Recording the Trend: The Role of the Climate Monitoring Vital Sign in Understanding Park Ecosystems

By Pam Sousanes

Climate, by definition, is the long-term statistical expression of short-term weather. Climate will change in different ways, over different time scales and at different geographical scales. In the past few decades, climate change has been affecting the northern latitudes, including Alaska, more than any place on earth (*ACIA 2004*). Changes that have already taken place are evident in the decrease in extent and thickness of Arctic sea ice, permafrost thawing, coastal erosion, shrinking glaciers, and altered distribution of species (*IPCC 2007*).

Climate has been identified as one of the most important vital signs to monitor for the four National Park Service (NPS) Inventory and Monitoring (I&M) networks in Alaska. The climate varies tremendously as you travel from the maritime parks along the Gulf of Alaska, to the continental interior parks, to the Arctic parks along the Chukchi Sea. Models show that annual precipitation in the higher elevations along the southern coast can exceed 295 inches (7500 mm), while typical low elevation Interior Alaska sites record annual totals between 12-15 inches (300-400 mm) (*Figure 2*). Temperatures along the coast are moderated by warmer sea surface temperatures, while interior locations experience wide temperature fluctuations between seasons, with warm summers and cold winters. Multiple mountain ranges, local topographic features, and proximity to the ocean are all factors that influence the local temperature and precipitation patterns, which in turn drive the assemblage of flora and fauna found in the Alaska parks.

Figure 1. The 4,060 foot elevation climate station at Gates Glacier in Wrangell-St Elias National Park and Preserve is the highest station operating in the Wrangell Mountains, one of 25 deployed by the NPS from 2004-2009.

Climate patterns are key to understanding ecosystem processes, yet the available analyses, trends, and models for Alaska are based on relatively few observations. One of the fundamental ways the Alaska I&M program is helping to assess climate change is by deploying climate stations that record temperature, precipitation, wind speed and direction, soil temperature, relative humidity, snow depth, and solar radiation (*Figure 1*). These new climate stations are providing critical quantitative data for current and future research and management decisions.

Shifting baselines

An analysis of existing long-term climate data in central Alaska linked annual, and especially winter, air temperatures to atmospheric and oceanic circulations of the North Pacific Ocean (*Keen 2008*). One index that is particularly relevant to climatic trends in Alaska is the Pacific Decadal Oscillation (PDO), an index of sea surface temperatures. Typical winter sea surface temperatures during the warm phase of the PDO are warmer off of the Gulf Coast of Alaska moderating air temperatures over Alaska. Figure 3 illustrates that temperature trends that have shown climatic warming tend to be strongly biased by a sudden shift in 1976 from the cooler regime to a warmer regime (*Hartmann and Wendler 2005, Keen 2008, Wendler and Shulski 2009*). The PDO seems to cycle through a warm and cool phase every 20 -30 years.

While the north Pacific seems to explain some of the temperature trends in the region, the Arctic Ocean, and in particular the extent of sea ice plays a crucial role in the Arctic climate. Reduction of ice extent leads to warming due to increased absorption of solar radiation at the surface (*IPCC 2007*). Figure 4 shows the continued and significant reduction in the extent of the summer sea ice cover and the decrease in the amount of relatively older, thicker ice in recent years (*Richter-Menge and Overland 2009*). These are complex processes that have confounding effects; sometimes the expected does not happen, even if models predict a certain outcome, which is why weather observations in the parks are so important.

More stations, more data, better science

The available long-term climate records from the state are almost exclusively from low elevations, in populated areas near the coast, and along rivers. The NPS lands in Alaska encompass most of the mountainous areas of the

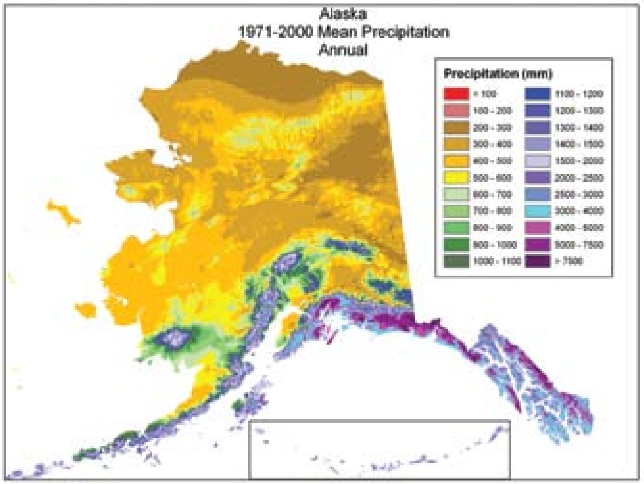

Figure 2. PRISM climate models combine observed climate measurements, landscape characteristics, and atmospheric circulation to create regional climate maps – such as this map showing mean annual precipitation for Alaska.

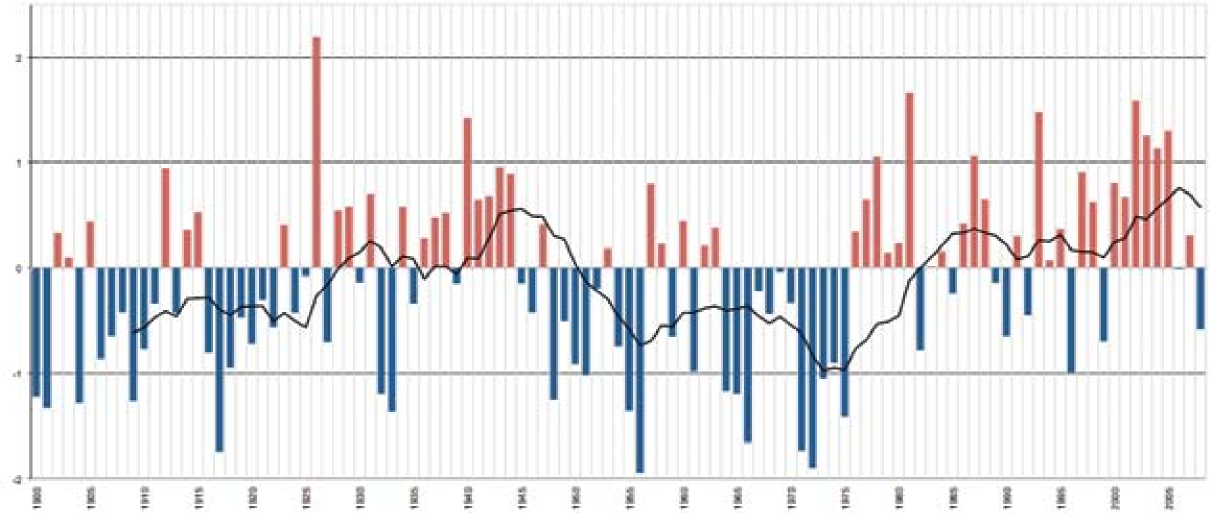

Figure 3. Mean annual temperature departure for Central Alaska; blue bars are negative and red bars are positive departures. The phase shift in the PDO is apparent as it shifts from a cool to warm phase in 1976.

state, and provide a great opportunity to fill in data gaps in the climate record. The Central Alaska Network (CAKN) and the Southwest Alaska Network (SWAN) were the first I&M networks in Alaska to implement monitoring programs; they partnered with the Western Regional Climate Center (WRCC), the National Weather Service, and others to develop robust, realistic methods for monitoring climate in remote and environmentally challenging areas.

The I&M networks share common goals and objectives to meet this challenge: to identify long and short term trends by monitoring and recording weather conditions at representative locations in the parks, a commitment to making these data available to everyone, and utilizing these data for larger-scale climate monitoring and modeling efforts. The CAKN and SWAN currently have 25 stations actively recording climate trends across 31.1 million acres of Alaska park lands (*Figure 5*). The Arctic and Southeast Alaska Networks, comprising another 22.6 million acres, are currently developing a detailed climate monitoring plan using the foundation established by CAKN and SWAN. This will result in installations of new stations in areas where data is critical, including the vast upland areas of the Arctic parks and the coastal areas in Southeast Alaska.

The climate monitoring program now has products available for use in understanding climate and ecosystem change, such as publicly accessible data and data analysis tools, climate summary maps, and reports summarizing annual climate factors and long-term trends (*Davey et al. 2006, Keen 2008*). The WRCC has been instrumental in disseminating and archiving the network climate data; these data flow systems are well established and secure, and dissemination is wide.

Into the Future

The focus for CAKN and SWAN over the next few years is to maintain the integrity of the new stations, promote the use of data for ecological and climatic analysis, improve data query tools, and integrate the NPS climate products with other climate change research and monitoring efforts. The NPS recently partnered with the PRISM (Parameter-elevation Regressions on Independent Slopes Model) Climate Group at Oregon State University to update the gridded monthly and annual precipitation and temperature data sets for Alaska for the 1971 - 2000 climate period. These maps help estimate variations in temperature and precipitation around existing climate stations and will be used to update the projected climate change scenarios for the national park units in the state. The current projections were modeled using older datasets. With the availability of new temperature and precipitation datasets, these models can be improved and refined.

The NPS has invested substantial time and effort to develop an effective and robust climate monitoring program that will answer critical questions about how the trends in temperature and precipitation are changing in Alaska national parks. These data will make a critical difference in our understanding of climate trends in Alaska over the next 50 years.

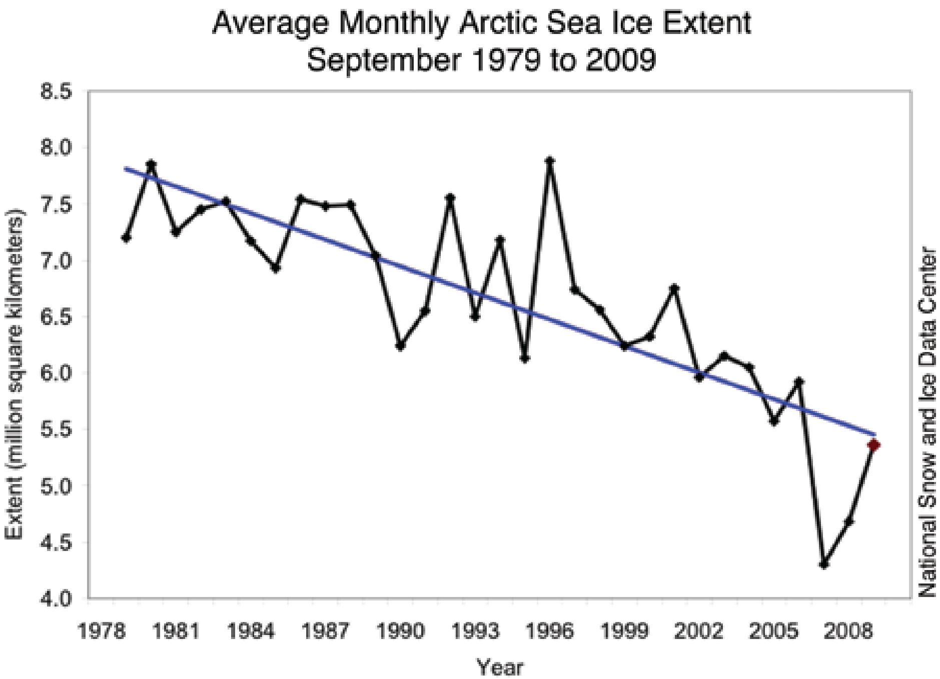

Figure 4. Average monthly sea ice extent has decreased steadily over the past 30 years, one of many contributors to rising terrestrial temperatures (Figure from the National Snow and Ice Data Center Sea Ice Index. Retrieved on November 1, 2009 from http:// nsidc.org/data/ seaice_index).

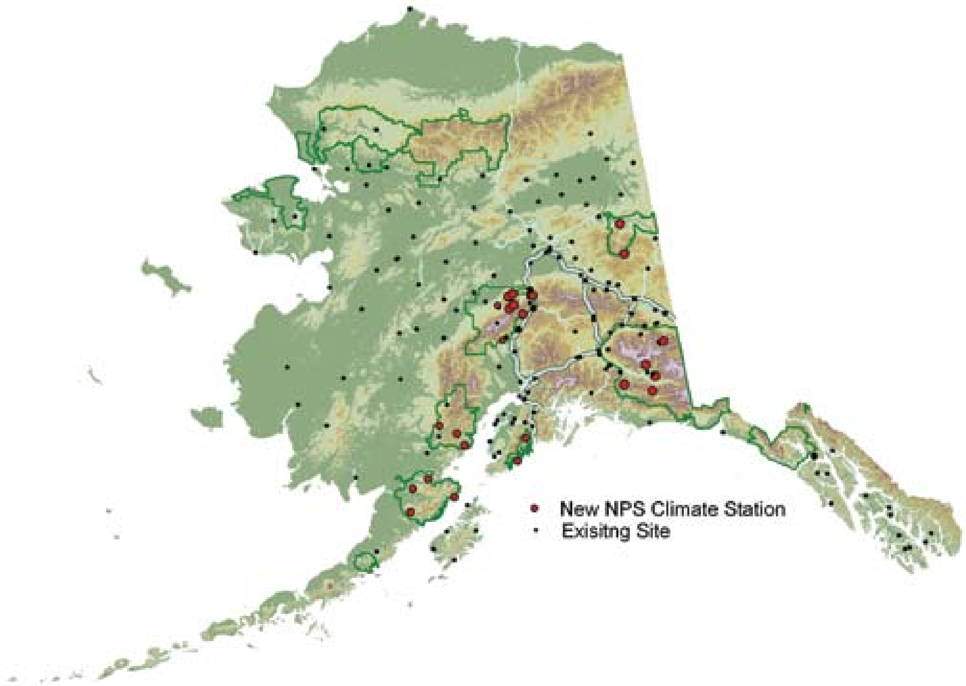

Figure 5. NPS lands in Alaska including terrain features and the location of the 25 new climate stations in the CAKN and SWAN networks.

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