



**The Potential Consequences
of Climate Variability
and Change**

ALASKA

A Report of the Alaska Regional Assessment Group

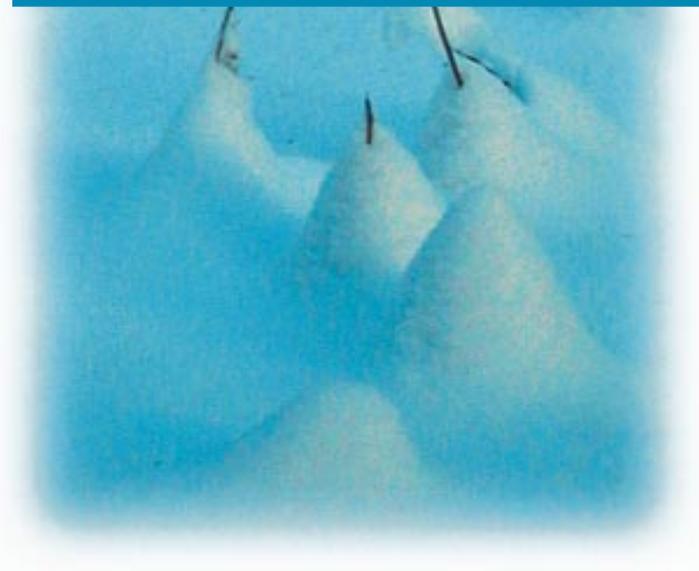
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**PREPARING FOR A
CHANGING CLIMATE**



Participating Agencies



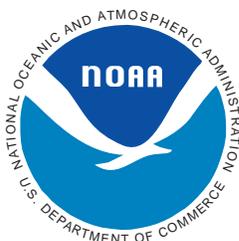
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Preface

Our assessment of the impacts of climate change in Alaska and the Bering Sea region started in 1995 and has now spanned a period of almost five years, with workshops taking place each year. The present report is a summary of the findings from all of these workshops. In 1995 our first workshop was on “Preparing for an Uncertain Future: Impacts of Short- and Long-Term Climate Change on Alaska.” In 1996, the International Arctic Science Committee (IASC) provided funds for an impact assessment on the Bering Sea under an IASC project called BESIS (Bering Sea Impact Assessment). A proposal to the Office of Polar Programs, National Science Foundation was also funded and allowed us to conduct our second workshop in September 1996. The 1997 workshop received funding from the Department of Interior and was recognized by the U.S. Global Change Research Program (USGCRP) as the national workshop for the Alaska region. A fourth impacts assessment workshop under the USGCRP took place in Fairbanks, Alaska, in October 1998 with Department of Interior funding. With NOAA and IASC funds we also organized an international workshop in Tromsø, Norway, in April 1999, to begin a pan-Arctic assessment of the impacts of climate change.

Many people contributed to these workshops and we cannot list them all here. The names of the workshop leaders can be found in the appendix; the names of all participants are in the various publications that resulted from the workshops and which are listed below. These publications formed the basis of the present report.

Preparing for an Uncertain Future: Impacts of Short- and Long-Term Climate Change in Alaska. Eds. Anderson, P., and G. Weller. Proceedings of a Workshop in September 1995, Center for Global Change and Arctic System Research, University of Alaska Fairbanks, 43 pages.

The Impacts of Global Climate Change in the Bering Sea Region. An Assessment Conducted by the International Arctic Science Committee under its Bering Sea Impacts Study (BESIS). Results of a Workshop at Girdwood, Alaska, September 1996. Center for Global Change and Arctic System Research, University of Alaska Fairbanks, 40 pages.

Implications of Global Change in Alaska and the Bering Sea Region. Proceedings of a Workshop at the University of Alaska Fairbanks on 3–6 June 1997. Eds. Weller, G. and P. Anderson, Center for Global Change and Arctic System Research, University of Alaska Fairbanks, 152 pages plus appendices.

Assessing the Consequences of Climate Change for Alaska and the Bering Sea Region. Proceedings of a Workshop at the University of Alaska Fairbanks, 29–30 October 1998. Center for Global Change and Arctic System Research, University of Alaska Fairbanks (in press).

Impacts of Global Climate Change in the Arctic Regions. Report from a Workshop on the Impacts of Global Change, 25–26 April 1999, Tromsø, Norway. Eds. Weller, G., and M. Lange. Published for International Arctic Science Committee by Center for Global Change and Arctic System Research, University of Alaska Fairbanks, 59 pages.

Measurements throughout this publication are given in medieval units (feet, miles, °F, etc.), followed by scientific metric units in brackets.

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Jack Ahgoot and Raymond Paneak ice fishing, Chandlar Lake, 1947

Executive Summary

Alaska is vulnerable to climate change. Climate trends over the last three decades have shown considerable warming. This has already led to major impacts on the environment and the economy. If present climate trends continue these

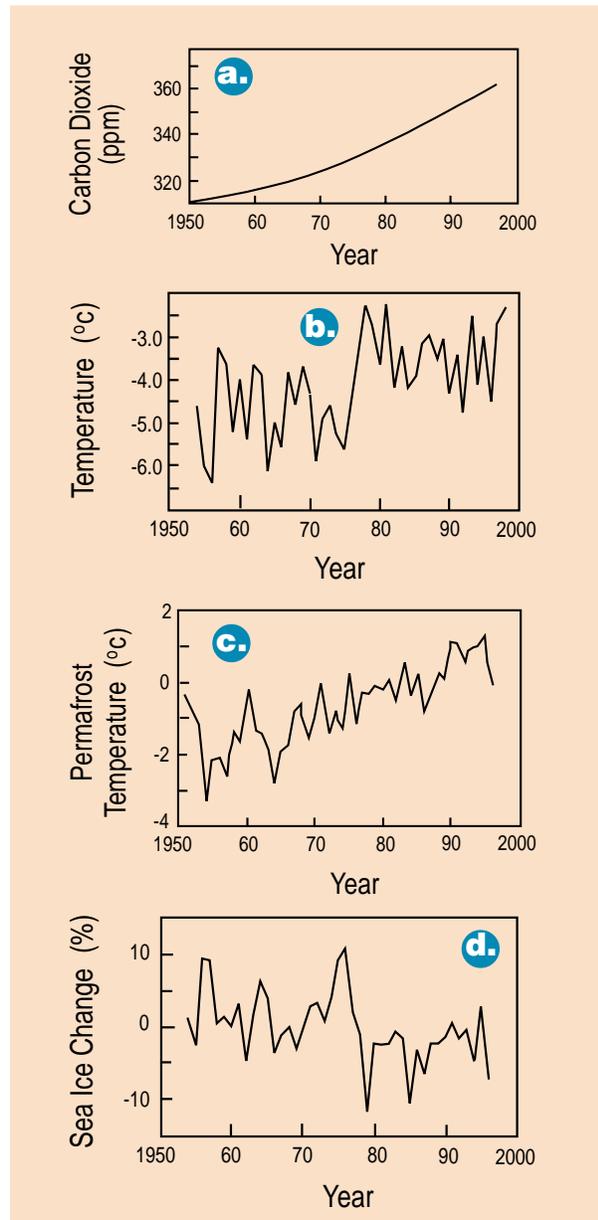


Fig. 1. Climate and climate-related trends in Alaska. a) CO₂ at Barrow, Alaska (smoothed), b) annual mean temperature composite from Anchorage, Fairbanks, Nome and Barrow, c) permafrost temperatures at Fairbanks, d) change in sea ice extent (%) in the Bering Sea.

impacts will be exacerbated and will hit the state's strongly natural resource-dependent economy hard. In Alaska there are few cities and many rural communities. Predominant economic activities include oil production along the Arctic coast (20% of total U.S. production), fishing in the Bering Sea and off the south coast, forestry in the southeast, agriculture and forestry in the interior, and a growing tourism industry. Subsistence livelihoods in Native communities throughout the state depend on fish, marine mammals and other wildlife, and play a very important social and cultural role.

Alaska's ecosystems are also threatened. They range from cool spruce-hemlock forest in the southeast and south-central coastal regions to boreal spruce forest in the interior and south-central region. Further north, tundra meadows and barrens dominate. Large areas of land are set aside in national parks, wilderness areas, and nature preserves. Small areas of land are in agriculture, with rather larger areas used for pasture and reindeer grazing. The marine ecosystems of the Bering Sea and Gulf of Alaska are among the most productive in the world and are highly susceptible to climate change.

Observed Climate Trends

Alaska's enormous size encompasses extreme climatic differences. The southern coastal margin is climatically similar to the Pacific Northwest, although cooler and with longer winters. North of the Alaska Range, the climate is continental, with moderate summers, very cold winters, and annual precipitation of 8–16 in (20–40 cm). North of the Brooks Range, an arctic semi-arid climate prevails, with less than 8 in (20 cm) of annual precipitation and snow on the ground for nine months of the year. There are widespread areas of permafrost and large glaciated areas throughout the state, and extensive sea ice along the western and northern coasts.

Alaska has experienced the largest regional warming of any state in the U.S., with a rise in average temperature of about 5°F (3°C) since the 1960s and 8°F (4.5°C) in winter. Records from some regions show a warming of nearly 3–4°F (1.5–2°C) quite suddenly in the late 1970s (Fig. 1). There has been extensive melting of glaciers, thawing of permafrost and reduction of sea-ice. The Alaskan regional

warming is part of a larger warming trend throughout the Arctic. The large observed warming has been accompanied by increases in precipitation of roughly 30% between 1968 and 1990. Alaska is also strongly affected by El Niño and the interdecadal Arctic Oscillation, bringing warmer and wetter winters to coastal Alaska in their warm phases, and cooler, drier winters in their cool phases.

Scenario of a Future Climate

Climate projections suggest a continuation of the strong warming trend of recent decades, with the largest changes coming during winter months. In the models used in this assessment, warming of approximately 3–5.5° F (1.5–3°C) is projected by 2030 with 9–18° F (5–10°C) warming by 2100. The models also show Alaska getting wetter, with larger increases in northern and western Alaska and smaller increases or possibly decreases in the southeast. The reduction or loss of snow and ice has the effect of increasing the warming trends as reflective snow and ice surfaces are replaced with darker land and water surfaces that absorb more solar radiation. As a result, one of the two models analyzed in this study projects near-total melting of arctic sea ice by 2100. Large winter warming in Alaska will likely accelerate already evident trends of a shorter snow season, retreat and thinning of sea ice, thawing of permafrost, and accelerated melting of glaciers.

A Key Issue: The Melting of Snow, Ice and Permafrost

Alaska has undergone a marked reduction in extent and duration of snow cover, shorter seasons of river and lake ice, melting of mountain glaciers, retreat and thinning of sea ice, retreat of permafrost and increased depth of its active layer. The thawing that Alaska has already experienced has brought major ecological and socioeconomic impacts, which appear likely to be emblematic of further changes under projections of continued greenhouse-induced warming. Thawing and northward movement of the permafrost line over the past several decades has required costly road replacement, increased maintenance costs for pipelines and other infrastructure, changed forests to bogs and grasslands, and increased slope instabilities. Reduced sea-ice along Alaska's coasts has allowed increased coastal erosion and increased vulnerability to storm surges, but has also the potential of benefiting shipping and offshore petroleum exploration.

Forests and Agriculture

Warmer temperatures have brought some northward expansion of boreal forest, as well as significant increases

in fire frequency and intensity, unprecedented insect outbreaks, and a 20% increase in growing-degree days, the latter having benefited both agriculture and forestry. Both the expansion of forests and their increased vulnerability to fire and pest disruption are expected to increase. One projection shows a 200% increase in the total area burned per decade, leading to a deciduous forest-dominated landscape on the Seward Peninsula, presently dominated by tundra vegetation.

Marine Ecosystems and Fisheries

Recent observations of climate-related changes in the Bering Sea showed abnormal conditions during 1997–1999. The changes observed include extreme die-off of seabirds, rare algal blooms, abnormally warm water temperatures, and very low numbers of returning salmon. While some of the changes observed in the 1997 and 1998 summers, such as warmer than usual ocean temperatures and altered currents and atmospheric conditions, might have been caused by El Niño, the area has been undergoing change on a much longer time scale going back several decades. Over that period one species of sea lion, for example, has declined by between 50% and 80%. Northern fur seal pups on the Pribilof Islands—the major Bering Sea breeding grounds—have declined by half between the 1950s and the 1980s. In parts of the Gulf of Alaska, harbor seal numbers are as much as 90% below what they were in the 1970s. There have been significant declines in the populations of some seabird species, including common murre, thick-billed murre, and red- and black-legged kittiwakes. Also, the number of returning salmon was far below expected levels, the fish were smaller than average and their traditional migratory patterns seemed to have been altered. Further impacts of climate change on Alaska's fisheries can be expected as the climate continues to warm.

Subsistence Livelihoods

Subsistence livelihoods are already being threatened by multiple climate-related factors, including reduced or displaced populations of marine mammals, seabirds and other wildlife, and reduction and thinning of sea-ice, making hunting more difficult and dangerous. Diverse forms of subsistence livelihoods that sustain Native communities depend on fish, marine mammals, and other wildlife, and include trapping, fishing and reindeer herding. They play a social and cultural role vastly greater than their contribution to monetary incomes.

