

Monitoring Seasonal and Long-term Climate Changes/Extremes in the Central Alaska Network



Central Alaska Network
Denali National Park & Preserve
Wrangell-St. Elias National Park & Preserve
Yukon-Charley Rivers National Preserve



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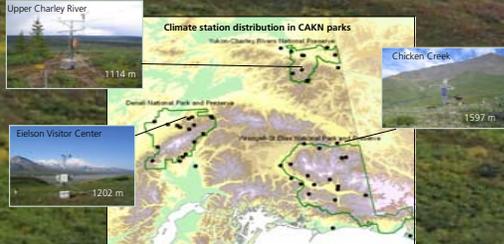
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Introduction

Climate is a primary driver of ecological change in the Central Alaska Network (CAKN) which includes Denali National Park and Preserve, Wrangell – St. Elias National Park and Preserve, and Yukon – Charley Rivers National Preserve. In 2003 we began the design of a regional climate monitoring strategy that included comprehensive site evaluations, formal protocol development, and 15 new monitoring sites, including two SNOTEL sites. CAKN has sought assistance and advice from the Western Regional Climate Center (WRCC) and Dr. Richard Keen to produce a climate station inventory and baseline climate data analysis for the region. The initial results highlight relationships between the available long-term station data and climate indices affecting the region.

Study Area

- 21 million acres in central Alaska, spanning 12 ecoregions
- Elevations range from 0 m to 6194 m (Mt. McKinley)
- Northern boundary at 65 degrees north latitude



New high elevation sites highlighted. Note: Sites >1000m are considered high elevation in AK.

Methods

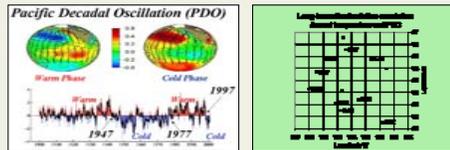
Climate data from approximately 99 climate stations, 61 snow monitoring stations, and 36 Remote Automated Weather Stations (RAWS) within and near the three units of the CAKN have been documented, tabulated, summarized, and analyzed to provide a record of past climate changes and fluctuations over the period of record, 1899-2006. The data and analysis provide baseline normals and averages to help assess future climate variations, and give some insight to the possible causes of the climate variations. Analysis and results are based on long-term data sets or a combination of stations – there are 9 time series >82 years.



Results

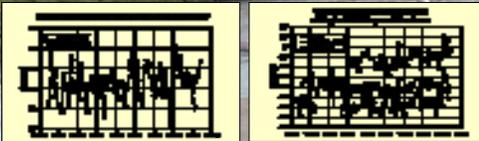
Temperature:

Best correlation between regional temperature and climate indices is:
• Winter temperatures and winter (DJF) PDO: R=0.80

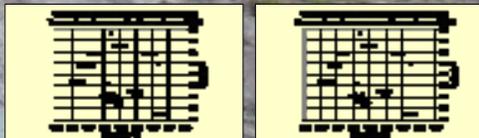


- Summer temperatures are not significantly correlated with any circulation indices.
- Temperature departures tend to be fairly consistent across the region.
 - Correlations for summer (June-August) temperatures over the period of record, between the individual long term stations and the average of all nine range from 0.65 to 0.89.
 - Correlations for winter (December-February) temperatures, are even better, ranging from 0.84 to 0.94.
 - Correlations for annual mean temperatures range from 0.77 to 0.92.

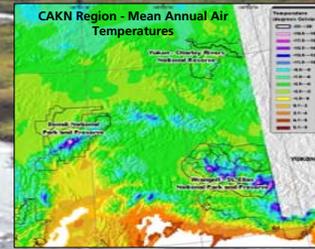
Other indicators of climate change are extremes, such as the highest temperature recorded each year at a station, or the lowest temperature recorded over the winter:



The following sequence of maps shows the spatial distribution of temperature anomalies (departures from the 1971-2000 normals, degrees F) for the long-term stations in the CAKN region during a selection of extreme years.



The mean annual temperature for most of CAKN is near the freezing point. In many places only a small shift in temperatures will change the climatic regime from one where temperatures are near freezing to one where temperatures are slightly above freezing. This is most relevant to the southern areas of Wrangell – St. Elias where there are many large glaciers and the Bagley Icefield.



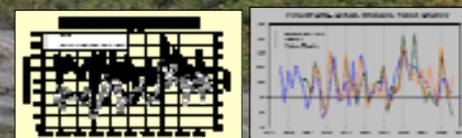
Precipitation:

The most consistent long-term precipitation record is from 61 SNOTEL and snow course sites and the long-term COOP site McKinley Park. The following table lists correlations between the yearly SWE at the three CAKN units, and the three-unit average, with three climate indices.

	Correlation of CAKN Snow Water Equivalents with Climate Indices			
	Arctic Temp 64N-90N	NP Nov-March	AO/NAM Dec-March	PDO Dec-March
Wrangell-St Elias	0.08	0.25	0.22	-0.11
Denali	-0.02	0.46 **	0.37 *	-0.37 *
Yukon-Charley	0.16	0.38 *	0.37 *	-0.29
Average	0.06	0.39 **	0.29	-0.31 *

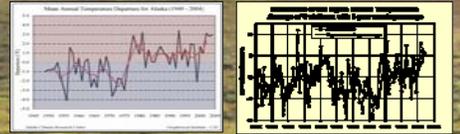
With approximately 40 years of data, correlation coefficients of 0.30 and 0.39 are significant at the p=0.05 and p=0.01 levels, respectively. The best correlation on the grid is between Denali SWE and the NP and PDO indices, indicating that a weaker Aleutian Low is linked to greater snowfall at Denali (and to a lesser extent, Yukon-Charley).

Annual variations are coherent between the three parks.



1976 regime shift:

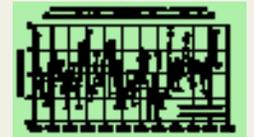
The trends that have shown climatic warming tend to be strongly biased by the sudden shift in 1976 from the cooler regime to a warmer regime. When analyzing the total time period from 1951 to 2001, warming is observed, however the 25-year period trend analyses before 1976 (1951-1975) and thereafter (1977-2001) both display cooling, with a few exceptions.



Period of record makes a difference in how the data are analyzed

Average annual temperatures (F) for nine long-term Alaskan stations during the three PDO regimes of the past century:

- 1923-1945 - 31.7°
- 1946-1976 - 29.9°
- 1977-2004 - 32.0°



Although the decades since 1977 have averaged two degrees F warmer than the previous three decades, those decades were in turn two degrees F colder than 1923-1945. Therefore, the net change in temperature since 1920 is less than 0.5 degree F.

Summary

- Temporal variability is of great significance for CAKN, especially two modes – 1) variability on the half-century time scale (Pacific Decadal Variability) reflecting ocean behavior to the south, and 2) high latitude manifestations of climate change.
- The major control of variations of central Alaska's climate appears to be the Aleutian Low and the PDO. Any analysis or interpretation of Alaska's climate must take this into account.
- "Baseline" averages from one PDO regime will bear little semblance to the climate in the other regime.
- Parts of the Alaska Range and of the Chugach Range are near the mean annual freezing mark. In these zones, small changes that move temperature from below to above freezing have significant potential to affect mass balance of ice fields, and to affect the character of storms by increasing the ratio of rain to snow.
- Baseline analyses are based on long-term low elevation stations; new high elevation stations have been deployed in the past few years to fill in critical data gaps.

The next 10 years will be interesting – will we shift back to a cold regime?