

Late Summer Sea Ice Conditions

Abstract

Typical sea ice types are shown here at the end of the summer melt season, as well as how often sea ice has been present at any location on September 10 over the last 30 years. Based on the observations of sea ice extent and types over the last 30 years, this map shows how frequently sea ice has been present and what is the most likely predominant ice type and where. Sea ice is any form of ice that is found at sea and has originated from the freezing of seawater. The ice type gives an indication of the thickness of sea ice such as new ice, grey ice, grey-white ice, first year ice, and old ice. Ice represents a danger for navigation. Information on sea ice is essential in estimating transportation costs, and what type of vessel is appropriate.

This map shows the typical sea ice types at the end of the summer melt season (September 10) as well as frequency of sea ice on that date. The frequency of sea ice indicates how often sea ice has been present on September 10 over the last 30 years.

The ice type gives an indication of the thickness of sea ice. When sea ice first forms it is referred to as new ice. As winter progresses it grows in extent and thickness. As sea ice thickens it is referred to successively as grey ice, grey-white ice and first year ice. During the summer sea ice melts and any first year ice remaining at the end of the summer melt is then renamed "old ice" on October 1.

Various ice types can be present in a given area, but one of them will be predominant. The predominant ice type is the one with the greatest concentration in a particular area. However, because of the danger that old ice represents for navigation, and if 40% or more of the area contains old ice then the predominant ice type will be old ice even if thinner ice in greater concentration is present.



Figure 1: Norwegian Bay (Nunavut) early October from 30 feet showing second year ice (old ice) and frozen puddles.

Source: Environment Canada, Canadian Ice Service.

Map Description

This map shows the frequency of sea ice and the most likely predominant ice type encountered at the end of the summer melt season (September 10). At the end of summer melt, all the sea ice in southern latitudes will have melted and sea ice will remain only in northern Canadian waters. Moreover, since the thinner types of ice melt first, only the thicker types, such as old ice and first year ice, will remain.

There are extended areas of old ice in most Canadian Arctic waters including Beaufort Sea and Baffin Bay. It should be noted however that in most of these areas the frequency of the presence of sea ice is mostly less than 25% and concentrations (being the proportion of water surface covered by ice) are low. Typically, the presence of old ice at the end of the summer melt is limited to areas between the Arctic islands and in the Arctic Ocean (as shown by frequencies greater than 50%) but still presents a danger for navigation.

Also shown are areas of permanent ice and the estimated maximum extent of ice observed outside Canadian waters. Areas designated permanent ice indicate where ice has been observed all year round throughout the period 1969 to 1998. The estimated maximum extent of ice outside Canadian waters displays where ice has been observed on September 10 at least once over the 30 year period.

Sea Ice Animations

Minimum Extent of Sea Ice 1969 to 1998

Animation of the Minimum Extent of Sea Ice 1969 to 1998 presents the variation of the minimum extent of ice between each year for the period 1969 to 1998, with a concentration of 9/10 or greater. A concentration of 9/10 corresponds to at least 90% of the water which is covered by ice. 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

Seasonal Change of Sea Ice

Animation of the Seasonal Change of Sea Ice presents a normal ice season in Canadian waters by showing the normal evolution of sea ice throughout the course of a year. The animation does not reflect any real observed sea ice season, but rather a 30-year statistical compilation. 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

Definitions of underlined terms

First Year Ice: Ice resulting from not more than one winter's growth, ranging in thickness from 30 cm to 2 m. It is usually greenish-white in colour and contains some salt.

Grey Ice: Young ice 10 – 15 cm thick

Grey-white Ice: Young ice 15 – 30 cm thick

Ice Concentration: The ratio (in tenth) expressing the proportion of water surface covered by ice in a given area. Based on concentration, drift ice is identified as very open (1/10 – 3/10), open (4/10 – 6/10), close (7/10 – 8/10), very close (9/10 – < 10/10) or compact (10/10).

New Ice: General term for recently formed sea ice up to 10 cm in thickness. It can consist of ice crystals barely held together or of thin elastic crust of ice.

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.

Map Sources

Late Summer Frequency of Sea Ice (September 10)

Regional Ice Charts from 1969 to 1998, Canadian Ice Service, Environment Canada.

Late Summer Predominant Ice Type (September 10)

Regional Ice Charts from 1969 to 1998, Canadian Ice Service, Environment Canada.

References

Canada. Environment Canada. 2001. Sea Ice Climatic Atlas: East Coast of Canada, 1971-2000. Ottawa: Canadian Government Publishing.

Canada. Environment Canada. 2002. Sea Ice Climatic Atlas: Northern Canadian Waters, 1971-2000. Ottawa: Canadian Government Publishing.

Related Web sites (1999 – 2009)

Federal Government

Environment Canada: Canadian Ice Service
<http://ice-glaces.ec.gc.ca/>

Environment Canada, Canadian Ice Service: Climatic Ice Atlas
<http://ice-glaces.ec.gc.ca/App/WsvPageDsp.cfm?ID=115&LnId=23&Lang=eng>

Environment Canada, Canadian Ice Service: Ice Terminology
<http://ice-glaces.ec.gc.ca/App/WsvPageDsp.cfm?ID=181&LnId=22&Lang=eng>

Environment Canada. Cryosphere System in Canada (CRYSYS): Learn More About Sea Ice
http://www.msc.ec.gc.ca/crysys/education/seaice/seaice_edu_e.cfm

Environment Canada. Cryosphere System in Canada (CRYSYS): Photo Gallery
http://www.msc.ec.gc.ca/crysys/education/photogallery/photogallery_edu_e.cfm

Environment Canada. Cryosphere System in Canada (CRYSYS): Publications
http://www.msc.ec.gc.ca/crysys/science/research/crysys_research_seaice_e.cfm

Environment Canada, Ecological Monitoring and Assessment Network: Ice Watch
<http://www.naturewatch.ca/english/icewatch/>

Fisheries and Oceans Canada, Canadian Coast Guard: Icebreaking Program
http://www.ccg-gcc.gc.ca/eng/CCG/Ice_Home

Other

United States Government. Department of Commerce. National Oceanic and Atmospheric Administration. National Ice Centre
<http://www.natice.noaa.gov/>

The National Ice Center (NIC) is a multi-agency operational center representing the Department of Defense (Navy), the Department of Commerce's National Oceanic and Atmospheric Administration (NOAA), and the Department of Homeland Security (Coast Guard).

University of Colorado. National Snow and Ice Data Centre. Current View of Sea Ice Concentration (United States)

<http://nsidc.org/data/seaice/current.html>

NSIDC is part of the University of Colorado Cooperative Institute for Research in Environmental Sciences, and is affiliated with the National Oceanic and Atmospheric Administration National Geophysical Data Center through a cooperative agreement.

University of Colorado. National Snow & Ice Data Centre (NSIDC): NSIDC's Image and Photo Gallery (United States)

<http://nsidc.org/gallery/index.html>

University of Waterloo, State of the Canadian Cryosphere: Current Arctic Sea Ice Extent

http://www.socc.ca/seaice/seaice_current_e.cfm

International Government

United Nations Environment Programme. Environment Network: Arctic Environment Atlas

<http://maps.grida.no/arctic/>