Alaska Climate Teleconferences
Hosted by the Alaska Center for Climate Assessment and Policy

ALASKA CLIMATE VARIABILITY IN THE MODERN ERA
*Rick Thoman, National Weather Service*
Wednesday, January 21, 2009; 10:00-11:00AM (ADT)

SUMMARY
Written by Brook Gamble

We had over thirty participants, including representatives from Cook Inlet Keeper, Alaska Climate Research Center, Alaska Daily News, Fairbanks Daily News Miner, Denali National Park, Alaska Department of Transportation, Alaska Public Radio, National Center for Atmospheric Science, NOAA National Weather Service, National Marine Fisheries Service, Rural Community Assistance Corporation, Tetlin National Wildlife Refuge, and University of Alaska.

PRESENTATION
The teleconference presentation is available as a .pdf and podcast as an MP3 file on the ACCAP Climate Teleconference Website under "Archive of Past Conferences":
http://www.uaf.edu/accap/teleconference.htm

## ALASKA CLIMATE VARIABILITY IN THE MODERN ERA
***Rick Thoman, National Weather Service***

Weather is the short-term state of the atmosphere: days-months in duration. Climate is the long term statistics of weather- frequencies of events, thresholds, and extremes of weather events. To define climate, this includes a minimum of 3-5 decades of weather data. A sports analogy is to think of climate as a player's entire career. A season is a season in their career. Weather is an individual game in their career- you can't tell much about a player's career from one game or even one season- you need many years of games/seasons. To analyze climate, it isn't helpful to go outside and look at the weather right now. You need many years of weather to talk about climate trends.

Variation in instrumental climate data sets can be attributed to 1) variation in the way we have gathered the information and 2)physical changes or variation in the atmosphere.

Records of observational weather data in Alaska date back to before the purchase of Alaska by the U.S. There is some data, mostly on precipitation, from the Russian period. In 1867, the U.S. purchased Alaska. The number of weather observations increased, but before the 1890's, most weather observations were from coastal areas. Starting in 1898 with the Gold Rush, there were sustained weather observations throughout Alaska. The National Weather Bureau opened its first weather office in 1917 in Juneau and by 1930 there were 12 offices state-wide taking professional observations.

Sites with instrumental data go back to the 1920's. There are some areas with a lack of continuity in data to comprise a long-term climate data set. Interior, North East, Arctic, and Aleutians Alaska have the least amount of data. World War II contributed to the infrastructure that brought a continuous, long-term instrumental weather set for Alaska, from the 1940's on. These past 60 years allow us to look at climate changes over time. However, there are still gaps state-wide in weather data.

Standard measurements at weather stations now include daily precipitation, daily weather extremes, snowfall, snow depth in some places, wind, pressure, sky cover, humidity and sunshine.

The advantages of the instrumental data record of weather are that it is contemporary, recorded in real time, high-resolution, there is *theoretically* and ideally a standardized method of data collection. Problems with instrumental data in Alaska are that the data is not evenly distributed across the entire state and that human influences can interfere with the consistency and the quality of data. For example, locations of observing places have changed, changes have occurred in instrumentation and observing practices since the 1920's, and the time zone change in 1983 impact climate data for part of the year. People obviously use what they think are the best practices, but it is important to understand these differences in collection before you analyze data. The following two examples illustrate some of the potential pitfalls to using climate data in Alaska.

In Barrow, snow measurements are challenging to obtain because of the quality of 'dry' snow and the wind conditions that can confound the measurement. Records of liquid to snowfall ratio pre-1988 are low. Values after 1988, are significantly higher. The difference can be entirely attributed to changes in measurement practices.

Another example is a wind speed and direction anemometer deployed in Fairbanks in 1929. Initially, the equipment was deployed at approximately 90 feet high. When it was re-positioned to 30 feet in the mid 1950's, the readings changed drastically. The climate record shows that 9 of the 12 months of high wind records in Alaska occurred when the anemometer was deployed at the high spot. This ‘trend’ is entirely a factor of anemometer location, not physical weather variation.

Sensitivity to observational changes is not one-size fits all. Different places are sensitive to different measurements. All of Alaska is extremely sensitive to variation in topography, particularly in coastal areas that see extreme differences in, for example, snowfall, depending on the surrounding terrain and slight elevation changes.

Statistical significance is important to consider when looking at climate data. Statistical significance at a predetermined confidence interval, not just mathematical trends or charts that appear to show trends, must be taken into account to determine whether changes may be statistically attributed to anything other than random variation. The time frame in which the data were analyzed is also an important consideration.

Physical influences on climate variability in Alaska include El Niño Southern Oscillation (ENSO) and the Pacific Decadal Oscillation (PDO). The PDO is a multi-decadal variation in non-equatorial sea surface temperatures. It is likened to a northern latitude version of ENSO, but on a much longer time scale. There is a fairly strong correlation between Alaska weather and climate and the PDO. PDO was only ‘discovered’ in the mid-1990s, but has been back calculated. In the PDO index, positive values mean warmer than normal sea surface temperatures, while negative values mean cooler than normal temperatures.

What is happening now with the PDO? There is speculation that in the late 90’s we entered into a positive, or warm phase, but now some scientists speculate that we are plunging into a negative phase. The temperature correlation at Pacific coastal locations to PDO conditions is quite high- Interior locations are less so, and the Arctic doesn’t see as much correlation because of its distance to the Pacific and the mountain ranges in between. Precipitation is correlated to PDO to a much lesser extent. Temperature distributions are showing asystematic change. Despite the evidence that suggests that PDO is highly correlated with weather and climate in Alaska, not all weather or climate-related events can be tied to PDO. Going back through four phases of the PDO, positive *and* negative, from the 1920s to the present in Fairbanks, there is a positive liner relationship between year and an earlier start to summer.

Another physical impact of climate change in Alaska is the dramatic change in Arctic sea ice. Changes in precipitation, snowfall and instrumental weather aren’t the primary concern, in relation to sea ice. Issues of importance include increased storm events and erosion from increased wave action due to lack of ice cover [see summary of coastal erosion teleconference, October 9, 2007]. Since those can’t be directly measured with the instrumental record, a proxy may be average temperatures in Barrow, Alaska. The average temperature has skyrocketed to 2.5 degrees higher in the 90 year record. This change in temperature is directly attributable to an increasing lack of sea ice. As few as thirty years ago, sea ice was totally inshore by October. In the last few years, there was no sea ice inshore until November. Water vs. ice makes a big difference in the temperature record.

DISCUSSION

Q: Is the suggestion that the PDO is entering a negative phase based on the last few years of data or is their statistical information/scientific justification that backs up the assertion?
A: If we look at a long term set of data- 8-10 years of running means of the PDO index, it is just now getting back to 0 and is falling rapidly. This is the best internal evidence we have that the PDO is entering a negative phase/going through a phase shift.

Q: What will that mean?
A: We think it means that when the PDO is negative, we can expect cooler temperatures in Alaska, south of the Brooks Range. Again, this is climate- most of Interior Alaska has experienced the highest temperatures in Alaska on record in January. That is *weather*, not climate.

Q:You talked about the increased temperatures in Barrow being caused by a lack of sea ice. How can you say that one causes the other- don't they run together?
A: I wouldn't think so- pack ice is physically invected to the Arctic coast. Invection of the pack ice is historically the issue in Barrow.

Comment: Things in weather and short-term climate aren't isolated from one another. Do you agree?
A: Of course, it's all interconnected. That's what makes it so fun.

Q: Coming back to PDO, there's been a fair amount of progress in the last decade with respect to ENSO and trying to predict the onset of ENSO events. Is there anything similar on the horizon for the PDO? Do you think we'll reach a stage where we not only think the shift has occurred, but we may be able to predict when the shift may occur?
A: Not to the best of my knowledge. There are PDO experts on the line- please chime in. [no one does]

Q: Are systems like ENSO and PDO riding the larger wave that is climate change or are they more equals or is one below the other?
A: ENSO is primarily a short-term equatorial event 6 months to 3 years. It has secondary implications on the non-tropical Pacific. The PDO is a much longer time scale phenomena. There has been recent work done on correlating the two.

What does a warm + warm phase for both result in?? If there are larger scale climate change issues, this data is super-imposed on that- it is all tied together.

Q: What is the time scale in terms of years on the slides showed with PDO correlations between temperature and precipitation?
A: Data since the late 1946 phase shift- to include cold and warm PDO phases through 2005.One apparently full cycle with two phases [he initially said it was two full cycles, then corrected himself in later questions].

Q: If PDO has shifted, if there potential for sea ice recovery or is that too far gone?
A: Based solely on observations of temperatures in Barrow not being highly correlated with PDO, then no, there is apparently not potential for sea ice recovery. But the PDO doesn't work in isolation- there are also other issues.

Q: What is the magnitude of observational variability versus physical variability?
A: It is very site-dependent. Places in rural Alaska with limited changes in population will have some instrumentation issues but clearly have impacts that are on an order of magnitude less than urban places like Fairbanks where there are changes in observation location and population growth and the resulting anthropomorphic changes. You have to analyze data on a site-by-site basis.

Q: Can we use the past information on cycles/phases to extend the PDO record and predict it in the future? There is a lot of speculation as to whether Alaska is entering an extended cold phase. But someone at the Weather service told me that PDO is correlated with ENSO. What should we expect in the future? Will this next phase be an extended cold phase?
A: There has been work to extend the PDO record back into the 1600's using tree ring analysis. If you accept that method, which proves to be fairly tight, then 1947-1976 was an unusually strong cold phase. There is a lot of month to month variability in the "cold" and "warm" phases. However the PDO is a multi-decadal, longer term phenomena that is NOT directly tied to ENSO- ENSO is super-imposed on this and may be part of the driver, but ENSO is not the same thing.

Q: The drivers are fairly well defined in the model, presumably? What are the drivers?
A: When the PDO is in the warm phase, on a large scale and time frame that enhances low pressure in SW Alaska and Bering Sea and Aleutians. In the negative PDO, more high pressure occurs which results in more off shore wind and flow. South winds are wetter and warmer, north winds are cooler and dryer for mainland Alaska.

Q: Are the high pressure systems in rotation or counter-rotation with the earth? Is the spin aligned or random? Southcentral has been experiencing a shift of wind- there is a new, west wind that the Athabaskan language doesn't even have a name for. This is puzzling.

A: Low pressures spin counter clockwise and high pressure spins clockwise- this refers to winds in the atmosphere, however, not ground winds that are a factor, largely of topography.

Q: What goes into calculating the PDO index?
A: One number is derived. The index created from the mean sea surface temperature north of 20 degrees north, de-trended and then standardized.

Q: Do you know how many data points that might include? Is it buoy data? Satellite data?
A: Since 2002 it is satellite derived.

Q: There was an increase in observing sites since WWII. Is the fact that agencies like the FAA have taken over some of the sites?
A: Yes, it is another variable in the weather observing record. But we shouldn't point fingers at any particular agency.

Q: Do YOU believe we are in a cold phase? Is 1.5 cycles enough information to say that we have a pattern that is going to repeat itself. What would explain the 20-30 year pattern.
A: I believe we are- what has convinced me is the long term average over a decade. It isn't proof, but the very long-tem average shows little flip flops, historically. The tree ring analysis suggests multi-decadal cycles. Explanation for the drivers behind the pattern is unknown- there are lots of things going on and science doesn't know.