



Warmer air and sea, declining ice continue to trigger Arctic change

As a part of the Arctic Report Card, it is reported that the Arctic is warming twice as fast as other parts of the planet, which has ramifications for global security, climate, commerce, and trade. This year's report shows the importance of international collaboration on sustained, long-term observing programs that provide insights to inform decisions by citizens, policymakers, and industry.

Some 70 authors from 10 countries, including U.S. federal agencies and academics, contributed to this annual peer-reviewed report, guided by an editorial team from the Office of Naval Research, and NOAA. This year's report features updates on key indicators as well as new reports on the status of walrus, the northward movement of fishes, increasing river discharge into the Arctic Ocean, and the importance of community-based monitoring. Major findings are as follows:

- **Air temperature:** The average annual air temperature over land areas between October 2014 and September 2015 was 1.3°C above average, the highest in the observational record which began in 1900. It is a 3°C increase since the beginning of the 20th Century.
- **Sea ice:** Maximum Arctic Ocean sea ice extent occurred on February 25, 2015, 15 days earlier than average. It was the lowest extent recorded since records began in 1979. Minimum sea ice extent observed on September 11, 2015, was the fourth lowest in the satellite record since 1979. Arctic minimum sea ice extent has been declining at a rate of 13.4% per decade (relative to the 1981-2010 average). First year ice now dominates the winter ice cover, comprising about 70% of the March 2015 ice pack, and compared to about half that in the 1980s when older, thicker ice was more prevalent. The thinner, younger ice is more vulnerable to melting in the summer.
- **Snow cover:** While Arctic-wide terrestrial snow cover extent in April was above average, June snow cover in both the North American and Eurasian parts of the Arctic was the second lowest in the satellite record that began in 1967. Arctic-wide June snow extent has declined 18% per decade since 1979. Snow cover variability in April through June is important as the Arctic's transition from winter to summer affects climate and terrestrial ecosystems.
- **Greenland ice sheet:** For the first time since the exceptional melt of 2012, significant melting (more than 50% of the area) occurred on the surface of the Greenland ice sheet in 2015. Melt season was 30 to 40 days longer than average in western, northwestern and northeastern Greenland, but was close to or below average elsewhere on the ice sheet. Between the end of the 2014 and 2015 melt seasons, 22 of 45 of the widest and fastest flowing glaciers terminating in the ocean had retreated, but the advance of 9 relatively wide glaciers resulted in a low annual net loss of 16.5 sq km.
- **Arctic Ocean temperature:** As sea ice retreats in summer, SST in all the seas of the Arctic Ocean is increasing. Mean sea surface temperatures in ice-free regions in August 2015 ranged from 0°C to 7 to 8°C in the Chukchi, Barents and Kara seas and eastern Baffin Bay off the west coast of Greenland. The Chukchi Sea northwest of Alaska and eastern Baffin Bay off west Greenland have the largest warming trends: nearly 0.5°C since 1982.
- **Arctic Ocean productivity:** Melting and retreat of sea ice during spring is leading to an increase in sunlight reaching the upper layers of the ocean, promoting photosynthesis and stimulating the growth of algae (tiny marine plants which form the base of the food chain). Widespread and exceptional phytoplankton blooms were observed in 2015 in Arctic seas along the edge of the continental shelf, including waters to the southwest and east of Greenland, in the Bering Sea between Alaska and Russia, and in the Barents, Kara and Laptev seas north of Russia.
- **Vegetation:** Arctic tundra greenness, a measure of live vegetation (grasses, sedges, mosses, lichens, shrubs) productivity and biomass, had been increasing over the past two to three decades, as indicated by the satellite record. However, for reasons that remain to be identified, tundra greenness has been declining, or browning, consistently for the past two to four years.
- **Walrus habitat:** The decline in sea ice is dramatically changing the habitat for walrus--large marine mammals that traditionally use sea ice for mating, giving birth to young, finding food and shelter from storms and predators. In recent years, large numbers of walrus have been forced to haul out on land in northwest Alaska. This behavior, documented through aerial surveys, has created problems such as overcrowding which has led to stampedes that have killed calves, and difficulty finding food. Walrus must travel longer distances to the ice edge to find food. While walrus have new stressors, their populations have benefited from reduced hunting as more nations adopt conservation measures.

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Scientists from Norway and Russia drew on annual ecosystem surveys from the Barents Sea from 2004 to 2013 to show a northward movement of subarctic fish species such as cod, beaked redfish and long rough dab, into Arctic waters. These predators may pose potential problems for smaller Arctic fish that must now face these new warmer-water predators.

Freshwater discharge: In 2014, and for the first seven months of 2015, the combined discharge of fresh water from eight Eurasian and North American rivers into the Arctic Ocean was 10% greater than the discharge in the decade of 1980-89. Scientists attribute the rise in discharge to increasing precipitation linked to global warming

