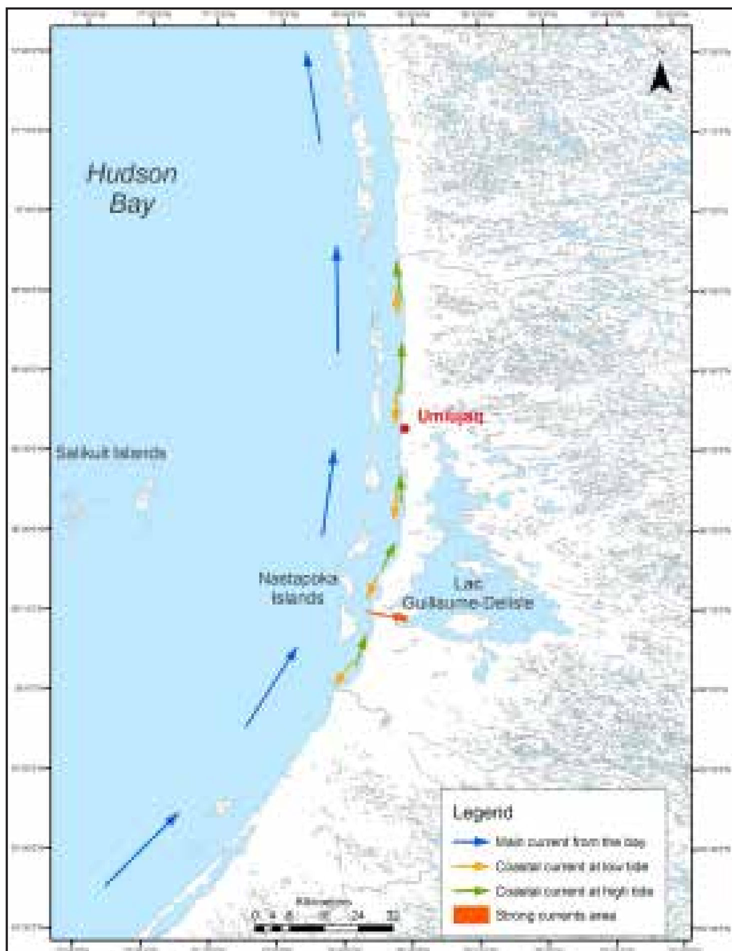


Figure 12: Currents in the Lac Guillaume-Delisle and Nastapoka Islands area. Source: Clerc et al., 2011.

13.10.4.2 Tides and Currents

Point Pamiallualuk is a narrow spur of rock that juts out some 2 km into Hudson Bay, just north of Le Goulet. There, the north-flowing tidal current of the bay collides with a weaker counter-current, causing significant turbulence that is further enhanced by strong winds. Powerful tidal streams in Le Goulet create whirlpools, making passage dangerous for small craft, except at slack water.

13.10.5 Sanikiluaq

Sanikiluaq, the most southerly community of Nunavut, is located on the north coast of Flaherty Island, the largest island in the Belcher Islands Archipelago. The terrain features numerous rocky cliffs that range from 50 m to 155 m in height.

13.10.5.1 Winds and Weather

The Belcher Islands have a much greater proportion of overcast skies and fog and stronger, more constant winds than the adjacent mainland. The surrounding waters also maintain a higher temperature. Sea ice forms in October or November and continues into June in some of the narrow bays and channels, providing a firm platform for travel up to 50 km west of the islands and north, towards the George and Sleeper islands. Extensive land-fast ice also forms to the south and southeast.

13.10.6 Kuujjuarapik

Kuujjuarapik is nestled among golden sand dunes on the north shore of Grande rivière de la Baleine, about 1.5 km east of Sandy Point. Whapmagoostui, its sister community, is found on the south shore. The surrounding landscape is flat and carpeted with moss and rock.

Hamlet of Kuujjuarapik. Photo courtesy of Shannon Badzinski.

13.10.6.1 Winds and Weather

In the early summer, winds from the north-northeast and west-southwest are dominant. July and August usually see the most stratus cloud and fog, which usually persists until there is a change in wind direction, although thick fog has even been observed with northwest winds as high as 40 kt. In September, winds from the west are often greater than 25 kt and there is an increasing frequency of northwest winds, which usually bring freezing drizzle and very low stratus. From October to early December, winds of up to 80 km/h are fairly constant, and the sky is continuously overcast. Prevailing winds are southwesterly, with southeast winds usually accompanied by heavy rains.

During the ice-free season, fog and very low stratus move onshore when the wind direction is from between the southwest to north quadrants, the worst visibilities and ceilings occurring when from the west or northwest. Visibility is less than 1 km for 33.9 and 39.9 hours, respectively, in June and July; 21.1 hours in August, as the ice disappears; 6.3 hours in October; 26.4 hours in November; and 28 hours in December, likely due to upslope flow and the proximity of large water reservoirs from the nearby dam. The arrival of cold Arctic air also usually results in zero, or near zero, ceilings and low visibility due to snow squalls.

13.10.6.2 Tides and Currents, Waves, and Anchorages

Tidal heights are influenced by wind direction and velocity. Spring tides are reported to rise 2.4 m and neap tides, 1.8 m. The river current varies from 1.5 to 2 kt. Offshore currents usually set north. Currents are reported to be strong off the southwest end of Bill of Portland Island.

Although the fetch length can be relatively long in the middle of Hudson Bay in any wind direction and in the western portion, in an easterly flow, it is often limited over the eastern portion, especially near the coast. Flows with a good easterly component are fetch-limited and do not lead to high seas, except over the western edge when strong winds are affected by downslope effects. Even westerly flows have difficulty causing high waves along the coast near the Belcher Islands due to the numerous islands and shoals that break their fetch. Wave heights greater than 6 m are possible west of the islands in a strong west-northwest flow but are limited to 3-4 m on their east side and near the Quebec coast.

Anchorage can be taken near Sandy Point, with shelter from west gales afforded in Laverock Bay, 13.5 km north-northeast of the point. During bad weather, it may not be possible to anchor in Manitounuk Sound, and vessels are recommended to remain offshore. It is not advisable to anchor off the Grande rivière de la Baleine if winds exceed 19 kt. Between the river and Pointe Louis-XIV, 130 km to the southwest, the generally regular coastline has only a few minor indentations with no sheltered anchorages. Shallow water and shoals may exist in the vicinity of the islands along this low-lying section.

13.11 James Bay Marine Region

James Bay is a large body of water at the southern end of Hudson Bay. The southernmost part of the Arctic Ocean, the bay borders the provinces of Quebec and Ontario, although its islands (the largest of which is Akimiski Island) belong to Nunavut. The entrance to the bay is 153 km across (approximately the same as its average width of 160 km) and spans the distance from Cape Henrietta Maria, on its western coast, to Pointe Louis-XIV, on its eastern. The bay extends 385 km south down to Péninsule Ministikawatin, which separates Hannah Bay and Rupert Bay on its western and eastern sides, respectively.

Figure 13: Local effects for the James Bay Marine Region.

Depths in the central part of James Bay range from 36.6 to 54.9 m; however, shallow waters of less than 6 m line much of its coastline up to 15 km offshore. The bay is ice-covered eight to nine months a year, although extensive shore leads develop throughout the region due to the constantly blowing wind. The tidal range averages 1-2 m.

Numerous rivers flow into the bay through shallow estuaries of mud and shingle flats—the most important being the Attawapiskat and Albany rivers, both located in the lower half of its western coast. These and the other rivers that empty into the bay greatly decrease the salinity of its waters and also affect a wide area of southeast Hudson Bay.

The shores of James Bay are low and flat, backed by rolling hills that are seldom more than 30 m high. The bay is fringed by wide, tidal mud flats beyond which areas of shallow water, often only 1 or 2 m deep, extend to as much as 32 km offshore. The eastern shore is mostly a skerry coast—rocky, rolling and complex, fringed by shoals and more than 500 flat and low-lying islands, islets, and rocky outcrops. The western shore of James Bay is regularly shaped and almost free of islands, except for Akimiski, which is located about midway off its coast. It, too, is bounded by extensive mud flats, wide coastal-deltaic plains, and salt marshes.

The shores of James Bay are sparsely populated. On its eastern shore are the Cree communities of Chisasibi, Wemindji, Eastman, and Waskaganish. On its western shore, the settlements of Attawapiskat, Kashechewan, Fort Albany, Moosonee, and Moose Factory.

13.11.1 Winds and Waves

Wind and wave conditions in the James Bay Marine District vary from north to south and from west to east. On light wind days, sea breeze effects kick in. Waves not only break as they near the skerry, eastern coast but also can become quite large in the shallow waters further offshore in windy conditions. North and south flows have the largest fetch and, therefore, generate the biggest waves, while northeast flows cause the largest swells at the entrance to the bay. Smaller waves result from northwest to southwest flows due to their smaller fetch, combined with the shallow waters and large tidal flats.

13.11.1.1 Northwesterly Flow

Northwest flows are common over James Bay as surface lows or cold fronts move across Hudson Bay or James Bay. A long fetch will generate large swells, especially at the north end of the bay.

With a northwesterly gradient flow, the sea breeze on the western shore of James Bay veers to the northeast during the afternoon at Moosonee, with individual air parcels having long, over-water trajectories. Winds flow parallel to the coast further north (i.e., Akimiski Island) but turn offshore again by midnight. On the eastern shore of James Bay, the advective effect extends much further inland, as the prevailing onshore gradient flow is enhanced by the local sea breeze.

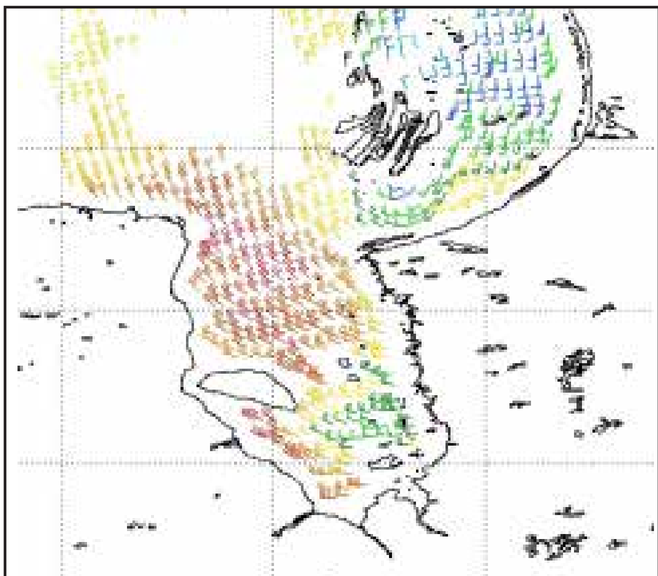


Figure 14: ASCAT from July 3, 2014.

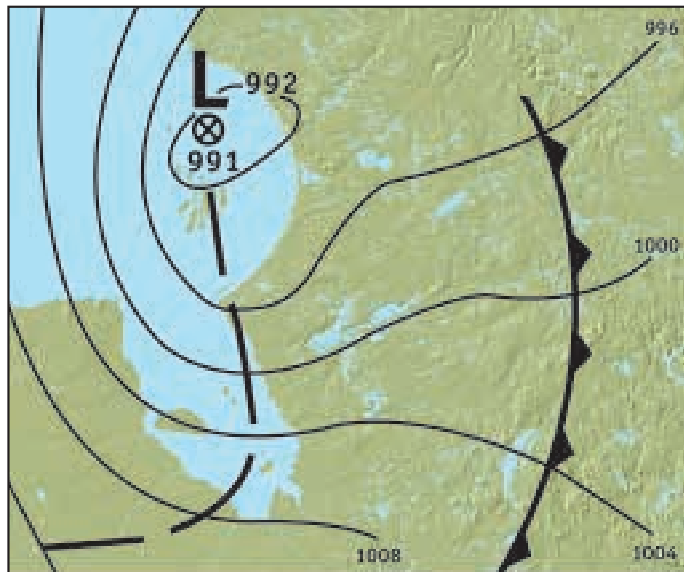


Figure 15: Surface analysis from July 3, 2014.

ASCAT image (left) and corresponding surface analysis (right) from July 3, 2014, showing a low north of the Belcher Islands and a trough extending southwards into James Bay, causing northwest winds of up to 30 kt. Wind shadowing is visible on the lee side of Akimiski Island.

13.11.1.2 Northeasterly Flow

Northeasterly gradient flows occur when a surface low moves from the southwest to the northeast, to the south of James Bay. Wave heights and swells tend to be higher along the western coast of James Bay than its eastern side, due to slightly stronger winds and a long fetch.

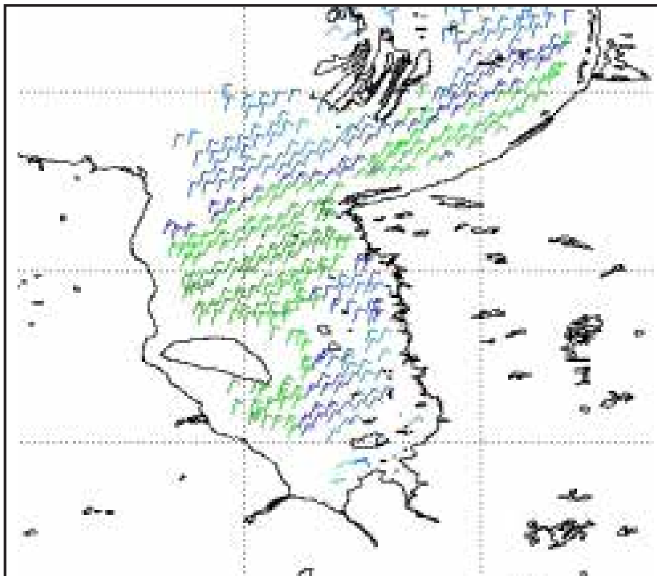


Figure 16: ASCAT image from July 8, 2014.

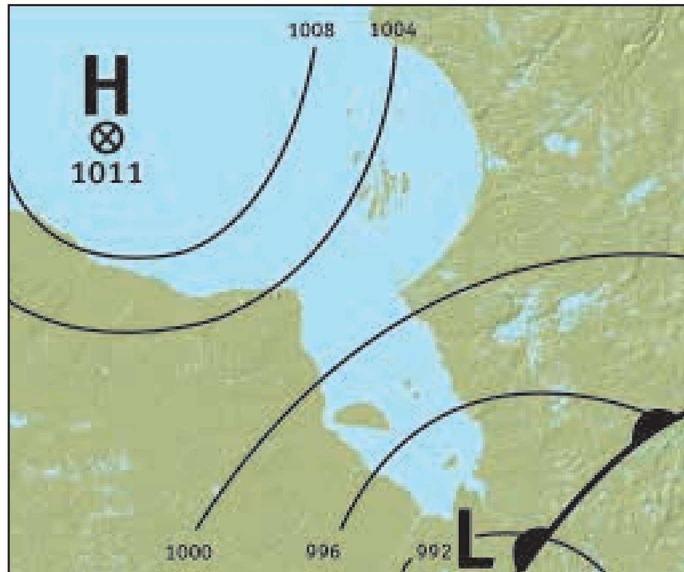


Figure 17: Surface analysis from July 8, 2014.

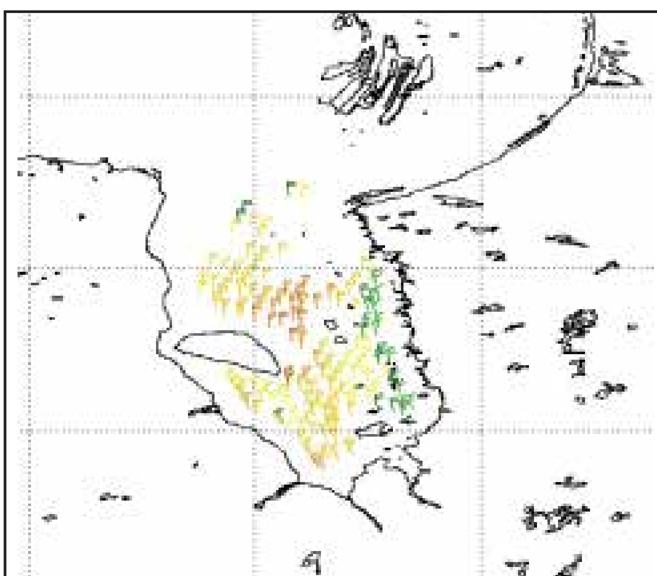


Figure 18: ASCAT image from July 9, 2014.

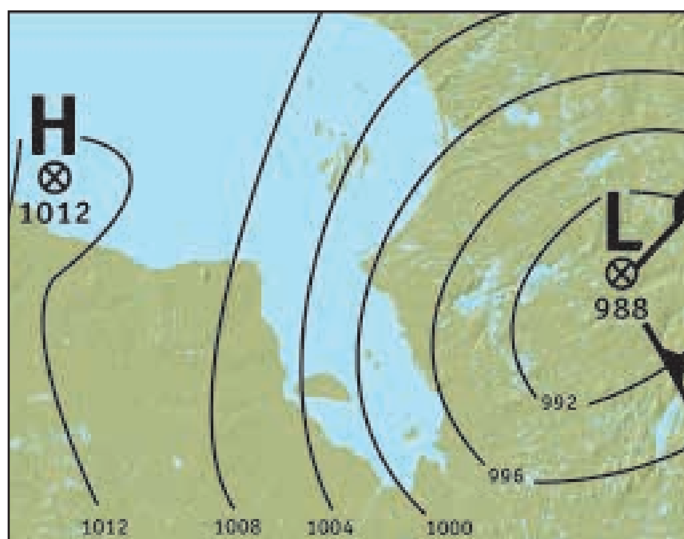
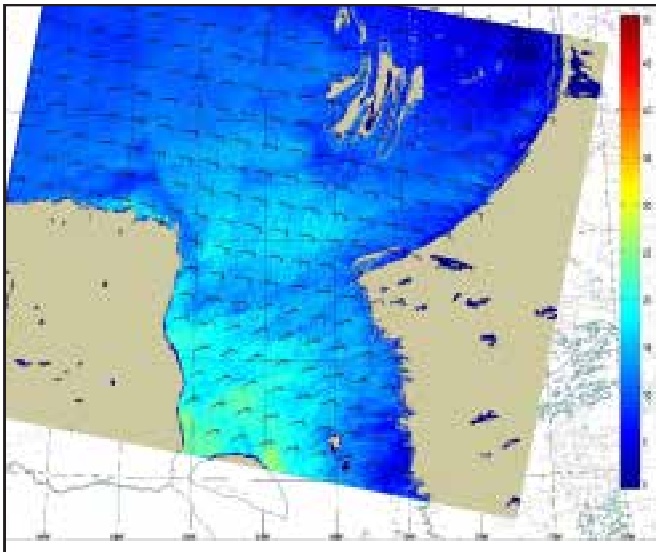


Figure 19: Surface analysis from July 9, 2014.

ASCAT image and corresponding surface analysis (top row) from July 8, 2014, and same (bottom row) from July 9, 2014, showing a deepening low-pressure system south of James Bay moving northeast into central Quebec. Winds increased from light northeast to north at 30 kt in the wake of the low.



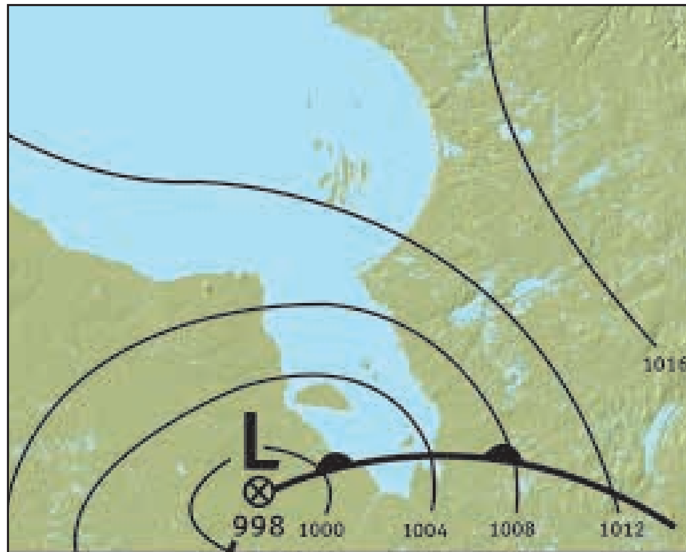
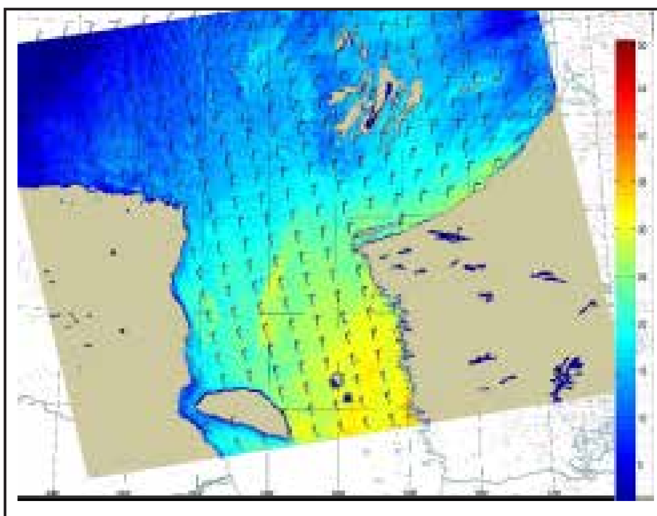


Figure 20: RADARSAT image from September 5, 2014.

Figure 21: Surface analysis from September 5, 2014.



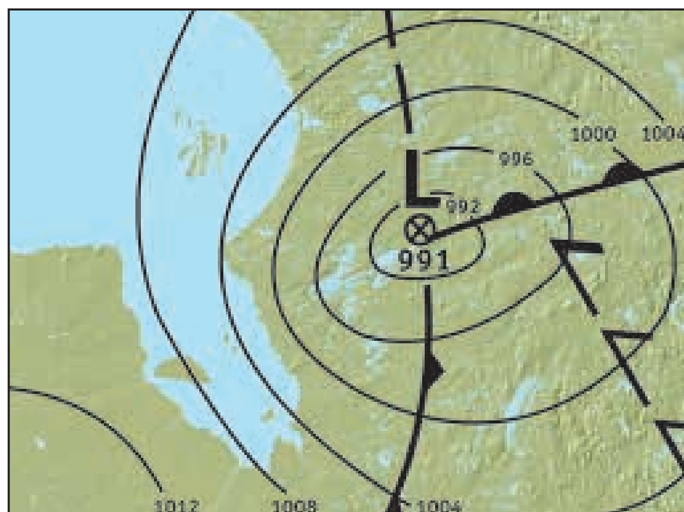


Figure 22: RADARSAT image from September 6, 2014.

Figure 23: Surface analysis from September 6, 2014.

RADARSAT images (left) and corresponding surface analysis (right) from September 5-6, 2014, showing the wind regime in the wake of a deepening low moving across James Bay into northern Quebec. As a result, the gradient flow went from an easterly wind ahead of the system to a northerly in its wake. The first RADARSAT image shows stronger winds from central James Bay into the western coast, while winds along the eastern coast remained weak. The second shows strong northerly winds along the eastern coast and a slight wind shadow in the lee of Akimiski Island.

13.11.1.3 Southerly Flow

Sea breezes associated with a southerly to southwesterly gradient flow show backing to the southeast and short over-water trajectories in the vicinity of Moosonee. Sea breezes develop on approximately 25 percent of summer days and, on occasion, penetrate as far as 100 km inland by late evening. Sea breeze onset is associated with increased wind speed in the case of both northwesterly and southwesterly/southerly gradient flows. Temperature is little affected in a southwesterly gradient flow.

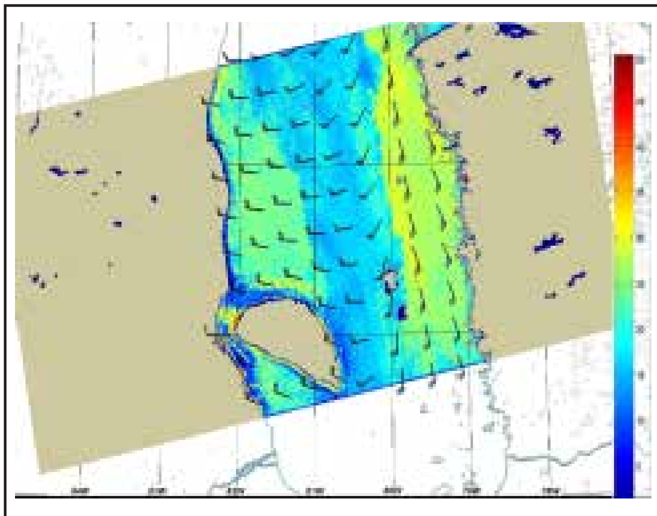


Figure 24: RADARSAT image from November 9, 2014.

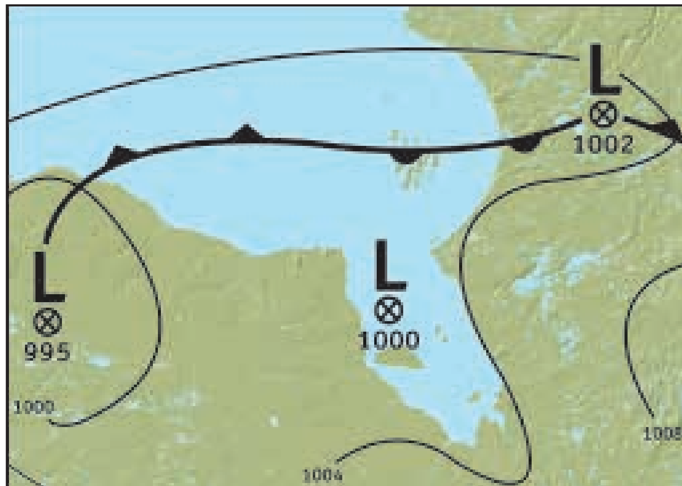


Figure 25: Surface analysis from November 9, 2014.

RADARSAT image (left) and corresponding surface analysis (right) from November 9, 2014, showing the wind regime as a trough of low pressure moves across James Bay into northern Quebec. Some of the stronger wind returns may be from ice forming in the bay. Strong southerly winds veered to moderate west to northwest winds behind a surface trough that moved across James Bay in the early evening. Light winds along the west coast and Akimiski Island may be due to ice formation in the area. Surface reports indicated southerly winds of 10 kt gusting up to 22 kt ahead of the trough, veering to west/northwest 20 kt and gusting at 25 kt behind it. Winds slowly diminished in intensity after the passage of the trough. Instability associated with the trough brought heavy flurries to many weather stations.

13.11.2 Shoals and Anchorages

Along the eastern shore of James Bay—and at its head—numerous bays and coves offer suitable harbour for vessels with a draught of less than 3.7 m. The most important are Chisasibi (Fort George), on the northeast shore of the bay, and two at its southernmost tip: Waskaganish (Fort Rupert), in Rupert Bay, and Moosonee, on the Moose River. The latter is also a terminus of the continental railway system.

The western shore of James Bay affords few anchorages suitable for even small craft, aside from the harbours at Fort Albany and Attawapiskat. Akimiski Strait, which separates Akimiski Island from the mainland, is considered unnavigable, except by small craft, due to the presence of extensive shoals. Shoal water extends a considerable distance from the west side of James Bay.

13.11.3 James Bay–Northern Half

The northern half of the James Bay Marine District extends—on its western coast—from Cape Henrietta Maria south to the Ekwan River, at the north end of Akimiski Strait. On its eastern coast, it encompasses the area from Pointe Louis-XIV to just north of Wemindji.

The eastern coast of James Bay, from Pointe Louis-XIV to the mouth of La Grande Rivière (nearly 90 km to the south-southeast), is low-lying and flanked by hills 30-60 m high. Numerous bays, separated by low, rocky points, punctuate the shoreline, which is fringed by innumerable islands and a shoal bank that extends several miles seaward. At the mouth of Rivière Roggan, 27 km south-southeast of Pointe Louis-XIV, a seasonal fishing camp affords emergency shelter. Paul Bay is large; however, extensive shoals make it unsafe, even for small craft.

In northeastern James Bay, the coastlines of small headlands and bays are extremely irregular in shape and fringed by myriad small islands, skerries, and shoals. Tidal flats, some of them fringed inland by wide salt marshes, are found in most large embayments and around most offshore islands.

13.11.2.1 Chisasibi

Chisasibi, formerly called Fort George, is a Cree community on the eastern coast of James Bank. It is situated on the south bank of La Grande Rivière, less than 10 km from its mouth.

Winds and Weather

In general, weather in the area is unsettled in September and October. Strong winds in the vicinity of Narwhal Anchorage usually start blowing from the south and southwest before veering northwest and increasing in strength to up to 60 kt. La Grande Rivière freezes over in mid-November, with break-up occurring toward the end of May.

Tidal Streams and Anchorages

Strong north- and south-going tidal streams have been experienced in the vicinity of Loon Island, and the outgoing stream in La Grande Rivière sometimes exceeds 3 kt.

Numerous islands and dangers encumber both the approaches to and the mouth of La Grande Rivière. Narwhal Passage, which separates Anik Islands from Qairulik Reef, is the recommended approach. Supply vessels calling at Chisasibi anchor at the Fort George Anchorage, where water depths are 6-8 m; however, it is highly exposed to northwest gales. Narwhal Anchorage (between Loon Island and Double Island) is well protected and its soft, clay bottom provides a moderate hold for anchors.

13.11.3 James Bay–Southern Half

The southern half of the James Bay Marine District extends—on its western coast—from the Ekwan River, at the north end of Akimiski Strait, to the southern head of the bay. On its eastern coast, it encompasses the area from just north of Wemindji to the same, southernmost point.

The head of the bay is low-lying and contains large areas of marshland. Numerous rivers enter James Bay along this coast, one of the most important being the Moose River. Although there are several settlements at the head of James Bay, there are few anchorages aside from the port of Moosonee.

The coast from Eastmain River southward is exceedingly low, with rocky hills only reaching the shoreline in a couple of places. Elsewhere, wide bays with sandy shores and boulder-strewn points rise slowly inland, faced by wide mud flats that are bare at low water. There are only a few islands off the coast, and they are difficult to approach due to the shallow water. Sherrick Mount, a granite peninsula joined to the mainland by a low, sandy neck, rises to 213 m above the sea at its highest point. Visible on the horizon long before the surrounding lower country, it marks the entrance to Rupert Bay—into which flow the Rupert, Nottaway, and Broadback rivers, all of which have brought down large quantities of sand and mud. Ships of draughts of less than 3 m can navigate only in the channels kept open by the currents of these rivers.

13.11.3.1 Wemindji

Wemindji is a small Cree village on the east coast of James Bay. It is located at the mouth of the Maquatua River, at the head of Paint Hills Bay.

Winds

Northwest winds predominate from June to August, occurring 27 percent of the time and averaging 11 kt. Southwest winds occur 26.4 percent of the time, with an average speed of 9 kt. From September to November, winds from the northwest to southwest occur 17 and 15.6 percent of the time, respectively, with average wind speeds increasing to 12 kt. Wind speeds of 15 to 20 kt occur 2.2 percent of the time during the summer and 4 percent, during the fall. Wind speeds greater than 20 kt occur 0.2 percent of the time from June to August and 0.7 percent of the time from September to November. The most common wind speed is 5-10 kt, which occurs nearly 42-46 percent of the time, with average wind speeds strengthening from September to November.

Anchorages

Vessels with a draught of 2.4 m or less can anchor off the settlement of Wemindji, while those with a draught of up to 6.4 m can anchor approximately 2.4 km northwest of Pointe Bourlamaque, where water depths are 7.3-9.1 m and the bottom is sand and clay.

13.11.3.2 Attawapiskat

Attawapiskat is a small community in the Hudson Bay Lowland. Located on the north bank of the Attawapiskat River, about 5 km inland from the James Bay coast, it is a typically subarctic landscape of muskeg and mostly coniferous forest. An extensive delta, composed of grassy islands intersected by several channels, forms the mouth of the Attawapiskat River. Akimiski Island, which lies nearly 13 km east-northeast of the river, is swampy and partially wooded, rising to a maximum elevation of 30 m on its south side. Kashechewan is located 100 km southeast of the community, on the north shore of the Albany River.

The settlement of Attawapiskat. Photo courtesy of Shannon Badzinski.

Tides and Shoals

The Attawapiskat River is reportedly navigable as far as the settlement by vessels with a draught of at less than 2.1 m, at high water and via its north channel. The banks of the river rise only about 1 m above mean high-water level. Tides are greatly affected by wind strength and direction and reverse the current of the river when they are in-going.

Akimiski Island can be approached only by small vessels due to the presence of the surrounding shoals. Depths of 0.9 m are found off Cape Duncan (the southeast extremity of the island), with shoal water extending nearly 13 km to the southeast and southwest. A chain of small islands stretches 5 km southeast of the cape.

13.11.3.3 Eastmain

Eastmain is a small Cree community located on the south bank of the Eastmain River, just over 3 km from the eastern shore of James Bay.

Winds

Northwest winds predominate during the summer and fall, with southwesterlies and southerlies increasing in October and November. Wind speeds greater than 15 kt are rare, occurring 0.8 percent of the time from June to August and 1.6 percent of the time from September to November. The most common wind speed is 5-10 kt, which occurs nearly half the time, with average wind speeds strengthening from September to November.

Shoals, Tides, and Anchorages

The Eastmain River is shallow and difficult to approach—even by small craft—as its entrance is encumbered by shoals and rocky islets. Thanks to local knowledge, vessels of up to 2.4 m draught can navigate nearly 10 km upriver at high water during spring tides. Tidal streams up to 5 kt are reported at the settlement. Anchorage can be obtained 24 km west-southwest of the settlement, about 3 km east of an unnamed island that lies approximately 10 km southwest of the Flock Geese Islands.

13.11.3.4 Waskaganish

Waskaganish, formerly known as Rupert House, is a small Cree community a short distance inland from James Bay, located on a small point on the swampy south shore of the Rupert River. Three other rivers converge with the Rupert at this point: the Nottaway, Broadback, and Pontax.

Winds and Weather

During the summer, the strongest winds come from the northwest, occasionally reaching gale strength. Winds at the Waskaganish airport blow most frequently from the south, southwest, or northwest in the fall, with the strongest coming from the northwest. Winds blow at less than 10 kt almost two-thirds of the time during the summer and fall; approximately 11-16 kt 25 percent of the time; 17-22 kt 3.7 percent of the time in summer and 8.4 percent, in the fall; and at over 22 kt 0.9 percent of the time in the summer and 3.5 percent, in the fall.

The river freezes up in early November and breaks up toward the end of May.

Shoals

Shoal water extends from the settlement for 1.5 cables and, off the north shore opposite, for four cables—leaving a navigable channel one cable wide, with a depth of at least 2.1 m. The entrance and three passages into shallow Rupert Bay are littered with islands, islets, and rocks—the only navigable channels through it are those kept open by the outflow of rivers on its east side.

13.11.3.5 Moosonee

Moosonee is a small, isolated community on the north bank of the Moose River, about 25 km inland from James Bay. It is the only saltwater port in Ontario where goods are transferred from trains to aircraft and barges destined for more northerly communities. About 2.5 km to the southeast, on Factory Island, lies the town of Moose Factory. Factory Island is part of a cluster of islands located where the Moose River broadens in width to nearly 5 km before emptying into James Bay.

Town of Moosonee. Photo courtesy of Shannon Badzinski.

Winds and Weather

Southwest winds predominate throughout the summer months at Moosonee Airport. Other wind directions are much less frequent and usually associated with the passage of low-pressure systems across the region. Both the mean wind speeds and maximum gust speeds show only slight seasonal variation, with winds being slightly stronger during the fall than the summer. Although winds from the west can be slightly stronger than 20 kt in October, they rarely reach warning strength. Fog is rare in the cold months and usually occurs only around sunrise in the summer months. Moosonee is prone to snowsqualls in a northern flow until freeze-up.

Tides and Currents

The waters of the Moose River are fresh in this area, with strong currents throughout the summer months and tides of nearly 2 m. The minimum and maximum tidal heights in Moosonee are 0.5 m and 2.6 m, respectively. Vessels with a draught of up to 2.4 m can reach Moosonee at high tide. The river is generally clear of ice between mid-May and early November.

13.12 Baker Lake Marine Region

Although the Baker Lake Marine Region is confined to Baker Lake, this section also includes information on Chesterfield Inlet.

Baker Lake is a non-tidal, freshwater lake 72 km long and 35 km wide. It covers an area of approximately 1887 km^2 and is navigable from end to end. Fed by the Thelon and Dubawnt rivers from the west and the Kazan River from the south, it empties into Chesterfield Inlet and, subsequently, into Hudson Bay, about 255 km to the southeast. Chesterfield Inlet stretches about 177 km through bare, rocky slopes 30-60 m high, from Chesterfield Narrows to Hudson Bay.

Figure 26: Local effects for the Baker Lake Marine Region.

The hamlet of Baker Lake lies at the mouth of the Thelon River, on the western end of Baker Lake, about 320 km inland from the west coast of Hudson Bay. The only inland community in the Canadian Arctic, the hamlet is known as the “Blizzard Capital of Canada”, averaging more than 20 blizzards per year. Strong winds from the barren plateaus and extremely cold winters make it one of North America’s most climatically harsh places to live.

13.12.1 Winds and Weather

North to northwest winds are dominant in the summer but shift more to northwest in the winter. North-northwest winds claim the highest percentage of winds greater than 20 kt. The secondary maximum in wind direction is from the southeast, which is more prevalent during the spring, summer, and fall, as low-pressure systems commonly track through the area from the west. Within Chesterfield Inlet, winds from these directions are usually stronger than those reported by Baker Lake Airport due to channeling effects. Fog is most common at Baker Lake in October, while freezing drizzle events peak in May (with an average of four events during the month) and October (with an average of six).

13.12.2 Anchorages

Chesterfield Inlet contains several harbours for small craft; however, there is no harbour for larger vessels, other than a sheltered anchorage about 28 km inside its entrance. Helicopter Island is often used as an anchorage before entering Chesterfield Narrows.

On Baker Lake, shoals are most likely to be encountered in the south channel (south of Christopher Island) and near the mouths of the Kazan and Thelon rivers. Shoals in Chesterfield Inlet include the Borealis Reef and White Rock, northeast and southwest of Helicopter Island, respectively.