IPCC AR5 WGI: Polar Regions

Polar Amplification, Permafrost, Sea ice changes

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Over the last two decades, the Greenland and Antarctic ice sheets have been losing mass, glaciers have continued to shrink almost worldwide, and Arctic sea ice and Northern Hemisphere spring snow cover have continued to decrease in extent (high confidence).

It is very likely that the Arctic sea ice cover will continue to shrink and thin and that Northern Hemisphere spring snow cover will decrease during the 21st century as global mean surface temperature rises. Global glacier volume will further decrease.
Polar Amplification – zonal mean surface temperature warming at high latitudes exceeds global average temperature change.

CMIP5 : 2081-2100

SAT anomaly (°C)

land
+4.9°C
+3.7°C

global

°C per °C global mean change

0 0.25 0.5 0.75 1 1.25 1.5 1.75 2

IPCC AR5 Working Group I
Climate Change 2013: The Physical Science Basis
Polar amplification

Polar Amplification – zonal mean surface temperature warming at high latitudes exceeds global average temperature change.

New temperature reconstructions and simulations of past climates show with high confidence polar amplification in response to changes in atmospheric CO\textsubscript{2} concentration.

In the absence of a strong reduction in the Atlantic Meridional Overturning, the Arctic region is projected to warm most (very high confidence)

Impact on ice sheet stability and global sea level, carbon cycle feedbacks e.g. permafrost melting
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Permafrost
There is high confidence that permafrost temperatures have increased in most regions since the early 1980s.

Strong warming of permafrost
- 3°C in parts of Northern Alaska
- 2°C in parts of the Russian European North
  - Reduction in permafrost thickness and areal extent.
  - S. boundary moves northward
    continuous permafrost – 50 km
    discontinuous permafrost – 80 km

Active layer thickness – generally increasing
Figure 12.33
Near surface permafrost area (frozen ground up to 3.5 m depth)
It is *virtually certain* that **near-surface permafrost** extent at high northern latitudes **will be reduced** as global mean surface temperature increases.

Important because carbon and methane reservoirs are very large
- moderate feedback on decades to centuries
- important on millenial time scales because of size of reservoirs
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Arctic sea ice
Arctic sea ice

The annual mean **Arctic sea ice extent decreased** over the period 1979 to 2012 with a rate that was **very likely** in the range 3.5 to 4.1% per decade (range of 0.45 to 0.51 million km\(^2\) per decade), and **very likely** in the range 9.4 to 13.6% per decade (range of 0.73 to 1.07 million km\(^2\) per decade) for the summer sea ice minimum (perennial sea ice).

There is **medium confidence** from reconstructions that over the past three decades, **Arctic summer sea ice retreat was unprecedented** and sea surface temperatures were anomalously high in at least the last **1,450 years**.
Figure 4.3

Annual and seasonal Arctic sea ice extent, 1979-2012
Figure 9.24a

Modeled Arctic sea ice extent, 1900-1912

(a) Arctic sea ice extent in September (1900-2012)

Sea ice extent ($10^6 \text{ km}^2$)

Year

CMIP3

CMIP5
Figure 9.24c

Distribution of observed Arctic sea ice extent trends

(c) CMIP5 Arctic ice extent September trends (1979 - 2010)
Projected Arctic sea ice extent changes

Figure 12.28ab

**Northern Hemisphere February**

Satellite obs. 1986–2005 avg: $15.5 \times 10^6$ km$^2$

CMIP5 historical 1986–2005 avg: $15.9 \times 10^6$ km$^2$

-8%

-34%

-94%

**Northern Hemisphere September**

Satellite obs. 1986–2005 avg: $7.1 \times 10^6$ km$^2$

CMIP5 historical 1986–2005 avg: $6.6 \times 10^6$ km$^2$

-43%

-94%
Maps of multimodel mean Arctic sea ice concentration

1986-2005
(39 models)

RCP 8.5, 2081-2100
(37 models)
A nearly ice-free Arctic Ocean in September is likely before mid-century under RCP8.5 (medium confidence)
Cryosphere (SPM)

It is very likely that the Arctic sea ice cover will continue to shrink and thin and that Northern Hemisphere spring snow cover will decrease during the 21st century as global mean surface temperature rises.
Climate Change 2013: The Physical Science Basis
Working Group I contribution to the IPCC Fifth Assessment Report

Full Report and Background Information

www.climatechange2013.org