

Assessing Climate Change: Did We Get it Right?

by Glenn Patrick Juday

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Introduction

Fairbanks, Alaska, January 1981.

The midwinter days are only about four hours long, and there is no particular warmth in the sun that will struggle a few degrees above the horizon near noon. As another workday begins, across the town curtains remain closed in residences because the inside lights would illuminate the household to the dark world outside. But groggy residents sitting down to breakfast hear a succession of strange sounds. There are muffled thumps and whooshing sounds, gurgles and splats. It's oddly familiar, but a bit distant in the memory of the residents too. People begin to flip on exterior lights and peek out to investigate what's happening in the dead of the subarctic winter.

It's a thaw. And not just a weak, barely above freezing thaw, but a well-above freezing spell that sets in and stays. First the snow accumulated in tree crowns sags, then falls to the ground with a thump. Then the branches of spruce trees spring back, uncompressed, flinging through the air with a whooshing sound. Then a drip line develops along the edge of roofs. Finally, snow and ice are falling and gurgling everywhere. It's a thaw. Only it's not spring. Snow and ice are returning to liquid form at the time of year with the lowest mean daily temperatures. What's happening?

Air from the mid-Pacific is rushing down the slopes of the north side of the Alaska Range, scouring out the normally stagnant pools of cold that develop on the floor of the Tanana Valley, and bathing the far north in extravagant warmth. This year, the mean monthly temperature in Fairbanks for January ends up 30.0° F (16.7° C) above normal—one of the warmest if

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not the warmest above-normal for any weather station in the history of North America. The immediate cause of this temperature increase is a circulation-driven

chinook (a southerly, downslope mountain wind), not direct greenhouse warming. But, after reports and hypotheses that the planet might warm as the result of carbon dioxide produced by humans accumulating as a greenhouse gas in the atmosphere, and that the warming would appear first in the Arctic—people wondered—is this spectacularly unusual warmth a signal of things to come?

The Conference

April 1982, Fairbanks.

A group of Alaska scientists and academicians led by the UAF Agricultural and Forestry Experiment Station (AFES) convene a national conference on The Potential Effects of Carbon Dioxide-Induced Climate Changes in Alaska. The Alaska Humanities Forum provides crucial financial support.

Although climate change research and assessment in 2006 is a minor industry at regional, national, and international levels, in 1982 there were few sources of support for an effort to pull together scholars across disciplines and look seriously at what the climate change issue would mean for society. Today it's hard to even catalog the notices of the meetings, workshops, task forces, and presentations.

In 1984, AFES published proceedings of the conference (McBeath et al. 1984), which contained papers from national experts and Alaska investigators and scholars. These academicians in the natural sciences, social sciences, resource management, and the humanities were in the best position to examine the past record of climate change, risks, vulnerabilities, and opportunities from climate change, and especially the potential effects of future climate change.

But a crucial question even today is whether academicians collectively are any good at assessing the climate change future. The 1982 Alaska conference

was one of the first regional meetings with this ambition in the climate change field. Considering the twenty-four years of events that followed, what can we say now compared to then? In other words, “Did we get it right?”

What follows are highlighted quotes from individual chapters in the 1982 conference proceedings, followed by an updated 2006 consensus in the literature. It is beyond the scope of this article to cite all of the conference papers and all of their major assertions, forecasts, or projections. But the papers that have been cited offer a good cross-section of the subjects covered and some statements that represent a good test of whether the view of the future offered back then was accurate or useful. The work of climate change assessment is now stretching out into a multigenerational effort, and a retrospective such as this one may be helpful for those who need to listen, ponder, and decide in the future.

The Chapters

Atmospheric and Oceanographic Measurement Needed for Establishment of A Data Base (Charles Keeling)

1982 Conference Quote: “The plotted values [of carbon dioxide at the Mauna Loa Observatory—ed.] range from 312 parts per million at the beginning of the record to about 340 parts per million at present.”

2006 Update: Atmospheric carbon dioxide concentration in early 2006 was nearly 380 parts per million (<http://www.cmdl.noaa.gov/ccgg/iadv/>). A half-century ago, when observations were first made at Mauna Loa in 1958, the year-to-year increase was about 1 part per million. Over the last decade the average annual increase was about 1.8 parts per million, with a most recent annual increase of about 2.2 parts per million.

Possible Effects of a Global Warming on Arctic Sea Ice, Precipitation, and Carbon Balance (Will Kellog)

1982 Conference Quote: In describing the results of a climate model “It can be seen that by the year 2000 the average global surface temperature could be warmer than at any time in the past 1000 years or more, ...”

2006 Update: The model results are supported by actual events. The Intergovernmental Panel on Climate Change concluded that “the rate and magnitude of global or hemispheric surface 20th century warming is likely to have been the largest of the millennium, with the 1990s and 1998 likely to have been the warmest decade and year” (IPCC 2001). The year 2005 had the highest global surface temperature in more than a century of instrumental data in the Goddard Institute for Space Studies (GISS) annual analysis, but the small amount by which it exceeded 1998 is within the margin of error (<http://data.giss.nasa.gov/gistemp/2005/>).

1982 Conference Quote: “In summary, then, what we can say about the Arctic Ocean ice pack is that theory (models) tells us that the Arctic Ocean will become ice-free in summer with a relatively modest [5 degrees C, ed.] warming, one that could occur very early in the next century, ...”

2006 Update: This projection is well supported by events. During the period 1979–2004, Arctic Ocean sea ice extent at the end of the melt season (September) declined by 7.7 percent per decade (Stroeve et al. 2005). In September 2005, sea ice in the Arctic reached a record minimum exceeding the previous record of 2002 (Serreze et al. 2003), more than 14 percent lower than the 1978–2000 mean. In the past, a low ice year would be followed by a rebound to near-normal conditions, but the three years since 2002 have been consistently low-ice years. The maximum amount of sea ice in the Arctic winter has fallen by six percent over each of the last two winters, as compared to a loss of merely 1.5 percent per decade on average annually since the earliest satellite monitoring in 1979. This is happening as summer sea ice continues its retreat at an average of ten percent per decade (http://www.nasa.gov/centers/goddard/news/topstory/2006/seaiice_meltdown.html).

1982 Conference Quote: “...if the tundra and taiga grow [increase in net growth, ed.] due to the increased temperature and longer growing season, this will take CO₂ out of the atmosphere and incorporate it into additional biomass. If, on the other hand, the material in the surface is dried out and oxidizes or decays, this will add CO₂ to the atmosphere. The result of the first would be a negative net feedback, and the result of the second would be a positive feedback that would accelerate the buildup of CO₂ and the consequent warming.”

2006 Update: Results since 1982 largely support a decrease in Alaska boreal forest growth, contributing to a large positive feedback to warming. Ground-based studies of tree growth across the boreal region of Alaska find that, surprisingly, summer warming causes a strong decrease in aboveground tree growth (and thus carbon uptake) in all the major tree species on several, but not all, site types (Juday et al. 2005).

- A spruce budworm outbreak, apparently enabled by warm early summers for several years, caused significant damage in productive forests in Interior Alaska in 2006.

- The pattern in time and location of decline (widespread stand-level tree death on hundreds of thousands of acres) of Alaska yellow cedar, Alaska’s most valuable timber tree, matches a model of the effects of winter warming.

Studies based on satellite remote sensing find that net surface photosynthesis actually decreased across most of the North American boreal forest during the period 1982–2003, with a particularly strong decrease in

Alaska. Most of the North American tundra grew more during the same period (Goetz et al. 2005). The Alaska tundra largely has become greener during since then. During the twentieth century, growing season length in central Alaska increased by at least fifty percent.

- Growing season 2006 was interrupted in early June by a frost in Fairbanks (not a record). But the date of first fall frost was the second latest in the 103-year record. It seems that while cold anomalies still happen, they are weaker, less frequent, and fewer in number than the positive temperature anomalies.

Temperature Trends in the Alaska Climate Record; Problems, Update, Prospects (Glenn Juday)

1982 Conference Quote: "...calendar year 1981 had the highest or second-highest mean annual temperature (MAT) in the record. Winter temperatures across much of the state have been especially high since the winter of 1976-77."

2006 Update: Fairbanks MAT has been high since 1977, but has not quite surpassed the 1981 value. The abrupt increase in temperatures in much of western North America that occurred from 1976 to 1977 and which largely has been sustained since, is now widely recognized. The 1977 climate change was so pervasive and powerful that it has been given the name "regime shift." (Ebbesmeyer et al. 1984, Miller et al. 1994).

1982 Conference Quote: "[Fairbanks] Summer temperatures have been warming but the trend may have passed its peak in 1980-81."

"Fairbanks warm season temperatures have continued to increase"

2006 Update: Fairbanks warm season temperatures have continued to increase, and even cool intervals such as those in 1984-85, 1992, and 2000-2003 were not as cold as earlier in the century. Mean temperature of the 2004 warm season set a record in the 102-year series.

1982 Conference Quote: "...an apparent correlation exists between the solar cycle and Alaska temperature trends. ... The hypothesis would then predict that the true direction of Alaska MAT trend would be downward to the mid-80s, and that MAT would peak again in the early 90s. ... If, as expected, CO₂ effect begins to overwhelm the natural range of climate variability between now and the end of the century, Alaska would experience a stairstep increase in temperatures, the peaks of which would reach unprecedented highs. A weak cycle peak in the early 1990s might delay the setting of new records until the expected temperature peak of the

2000-2010 decade. ... The 1980s to early '90s will be an interesting, and potentially important time to be observing Alaska's weather."

2006 Update: The tendency of Alaska MAT to follow a nine- to thirteen-year solar cycle was not as well defined in the last decades of the twentieth century compared to earlier decades, although temperatures did in fact decrease in the mid-1980s and increase in the early 1990s. Future trends could clarify whether the sustained high values since the early 1980s represent the end of strong decade-like cycles, or a staircase increase of a strong warming trend superimposed on continuing cycling behavior.

"The temperature of permafrost near the ground surface...shows a significant warming trend during the last thirty years. ...at some sites long-term permafrost thawing has started"

Potential Impact of a Warmer Climate on Permafrost in Alaska (Tom Osterkamp)

1982 Conference Quote: "It is clear that a warming of +3°C in Alaska would cause widespread thawing of permafrost in the discontinuous zone and substantial changes in the continuous zone. ... The degree of impact would hinge on the exact magnitude of the temperature change and the time scale over which it occurs. While these factors cannot be predicted accurately, the present evidence suggests that warming is likely to begin soon."

2006 Update: The temperature of permafrost near the ground surface in different long-term records in northern regions, especially between 55° and 65° North, shows a significant warming trend during the last thirty years. In Alaska the recent climate warming has brought soil temperatures very close to 0°C or thawing, and at some sites long-term permafrost thawing has started (Osterkamp et al., 2000; Osterkamp and Romanovsky 1999).

Observed and Predicted Effects of Climate Change on Wolverine Glacier, Southern Alaska (L.R. Mayo and D.C. Trabant)

1982 Conference Quote: "A small but hydrologically significant shift in climate occurred during the study period of 1967-1981 in the glacier-clad mountains of southern Alaska. Air-temperature and glacier snow-and-ice

balance measurements taken continuously show that air temperature increased abruptly in 1976 and was accompanied by substantial glacier growth.”

2006 Update: Changes in the amount of ice in Wolverine Glacier are mainly the result of changes in moisture brought into the region by the averaged wintertime air circulation. Many other Alaska glaciers respond to summer temperatures. Using 1965 as the reference level, the cumulative change in Wolverine glacier by 2004 was equivalent to the loss of 15 m of water over the area of the glacier (http://ak.water.usgs.gov/glaciology/all_bmg/3glacier_balance.htm). From the mid-1950s to the mid-1990s, 67 measured Alaska glaciers lost 0.52 meters per year in thickness. The estimated loss in volume of all Alaska glaciers during that time is 52 cubic kilometers per year (water equivalent), equal to a rise in world sea level of 0.14 mm/year. (Arendt et al. 2002).

Some Aspects of Vegetation and Temperature Relationship in the Alaskan Taiga (L.A. Viereck and K. Van Cleve)

1982 Conference Quote: “Higher average summer temperature with little or no change in precipitation would be expected to increase the frequency of naturally occurring wildfires in interior Alaska.”

2006 Update: The record high summer temperature of 2004 across most of Alaska was accompanied by a prolonged dry spell, and extreme warmth and drying occurred in the summer of 2005 also. The most extensive forest fires in the fifty-six-year Alaska record occurred in 2004, and 2005 was third highest in the series. The fires in those two years in Alaska and Yukon Territory burned an area equivalent to the nation of Ireland. Perhaps as much as one-fourth of all forest in the northeast quarter of Alaska burned in 2004 and 2005.

- A preliminary study by the Alaska Forest Health Survey detected dead and damaged birch trees in southcentral and interior Alaska that apparently match predictions of the likely effects of the record warmth of the summers of 2004 and 2005.

The Impact of Increased Air Temperature on Tundra Plant Communities (F.S. Chapin)

1982 Conference Quote: “An increasing air temperature is likely to exert its most important effects through changes in length of growing season rather than through direct temperature effects. ... The greatest unknown in the picture of increased carbon dioxide is water availability...water stress will lead to reduced photosynthesis and respiration.”

2006 Update: In Alaska north slope locations where temperature increases have been accompanied by drying, tundra has become a net

source of stored carbon moving into the atmosphere (Oechel et al. 1993, 2000). Where arctic climates have become warmer and wetter, tundra has been responsible for a net uptake of carbon from the atmosphere (Chapin et al. 2000). Across the Arctic moisture changes that have accompanied temperature increases have been regionally variable and so the carbon loss or gain of tundra has been variable, and net sum of the changes have not amounted to a major loss or gain of carbon to date (McGuire et al. In press).

Sea Ice, Carbon Dioxide, and Climate (Gunter Weller)

1982 Conference Quote: "...processes of antarctic sea ice...are complicated by various feedback mechanisms, and carbon dioxide mechanisms are difficult to quantify against a noisy background..."

2006 Update: For the period 1973-2002 there is either no trend in antarctic sea ice coverage (Pielke et al. 2004), or a slight overall increase. While the Antarctic Peninsula has continued to warm, the Antarctic continent has not warmed over the past two to three decades (Thompson and Solomon 2002).

Carbon Dioxide: Scientific Puzzle, Political Dilemma (George Woodwell)

1982 Conference Quote: "...solutions to this problem are closely related to solutions to other major environmental and economic issues. The carbon dioxide problem is part of the global problem with the management of resources of energy. Steps that result in reducing the total amount of fossil fuels burned...contribute as well to amelioration of...other problems."

2006 Update: Fossil fuels have remained the predominant portion of the mix of energy resources in Alaska, the U.S., and the world. Carbon dioxide releases are accelerating. Some progress has been made on individual environmental quality goals, such as new awareness, data, and policies for maintaining biodiversity resources, but the consequences of the use of fossil fuels and the greenhouse gasses they release have become more detectable, numerous, and challenging.

Overview

In retrospect, most of the positive assertions that the scientists felt they were able to make at the 1982 conference were close to the course of actual events twenty-four years later. Some directions of change, such as overall carbon storage or release, are still not clear because they result from a huge number of individual changes in soils and organisms that are still occurring. And some events and changes caused by high temperatures that are of great interest and importance in managing resources and the environment,

“most of the positive assertions...
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such as forest fires and large-scale tree death from insect outbreaks, were not a focus of attention. But, in a subject matter that is prone to controversy and intense debate about appropriate public policy measures, the scientists and other academicians who gathered twenty-four years ago can be seen as a generally reliable source of information when judged by the most demanding and inflexible standard of all—reality.

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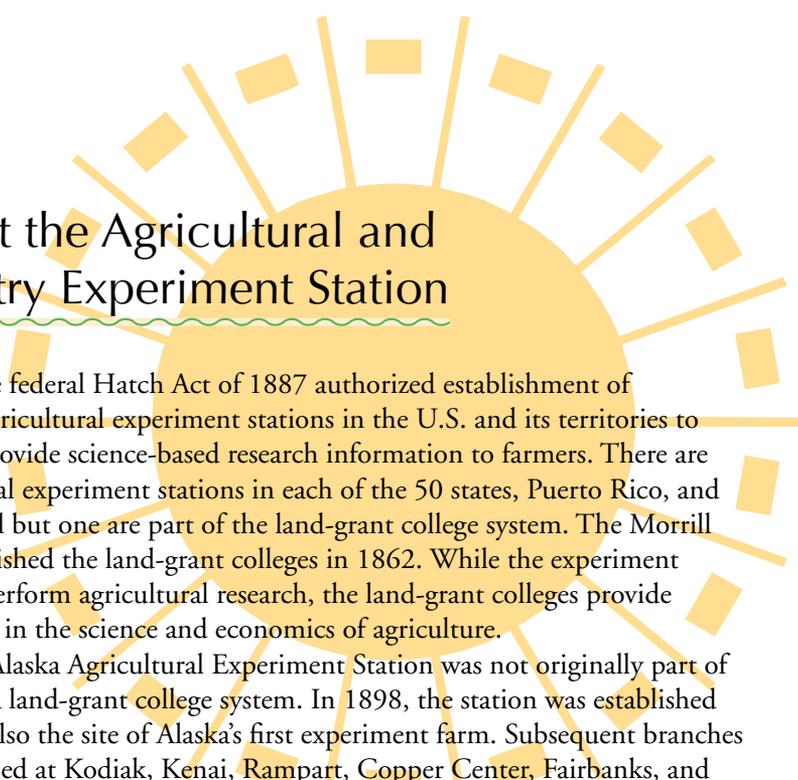
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About the Agricultural and Forestry Experiment Station

The federal Hatch Act of 1887 authorized establishment of agricultural experiment stations in the U.S. and its territories to provide science-based research information to farmers. There are agricultural experiment stations in each of the 50 states, Puerto Rico, and Guam. All but one are part of the land-grant college system. The Morrill Act established the land-grant colleges in 1862. While the experiment stations perform agricultural research, the land-grant colleges provide education in the science and economics of agriculture.

The Alaska Agricultural Experiment Station was not originally part of the Alaska land-grant college system. In 1898, the station was established in Sitka, also the site of Alaska's first experiment farm. Subsequent branches were opened at Kodiak, Kenai, Rampart, Copper Center, Fairbanks, and Matanuska. The latter two remain as the Fairbanks Experiment Farm and the Matanuska Experiment Farm. The USDA established the Fairbanks experiment station in 1906 on a site that in 1915 provided land for a college. The land transfer and money to establish the Alaska Agricultural College and School of Mines was approved by the U.S. Congress in 1915. Two years later the Alaska Territorial Legislature added funding, and in 1922, when the first building was constructed, the college opened its doors to students. The first student graduated in 1923. In 1931, the experiment station was transferred from federal ownership to the college, and in 1935 the college was renamed the University of Alaska. When campuses were opened at other locations, the Fairbanks campus became the University of Alaska Fairbanks.

Early experiment station researchers developed adapted cultivars of grains, grasses, potatoes, and berries, and introduced many vegetable cultivars appropriate to Alaska. Animal and poultry management was also important. This work continues, as does research in soils and revegetation, forest ecology and management, and rural and economic development. As the state faces new challenges in agriculture and resource management, the Agricultural and Forestry Experiment Station continues to bring state-of-the-art research information to the people of Alaska.

Agricultural and Forestry Experiment Station

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