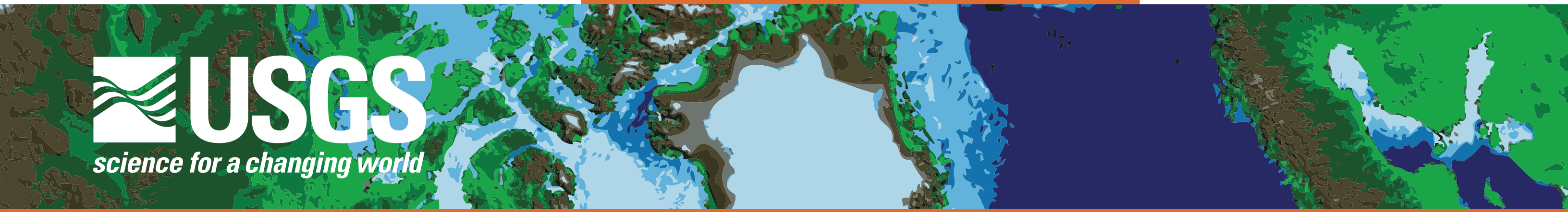

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Floating Ice—Sea Ice *and* Lake Ice and River Ice

Sea Ice

By Claire L. Parkinson[1] and Donald J. Cavalieri[1]

Sea ice covers vast areas of the polar oceans, typically ranging in extent from 5 to 7 million square kilometers (km^2) in September to approximately 15 million km^2 in March in the Northern Hemisphere (fig. 1) and from approximately 3 million km^2 in February to approximately 18 million km^2 in September in the Southern Hemisphere. Such an extensive cover of sea ice affects the atmosphere, the oceans, and terrestrial and marine ecosystems of the polar regions. Changes in the ice, if sufficiently large, can initiate regional and global climatological and ecological consequences.

Satellite data document considerable interannual variability in the spatial distributions of sea-ice covers in both polar regions. Many studies suggest possible natural connections between the sea ice and certain oscillations within the global climate system, such as the Arctic Oscillation, the North Atlantic Oscillation, and the Antarctic Oscillation (or Southern Annular Mode). Nonetheless, 29-year trends from late 1978 through the end of 2007 are statistically significant: a decrease in the extent of sea ice in the Arctic Ocean and adjacent seas and a lesser increase in the extent of sea ice in the Southern Ocean around Antarctica. On 14 September 2007, Arctic sea ice was much less than the typical yearly minimum, decreasing to 4.1 million km^2, a 29-year record low (fig. 2).

Satellite monitoring of the sea-ice covers in the two polar regions since the late 1970s has led to a greatly improved understanding of the seasonal cycle of the ice, trends in the ice, and the interannual variability of the sea-ice cover. Continuing satellite monitoring of the ice should contribute to even greater understanding of the various interconnections between the ice and other elements of the climate system and thereby to the possibility of more accurate predictions.

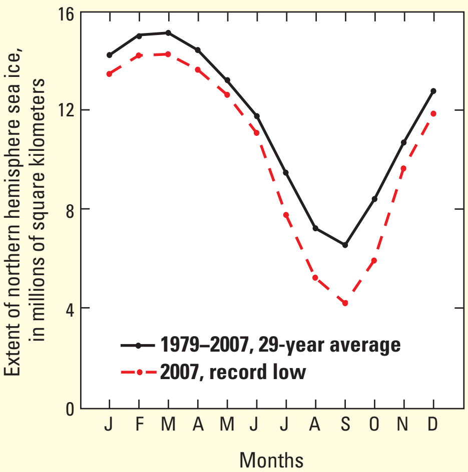


Figure 2. Graph showing a 29-year average (1979–2007) (black line), seasonal variation of sea ice extent in the Arctic Ocean and environs. The red dashed line shows seasonal variation for 2007, a record low.

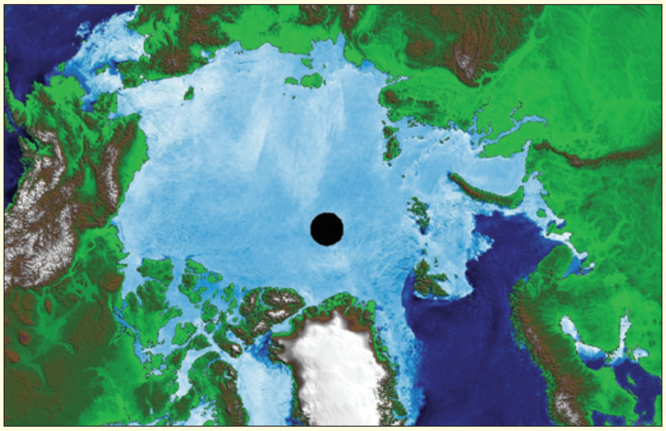
URL Addresses:

http://neptune.gsfc.nasa.gov/csb/

http://nsidc.org/sotc/sea_ice.html

http://southport.jpl.nasa.gov/polar/iceinfo.html

Figure 1. Sea ice in the Arctic region on 9 March 2003, shown on an image produced from data from NASA's Aqua satellite. Delineation of maximum areal extent of sea ice is shown by the boundary between open water (dark blue) and sea ice (lighter blue).



Contact information for Sea Ice

Claire L. Parkinson,
e-mail: claire.l.parkinson@nasa.gov
Donald J. Cavalieri,
e-mail: donald.j.cavalieri@nasa.gov

[1] National Aeronautics and Space Administration, Goddard Space Flight Center, Greenbelt, MD 20771 U.S.A.

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Lake Ice and River Ice

Lake ice and river ice occur primarily in the Northern Hemisphere, where most of the ice is seasonal. That is, ice forms in the autumn, thickens during the winter, and melts in the spring, as at Great Slave Lake (fig. 2). Much more rare but no less important than seasonal ice is the perennial ice that lasts for many years on a few lakes in Antarctica and at the highest latitudes in the Arctic. From the mid-19th century to the beginning of the 21st century, records of fresh water ice freezeup and breakup show that the duration of lake and river ice has been significantly shortened because of climate warming. In 2008, freezeup was 15 days later, and breakup was about 16 days earlier; duration was about 32 days shorter.

The scientific and engineering investigation of lake ice and river ice has a long history, driven by both natural curiosity and the vital need to understand processes that have significant geomorphological, limnological, ecological, and socioeconomic effects. Freshwater-ice events (for example, ice jams) can be very costly financially and emotionally to human populations. For example, an ice jam on the St. Lawrence River in 1993 lasted 40 days, stopped commercial navigation, and cost the Port of Montréal alone an estimated CDN$200 million. Flooding resulting from an ice jam in 1996 on the Susquehanna River in Pennsylvania caused 14 deaths and cost US$600 million. Frozen lakes and rivers are valuable recreational resources (for example, ice fishing, ice skating, and snowmobiling), and they create important corridors for winter transportation and communication that link remote northern communities where hunting and trapping are essential parts of the indigenous culture.

URL Addresses:

http://www.blueiceonline.com/howsite/lakeice_about.html

http://www.crrel.usace.army.mil/library/cat-river_lake_ice.html

http://nsidc.org/data/G01377.html

http://www.gi.alaska.edu/alison

Contact information for Lake Ice and River Ice

Martin O. Jeffries, e-mail: martin.jeffries@gi.alaska.edu
Kim Morris, e-mail: kim.morris@gi.alaska.edu
Claude R. Duguay, e-mail: crduguay@uwaterloo.ca

[1] University of Alaska Fairbanks, Geophysical Institute, Fairbanks, AK 99775-7320 U.S.A.

[2] University of Waterloo, Department of Geography, Waterloo, ON N2L 3G1 Canada.

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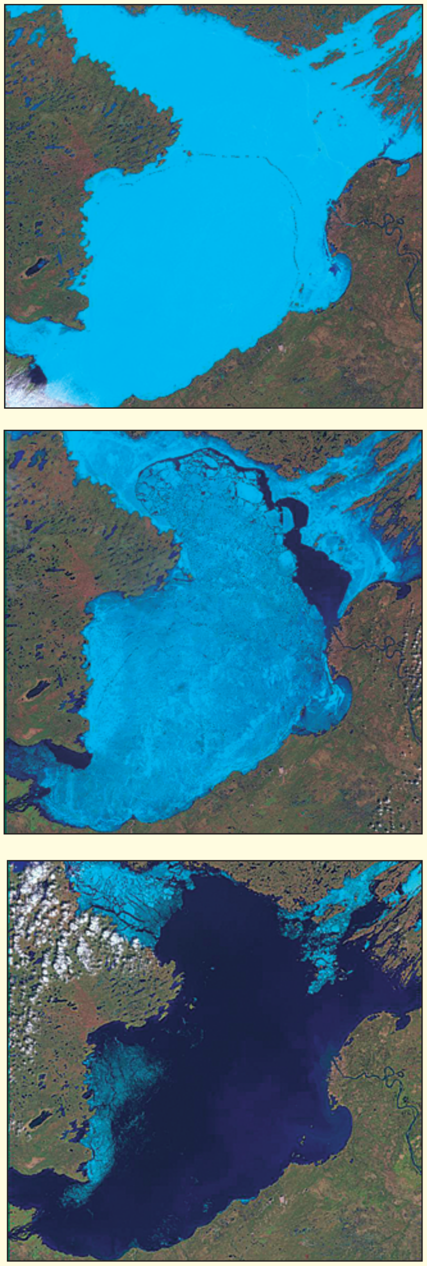

Figure 2. Three Landsat-7 ETM+ images (bands 3, 4, 5) of the breakup of ice on Great Slave Lake, Northwest Territories, Canada (at about latitude 61.5°N., longitude 14.5°W.) on (A) 4 May 2000, (B) 20 May 2000, and (C) 5 June 2000. Lake ice is shown in light blue, open water in dark blue. Each image covers an area of 185 km by 185 km.