Frequently Asked Question 4.1

Is the Amount of Snow and Ice on the Earth Decreasing?

Yes. Observations show a global-scale decline of snow and ice over many years, especially since 1980 and increasing during the past decade, despite growth in some places and little change in others (Figure 1). Most mountain glaciers are getting smaller. Snow cover is retreating earlier in the spring. Sea ice in the Arctic is shrinking in all seasons, most dramatically in summer. Reductions are reported in permafrost, seasonally frozen ground and river and lake ice. Important coastal regions of the ice sheets on Greenland and West Antarctica, and the glaciers of the Antarctic Peninsula, are thinning and contributing to sea level rise. The total contribution of glacier, ice cap and ice sheet melt to sea level rise is estimated as 1.2 ± 0.4 mm yr^{-1} for the period 1993 to 2003.

Continuous satellite measurements capture most of the Earth's seasonal snow cover on land, and reveal that Northern Hemisphere spring snow cover has declined by about 2% per decade since 1966, although there is little change in autumn or early winter. In many places, the spring decrease has occurred despite increases in precipitation.

Satellite data do not yet allow similarly reliable measurement of ice conditions on lakes and rivers, or in seasonally or permanently frozen ground. However, numerous local and regional reports have been published, and generally seem to indicate warming of permafrost, an increase in thickness of the summer thawed layer over permafrost, a decrease in winter freeze depth in seasonally frozen areas, a decrease in areal extent of permafrost and a decrease in duration of seasonal river and lake ice.

Since 1978, satellite data have provided continuous coverage of sea ice extent in both polar regions. For the Arctic, average annual sea ice extent has decreased by 2.7 ± 0.6% per decade, while summer sea ice extent has decreased by 7.4 ± 2.4% per decade. The antarctic sea ice extent exhibits no significant trend. Thickness data, especially from submarines, are available but restricted to the central Arctic, where they indicate thinning of approximately 40% between the period 1958 to 1977 and the 1990s. This is likely an overestimate of the thinning over the entire arctic region however.

Most mountain glaciers and ice caps have been shrinking, with the retreat probably having started about 1850. Although many Northern Hemisphere glaciers had a few years of near-balance around 1970, this was followed by increased shrinkage. Melting of glaciers and ice caps contributed 0.77 ± 0.22 mm yr^{-1} to sea level rise between 1991 and 2004

Taken together, the ice sheets of Greenland and Antarctica are very likely shrinking, with Greenland contributing about 0.2 ± 0.1 mm yr^{-1} and Antarctica contributing 0.2 ± 0.35 mm yr^{-1} to sea level rise over the period 1993 to 2003. There is evidence of accelerated loss through 2005. Thickening of high-altitude, cold regions of Greenland and East Antarctica, perhaps from increased snowfall, has been more than offset by thinning in coastal regions of Greenland and West Antarctica in response to increased ice outflow and increased Greenland surface melting.

Ice interacts with the surrounding climate in complex ways, so the causes of specific changes are not always clear. Nonetheless, it is an unavoidable fact that ice melts when the local temperature is

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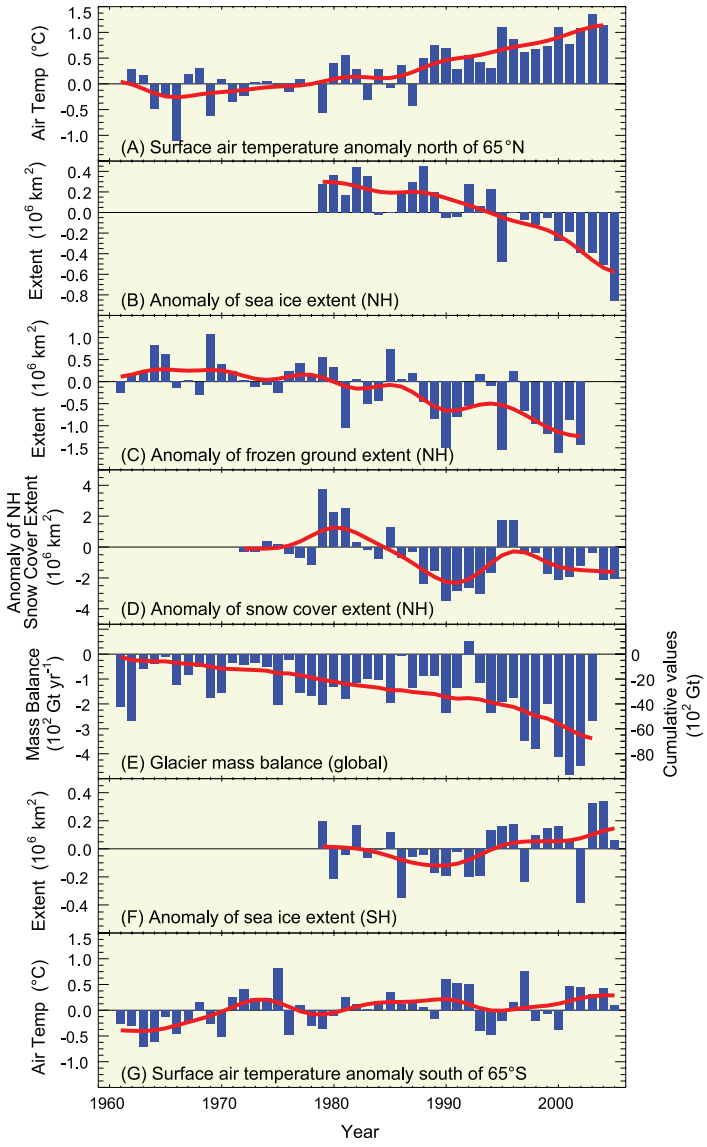

FAQ 4.1, Figure 1. *Anomaly time series (departure from the long-term mean) of polar surface air temperature (A, G), arctic and antarctic sea ice extent (B, F), Northern Hemisphere (NH) frozen ground extent (C), NH snow cover extent (D) and global glacier mass balance (E). The solid red line in E denotes the cumulative global glacier mass balance; in the other panels it shows decadal variations (see Appendix 3.A).*

above the freezing point. Reductions in snow cover and in mountain glaciers have occurred despite increased snowfall in many cases, implicating increased air temperatures. Similarly, although snow cover changes affect frozen ground and lake and river ice, this does not seem sufficient to explain the observed changes, suggesting that increased local air temperatures have been important. Observed arctic sea ice reductions can be simulated fairly well in models driven by historical circulation and temperature changes. The observed increases in snowfall on ice sheets in some cold central regions, surface melting in coastal regions and sub-ice-shelf melting along many coasts are all consistent with warming. The geographically widespread nature of these snow and ice changes suggests that widespread warming is the cause of the Earth's overall loss of ice.

From the report accepted by Working Group I of the Intergovernmental Panel on Climate Change but not approved in detail

Frequently Asked Questions

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