Snow, Water, Ice and Permafrost in the Arctic, 2017

Future Climate Change in the Arctic

Because the global climate system takes time to fully respond to changes in atmospheric greenhouse gas concentrations, scientists expect the trends and shifts underway in the Arctic to continue or accelerate through at least mid-century. After mid-century, the projected effects of emissions reductions versus a business-as-usual scenario become strikingly apparent (see figures below).

The Arctic of 2050 will be a substantially different environment from that of today, and by the end of this century Arctic warming may exceed thresholds for the stability of sea ice, the Greenland ice sheet, and boreal forests

About SWIPA 2017

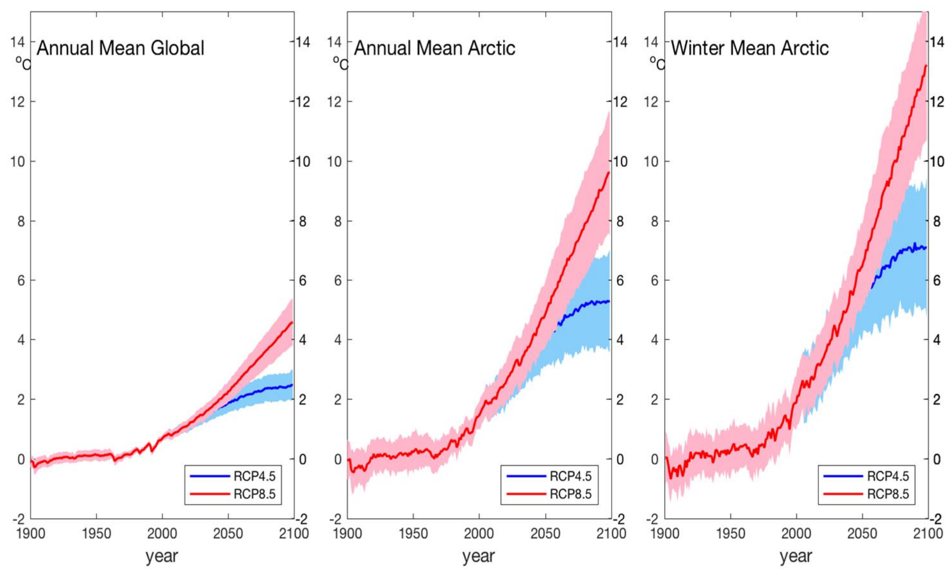
The Arctic Monitoring and Assessment Programme's Snow, Water, Ice and Permafrost in the Arctic (SWIPA) assessment focuses on changes to the Arctic cryosphere (the portion of the Arctic land and water that is seasonally or perennially frozen), and the implications of those changes. The second SWIPA assessment, which covers the period 2011–2015, with some updates to include observations from 2016 and early 2017, was published in 2017. This fact sheet reports on 2017's findings related to recent observed changes in the Arctic. For more information, see the chapters referenced in the fact sheet.

Mid-Century Projections

Climate models, using scenarios that depict potential changes in future greenhouse gas emissions and concentrations over time, offer the following medium-term projections for the Arctic in SWIPA 2017:

Temperature

Models project that autumn and winter temperatures in the Arctic will increase to 4–5°C above late 20th century values before mid-century, under either a moderate or high greenhouse gas emissions scenario. This is twice the increase projected for the Northern Hemisphere as a whole. (Chapter 2, Trends)



Observed and projected temperature changes for the world as a whole (left panel), the Arctic (center), and the Arctic in winter (right), compared with the 1900-1950 mean. The red line shows temperatures projected under a high-emissions scenario; the blue line shows temperatures under a moderate emissions scenario. Source: J. Overland, NOAA.

AMAP Arctic Monitoring and Assessment Programme

ARCTIC COUNCIL

Sea Ice

Extrapolations of recent observed data suggest a largely ice-free summer ocean in the Arctic by the late 2030s, which is earlier than projected by most climate models. The ice that appears in winter will be thinner, saltier, less rigid, and more mobile than today's sea ice. More open water is expected in winter, which would affect temperature and the exchange of moisture between the atmosphere and ocean, likely leading to more extreme weather locally and at lower latitudes. (Chapter 5, Sea Ice)

Snow and Permafrost

The duration of snow cover is projected to decrease by an additional 10–20% from current levels over most of the Arctic by mid-century under a high emissions scenario, and the area of near-surface permafrost is projected to decrease by around 35% under the same scenario. Areas with relatively warmer climates, such as Scandinavia and coastal Alaska, are most at risk for declining snow cover. (Chapter 3, Snow and Chapter 4, Permafrost)

End-of-Century Projections

As noted above, projections for the end of century differ widely based on assumptions about future emissions.

Temperature

By 2100, models project an increase of about 6–12°C in the Arctic during winter months, with 12°C representing a high-emissions scenario and 6°C a moderate-emissions scenario. (Chapter 2, Trends)

Higher sea levels will increase the risks of flooding and infrastructure damage from storm surge in many low-lying coastal areas around the world. Photo credit: U.S. National Park Service

Land-Based Ice

Losses of land-based ice—and corresponding sea level rise—have grown in recent decades, and losses are expected to accelerate further after mid-century. SWIPA 2017 estimates that the Arctic will contribute 19–25 centimeters to global sea level rise by the year 2100, with 19 centimeters representing the estimate under a moderate emissions scenario and 25 centimeters representing a business-as-usual scenario. When all sources of sea level rise are considered (not just those from the Arctic), the rise in global sea level by 2100 would be at least 52 centimeters under the moderate emissions scenario and 74 centimeters for the business-as-usual scenario. These low-end estimates are almost double the minimum estimates made by the IPCC in 2013, and recent studies on Antarctic ice melt, thermal expansion, and other factors suggest that even these estimates are conservative. (Chapter 9, Cross-cutting Scientific Issues)

Snow and Permafrost

Under a moderate greenhouse gas emissions scenario (similar to but not as stringent as that envisioned under the Paris Agreement), the duration of snow cover in the Arctic would stabilize at about 10% below current values by the end of the century. In contrast, a high-emissions business-as-usual scenario would lead to accelerating losses in snow cover throughout the century. The area of near-surface permafrost in the Northern Hemisphere could be reduced by as much as two-thirds by 2080 under a high-emissions scenario. (Chapter 3, Snow; Chapter 4, Permafrost)

Carbon Cycle Impacts

Reductions in sea ice and other changes may affect the amount of carbon dioxide absorbed by the Arctic Ocean, while thawing permafrost is expected to increase emissions of methane. However, projections of future impacts on Arctic sources and sinks of greenhouse gases are still hampered by data and knowledge gaps. (Chapter 8, Arctic Carbon Cycling)