

Sea Ice



Simply put, sea ice is any form of ice that is found at sea and has originated from the freezing of sea water. The formation and movement of sea ice is controlled by various atmospheric and oceanographic parameters including air temperature, winds, ocean currents and bathymetry.

The timing and amount of maritime activity in the eastern and northern waters of Canada is largely controlled by sea ice. By knowing the general nature of the ice cover at its maximum and minimum limits and the way the changes occur, it is possible to determine the possible access of commercial vessels to ports in eastern and northern Canada at any given time. Information on sea ice is also essential in estimating transportation costs and deciding on an appropriate vessel type. Constraints imposed by sea ice not only affect navigation but also the economy including winter employment in maritime regions. Monitoring of sea ice conditions is provided by ships, reconnaissance aircraft and satellites.



Figure 1: Canadian Ice Service Ice Reconnaissance aircraft C-GCFR equipped with a Side Looking Airborne Radar (SLAR) for both visual and remote sensing observations.

Source: Environment Canada, Canadian Ice Service



Figure 2: Radarsat Canadian satellite. The main sensor for ice observation is the Synthetic Aperture Radar (SAR).

Source: Environment Canada, Canadian Ice Service.

In the winter, sea ice is usually present in coastal waters of Canada except for those of British Columbia where warm ocean currents from the south prevent the formation of sea ice. Near the shore, the sea ice can remain uniform and stationary and is referred to as "landfast ice". Offshore, the sea ice is mobile and consists of a mix of ice and open water. In the summer, sea ice in Canadian waters is limited to the northern regions.

The map (below) shows the minimal (mid-September) and maximal (March) extent of the sea ice cover in Canadian waters. Beyond the minimal extent ice remains all year round. The progression from the annual minimal to maximal extent of the sea ice cover in Canadian waters is depicted in the animation of the Seasonal Change of Sea Ice. (Refer to this animation located at the bottom of this text.)

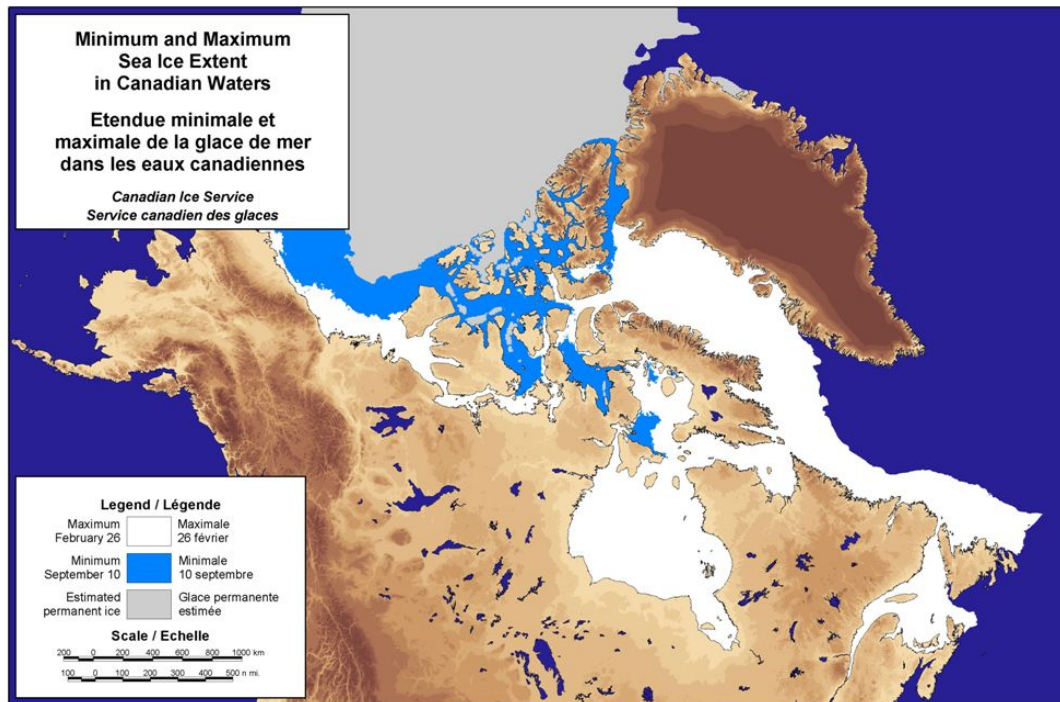


Figure 3: Minimum and Maximum Sea Ice Extent In Canadian Waters

Source: Canadian Ice Service

The ice extents described above represent normal or average conditions but there are variations from one year to the next due to changing atmospheric and oceanographic factors. This is shown in the bar graph below depicting the minimal extent each year (on September 10) of the ice cover in square kilometres for the period 1969 to 1998. Large variations are observed ranging from over 1.1 million square kilometres in 1978 to 500 thousand square kilometres in 1998. The animation of the Minimum Extent of Sea Ice 1969 to 1998 illustrates the variability of the minimal extent of the ice cover for the same period. (Refer to this animation located at the bottom of this text).

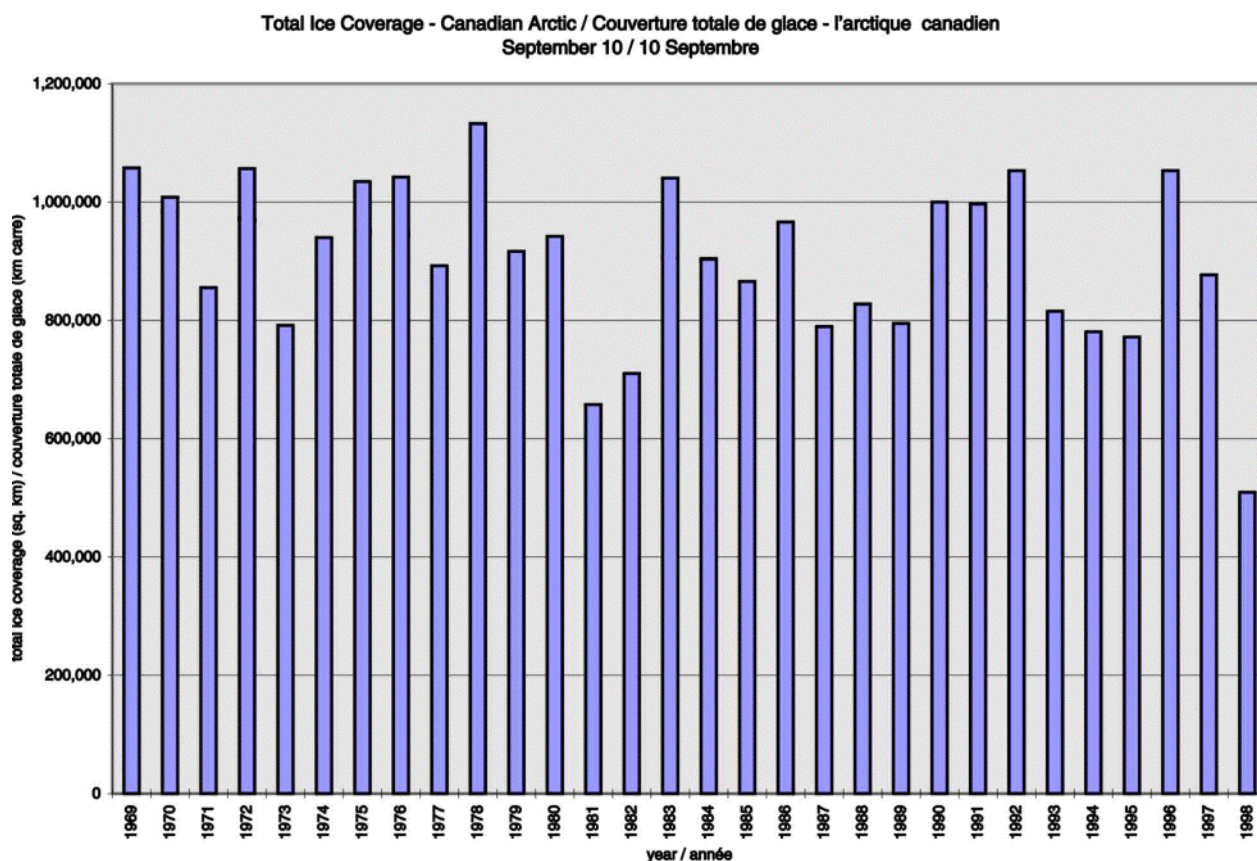


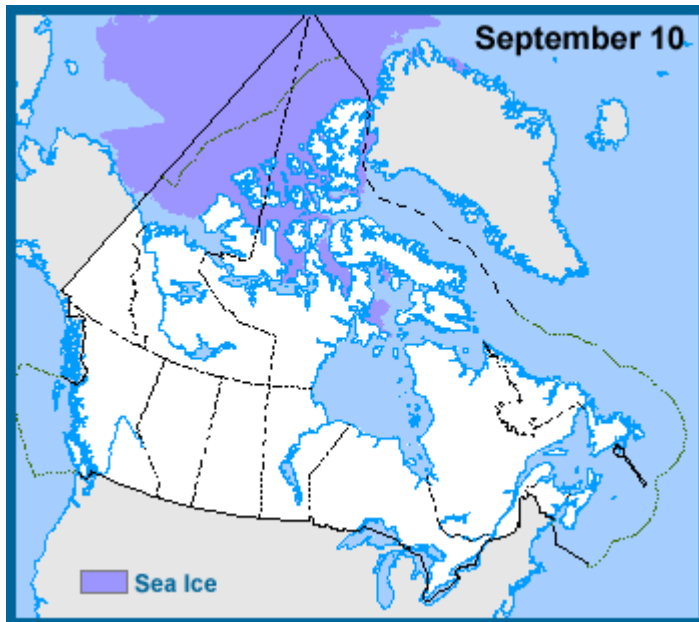
Figure 4: Total Ice Coverage, Canadian Arctic, September 10

Source: Canadian Ice Service

In recent years, concern about global climate change has drawn attention to the role of sea ice as a potential indicator as to whether or not the phenomenon is actually taking place, and if so, how rapidly. There is evidence of decreasing sea ice cover in the recent years but it is still too early to conclude whether the decrease is due to global warming or long term climate variability.

Animation of the Seasonal Change of Sea Ice

The animation, *seasonal_change_sea_ice(1).gif* is located in the animated gif folder.



Formation of sea ice begins in mid-September in the Canadian Arctic and advances southward through the onset of winter. Sea ice begins to form in the St. Lawrence estuary around January 1st and advances from coastal inlets into the Gulf of St. Lawrence. Sea ice in Canada normally reaches a maximum extent at the beginning of March. At that time, sea ice is usually present in coastal waters of Canada except for those of British Columbia where warm ocean currents from the south prevent the formation of sea ice.

Decay or melt of sea ice begins in the spring in the Gulf of St. Lawrence and over East Newfoundland waters and retreats northward towards the Labrador coast. In June openings appear in the northern portion of Baffin Bay and along the Western coast of Greenland which progress eastward and southward during June and July. During that time the Beaufort Sea begins to show signs of break-up while clearing is underway in Hudson Bay. Break-up continues throughout the summer months, reaching a minimum extent around mid-September, after which freeze-up begins through the remainder of September.

Source: Environment Canada. Canadian Ice Service. Regional Charts for the period 1969 to 1998

Animation of the Minimum Extent of Sea Ice 1969 to 1998

The animation, *extent_sea_ice(1).gif* is located in the animated gif folder.



At the end of the summer high concentrations (9/10 or greater) of mobile old ice are found in the Arctic Ocean and the nearby Arctic islands. Some of this old ice under the influence of winds and currents can penetrate further into the Canadian Arctic waters where it can be found in lower concentrations.

The minimum sea ice extent at the end of the summer varies from year to year due to a number of environmental factors such as wind speed and direction, ocean currents, sea and air temperatures, solar radiation and others. Also in a global warming scenario we would expect a reduction of this Arctic Ocean sea ice.

In this animation, a sea ice concentration threshold of 9/10 (90%) or greater was chosen in defining the minimum extent in order to focus on changes occurring in the main Arctic Ocean sea ice at the end of the summer melt season.

As can be seen in the animation the ice does vary in shape and extent from one year to the next due to the variations of environmental factors. However, the animation doesn't show the reduction of the ice indicating the onset of global warming. It should be noted that 1998 was an exceptionally mild year all over the Arctic and this is reflected in the minimum extent of sea ice for that year.

Source: Environment Canada. Canadian Ice Service. Regional Charts for the period 1969 to 1998

Definitions of underlined terms

Landfast Ice: Sea ice that forms along the coast and remains attached to the shore.

Old Ice: Ice that has survived through at least one summer's melt and increased again in thickness. It is harder and contains less salt than first-year ice, and has a pale blue colour.