National Park Service
U.S. Department of the Interior

Natural Resource Stewardship and Science

Annual Climate Summary 2010

Central Alaska Network

Natural Resource Data Series NPS/CAKN/NRDS—2011/199

ON THE COVER
Climate station at Gates Glacier Wrangell-St. Elias National Park and Preserve
Photograph by: NPS Photo by Pam Sousanes

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Pamela J. Sousanes

National Park Service
Central Alaska Network
PO Box 9
Denali Park, AK 99755

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Contents

Figures

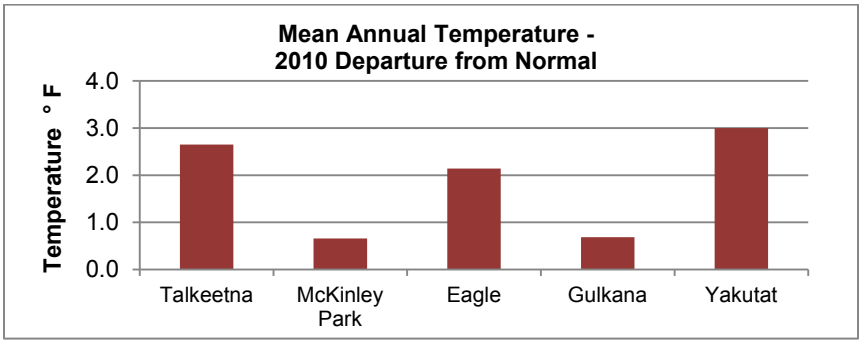
Page

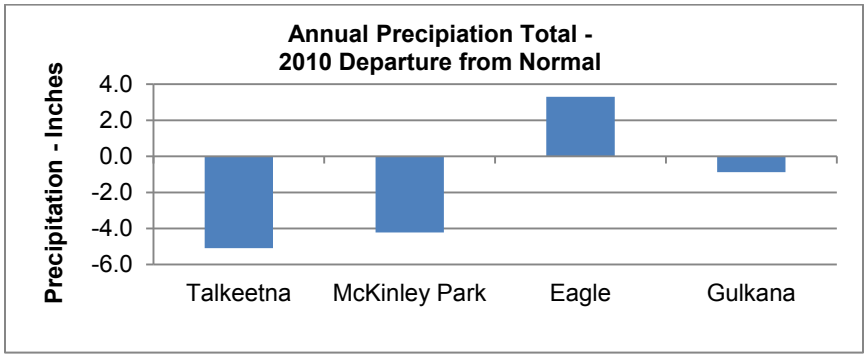
Tables

Page

Executive Summary

Using methodologies developed for the Central Alaska Network (CAKN), climate was monitored at existing National Weather Service stations and new CAKN climate stations in and around Denali National Park and Preserve, Wrangell -St. Elias National Park and Preserve, and Yukon-Charley Rivers National Preserve. Annual temperatures across the CAKN region were on average 1.8°F above normal. The strongest departures from normal occurred in February and November. February temperatures averaged 8.5 degrees warmer than normal and November averaged 6.7 degrees warmer than normal. There was quite a bit of variation in January monthly temperatures between sites; Denali Park temperatures were 6.2 below normal and Talkeetna had a 6.3 positive departure from normal. Yakutat also had a strong positive departure from normal in January at +4.7 degrees F. Spring temperatures across the region were about 3.2 degrees warmer than normal. June temperatures were near normal for most sites except for Yakutat which was 2.6 degrees F warmer than normal. July was cool at the northern sites, while Yakutat continued to have above normal temperatures. August was warmer than normal across the region. The fall season was on average 3.9°F warmer than the 1971-2000 average. The December of 2010 was cold. The temperatures ranged from 13 to 16 degrees F colder than normal at sites north of the Alaska Range. It was also 4.7 degrees colder than normal in Talkeetna and just below normal in Yakutat. The annual precipitation totals were well below normal at Talkeetna, McKinley Park, and Yakutat. Gulkana was near normal for 2010 and Eagle was the one site that had above normal precipitation for the year. The summer of 2010 was the wettest on record for Eagle with a total of 10.09 inches of rain for June, July and August. September and October were particularly dry in the Central Alaska region.





Yakutat precipitation is not included due to scaling issues. The 2010 annual total was 102.7 inches, normal is 160.4 inches per year.

Introduction

Denali National Park and Preserve, Wrangell–St. Elias National Park and Preserve, and Yukon-Charley Rivers National Preserve make up the Central Alaska Inventory and Monitoring Network (CAKN), covering over 21 million acres. The network was established to monitor key components of ecosystems of the parks and to provide that information back to park managers for use in stewardship of park resources. Climate is considered to be the most important broad-scale factor influencing ecosystems and therefore the natural resources of parks. Because global climate models indicate that climate change and variability will be greatest at high latitudes, climate monitoring will be critical to understanding the changing conditions of park ecosystems.

The CAKN climate monitoring program deployed sixteen new climate stations between 2003 and 2005, mostly at higher elevations, to capture elevational and latitudinal climate gradients within the parks, and to capture data in areas where there were no baseline references. The analyses for this annual report are based on the long-term National Weather Service cooperative sites in and around the CAKN parks that have been in operation for 62 to 85 years. The new sites are analyzed for comparison, but long-term trends will take time to develop. This is the sixth in a series of reports for the Central Alaska Network Climate Monitoring Program.

Central Alaska Network Climate Characterization

The central Alaska climate can be characterized by the three major climate regimes that span from the southern boundaries of the network along the coast to the interior. The southern coast of Wrangell-St. Elias is significantly affected by the Gulf of Alaska. The Pacific Ocean moderates the temperature along the coast in both summer and winter, and brings a considerable amount of precipitation to the coastal areas and the southern flanks of the mountain ranges, including the Chugach and St. Elias Ranges that ring the Gulf Coast. Just north of these mountain ranges the precipitation tapers off and seasonal temperatures are more extreme. The winters are cold and the summers can get hot. The CAKN areas farthest north, and the farthest from the coast, are true interior climates characterized by low annual precipitation and large seasonal variation in temperature.

The climate of Alaska is affected by solar radiation, atmospheric gases (volcanic eruptions, CO_2), the water temperature of the Pacific Ocean, and ocean currents. These large scale processes drive changes in atmospheric patterns, like the repositioning of the polar jet stream and the Aleutian low pressure system or the frequency of La Ninas and El Ninos (Papineau, 2003). Each of these can affect the regional patterns of storm tracks, prevailing winds, snowfall amounts, and the extent of sea ice (ACIA, 2005).

There are several large-scale climate patterns and indices that are of particular interest to Alaska, including the Pacific Decadal Oscillation (PDO) which is an index of sea surface temperatures in the North Pacific Ocean. 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 (Hartmann and Wendler, 2005; Keen, 2008). The PDO seems to cycle through a warm and cool phase every 20 -30 years. 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 (Figure 1).

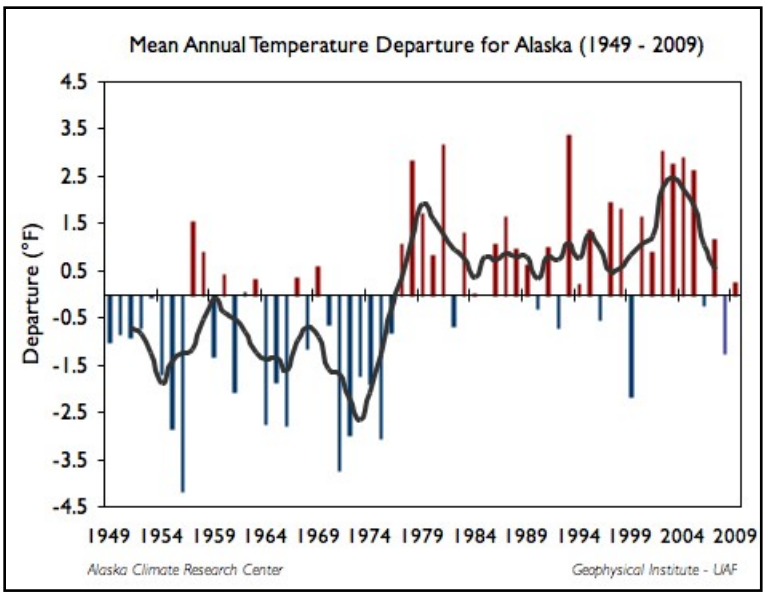


Figure 1. Mean annual temperature departures for Alaska showing the shift to a warmer regime in 1976 that correlates with the PDO. Graph courtesy of the Arctic Climate Research Center, retrieved from http://climate.gi.alaska.edu/ClimTrends/Change/TempChange.html.

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 will likely influence both temperature and precipitation patterns in Alaska. In recent years there has been a continued significant reduction in the extent of the summer sea ice cover and the decrease in the amount of relatively older, thicker ice (NSIDC, 2009). Models have predicted that the retreating sea ice should affect the temperature and ecosystems of adjacent lands. An increase in the amount of energy absorbed by vegetation and its transfer to the atmosphere, will contribute to the further high-latitude amplification of climate warming (Chapin et al., 2005).

Methods

Data were compiled from five long-term climate stations with the most complete records nearest the three CAKN parks that represent the major climate regimes in the network (Table 1). These stations have records for a sufficient number of years to compare 2010 data with the latest normal period, 1971-2000. For these sites temperature, precipitation, and snowfall are analyzed. The monthly means are simple arithmetic averages computed by summing the monthly values for the period 1971-2000 and dividing by thirty. Prior to averaging, the data are adjusted if necessary to compensate for data quality issues, station moves or changes in station reporting practices. Missing months are replaced by estimates based on neighboring stations. Two sites that have been included in previous reports, Cantwell and McCarthy were discontinued and no longer have records available. These were cooperative weather stations have been operated manually over the past several decades. The National Weather Service has not replaced these sites with automated sites.

Five additional sites were analyzed to try and capture winter temperature inversions and climate deviations at higher elevations (Table 2). Monthly means and annual totals were compiled for the newer CAKN stations including, temperature, wind, relative humidity, solar radiation, snow depth, and summer rainfall (Figure 2). Most of the summaries, analyses, charts, and graphs from NOAA and NRCS are in standard units; in order to standardize units throughout the report, data are presented in standard units. Period of record averages for the long-term sites are available in Appendix A, and extremes and records for these sites are listed in Appendix B.

Table 1. Long-term sites used in CAKN analysis.

Name	Lat	Long	Elev. (ft)	Network	Start	End	Park
Eagle	64.7666	-141.2000	850	COOP	1949	Present	YUCH
McKinley Park	63.7195	-148.9656	2060	COOP	1925	Present	DENA
Talkeetna	62.1800	-150.0600	350	COOP	1949	Present	DENA
Gulkana	62.1502	-145.4500	1580	SAO	1949	Present	WRST
Yakutat	59.5000	-139.6700	30	SAO	1936	Present	WRST

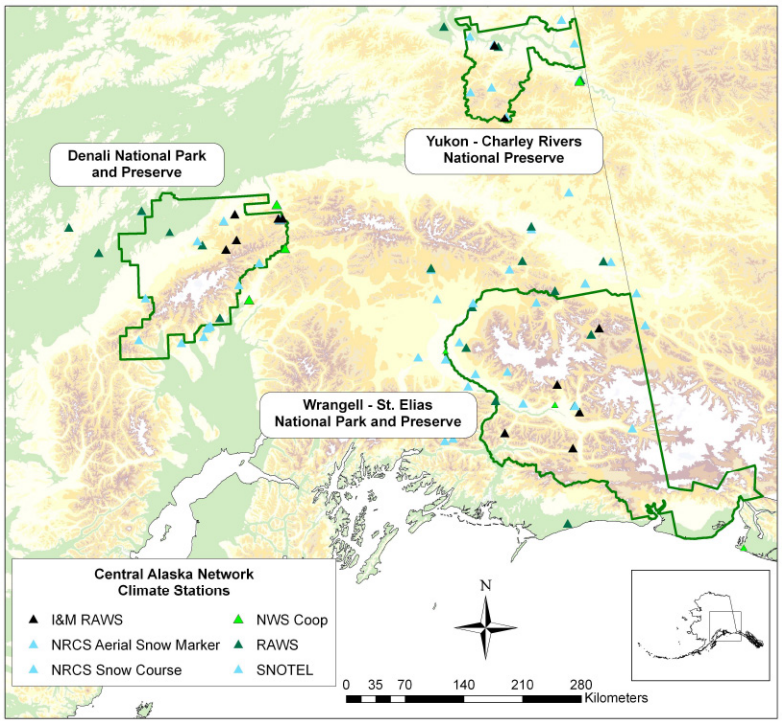


Figure 2. Map of CAKN climate station locations.

Table 2. CAKN and Remote Automated Weather Station (RAWS) sites.

Name	Lat	Long	Elev (ft)	Network	Start	End	Park
Stampede	63.7478	-150.3281	1800	CAKN RAWS	2003	Present	DENA
Toklat	63.5255	-150.0465	2920	CAKN RAWS	2005	Present	DENA
Eielson Visitor Center	63.4307	-150.3102	3730	CAKN RAWS	2005	Present	DENA
Wonder Lake	63.4900	-150.8800	2119	RAWS	1995	Present	DENA
Dunkle Hills	63.2670	-149.5415	2651	CAKN RAWS	2003	Present	DENA
Coal Creek	65.3041	-143.1570	820	CAKN RAWS	2004	Present	YUCH
Upper Charley	64.5169	-143.2023	3654	CAKN RAWS	2005	Present	YUCH
Chicken Creek	62.1240	-141.8473	5260	CAKN RAWS	2004	Present	WRST
Chisana	62.0775	-142.0500	3320	RAWS	1988	Present	WRST
Chititu	61.2735	-142.6209	4554	CAKN RAWS	2004	Present	WRST
May Creek	61.3208	-142.5844	1650	CAKN RAWS	1990	Present	WRST
Gates Glacier	61.6029	-143.0132	4060	CAKN RAWS	2005	Present	WRST
Klawasi	62.1469	-144.9269	3100	RAWS	1991	Present	WRST
Tebay	61.1810	-144.3392	1880	CAKN RAWS	2005	Present	WRST
Tana Knob	60.9080	-142.9013	3739	CAKN RAWS	2005	Present	WRST

Results

Climate Year 2010 Synopsis

The CAKN climate records show that 2010 was warmer and drier at most sites compared to normal. The mean annual temperatures at the longer-term sites averaged 1.8 degrees F warmer than normal. Temperatures were variable across the network from month to month, but the positive departures from normal in February and November stand out, with temps ranging from 6.3 to 10.6 degrees F above normal in February and from 3.8 to 11.5 degrees F warmer than normal in November. There were two other periods during the year with record breaking high daily temperatures region wide; the last week in May and mid September. All of the long-term sites had record breaking temperatures at some point between May 27 and May 30 and many had record breaking temperatures on September 14 and 15. The monthly temperatures for December deviated in the opposite direction; the average monthly temperatures were 13 to 15 degrees colder than normal at sites north of the Alaska Range.

The annual precipitation totals were below normal for most of the sites in CAKN except for Eagle. Eagle had the wettest summer on record with 10.09 inches of total rainfall, the normal summer total is 5.76 inches; the annual precipiation total was 15.3 inches, 3.3 inches above the 1971-2000 normal. Talkeetna and McKinley Park had annual totals that were 72 - 81% of normal. In Yakutat, along the Gulf of Alaska, the annual total was about 58 inches below the normal 160 inches per year, or about 64% of normal. September and October were noticeably dry with all of the long-term sites having negative departures from normal. Figure 3 shows the 2010 annual temperatures and total precipitation amounts compared with the 1971-2000 normals.

Based on data from January through December, the average annual temperature for the contiguous U.S. was 53.8 degrees F which is 1.0 degrees F above the 20th Century average (NOAA 2011). The average annual temperature for Alaska was about 0.7 degrees warmer than normal (Figure 4). Winter temperatures in 2009-2010 which includes December, January and February, were 3.1 degrees F above average (this includes December of 2009 and January and February of 2010); spring temperatures were 0.7 degrees F above average; summer was 0.4 degrees F (0.2 degrees C) above average, and fall was 3.1 degrees F (1.7 degrees C) warmer than the average (Figure 5).

The snowpack once again varied across the state for the 2009-2010 season. The southeast region of the state, including the Kenai Peninsula and the southern portions of Wrangell-St. Elias had normal to just above normal snowpack for the year. The central interior was below normal for most areas, with the lowest snow fall totals through the center of the state between the Brooks Range and the Alaska Range. There was record low snow water content in the spring at Lake Minchumina in the northwest portion of Denali and sites on the south side of the Alaska Range in Denali. The snowpack in Wrangell-St. Elias, in the Chugach and Wrangell Mountains, was near normal to above normal; however the Copper Basin floor was about 75% of normal. For the central Alaska region the snowpack accumulation started a bit later than usual at most sites, with the first persistent snow of the season beginning around the week of October 27th, almost 2 weeks later than normal. Other areas had 1-2 inches of snow starting the first week of October. The snow off dates for the region occurred during the last week of April and the first few days of

May. Figure 6 shows the statewide snowfall development from March through May (NRCS, 2011).

The warm temperatures in April and May sparked an early fire season. The snowpack melted, the ground surface dried out, and convective activity increased. This pattern was remarkably similar to the same time period in 2009 with record setting temperatures across the region for the end of May. The total area burned in the CAKN parks was 4,481 acres, almost all occurring within Yukon-Charley Rivers. Statewide there were a total of 688 wild land fires in 2010, with a total of 1,125,419 acres burned (AICC, 2011).

There was one climatically significant event that occurred during 2010. An unusual winter storm impacted large portions of Alaska on November 22 –24. Record-setting precipitation and record high temperatures created a winter ice storm that affected much of interior, northern, and south-central parts of the state. On November 22nd, a record 0.50 inches of rainfall was recorded in Fairbanks. A total of 0.95 inches was recorded over the three day period. The National Weather Service reported that the rain fell on top of the snow-packed roadways, leading to ice that covered nearly all of Alaska's road system and created dangerous driving conditions (NOAA 2011). Figure 7 shows the temperature anomalies for the state during this event.

In 2010 there was a dramatic shift in the El Niño–Southern Oscillation, which influences temperature and precipitation patterns around the world. A moderate-to-strong El Niño at the beginning of the year transitioned to La Niña conditions by July. At the end of November, La Niña was moderate-to-strong (NOAA 2011). The Pacific Decadal Oscillation, an index of sea surface temperatures in the north Pacific was positive for the first part of 2010 indicating warmer than normal sea surface temperatures off of Alaska's coast, but in June switched to stronger negative departures that persisted through the end of the year (JISAO, 2011) (Figure 8). Arctic sea ice extent for September 2010 was 4.33 million square kilometers (1.67 million square miles), the second lowest in the satellite record (Figure 9).

Globally, 2010 was tied with 2005 as the warmest year on record based on the analysis of global surface temperatures by NASA's Goddard Institute for Space Studies (GISS). The next warmest years are 1998, 2002, 2003, 2006, 2007, and 2009 since recordkeeping began in 1880. Throughout the last three decades, the GISS surface temperature record shows an upward trend of about 0.36°F per decade (GISS, 2011).

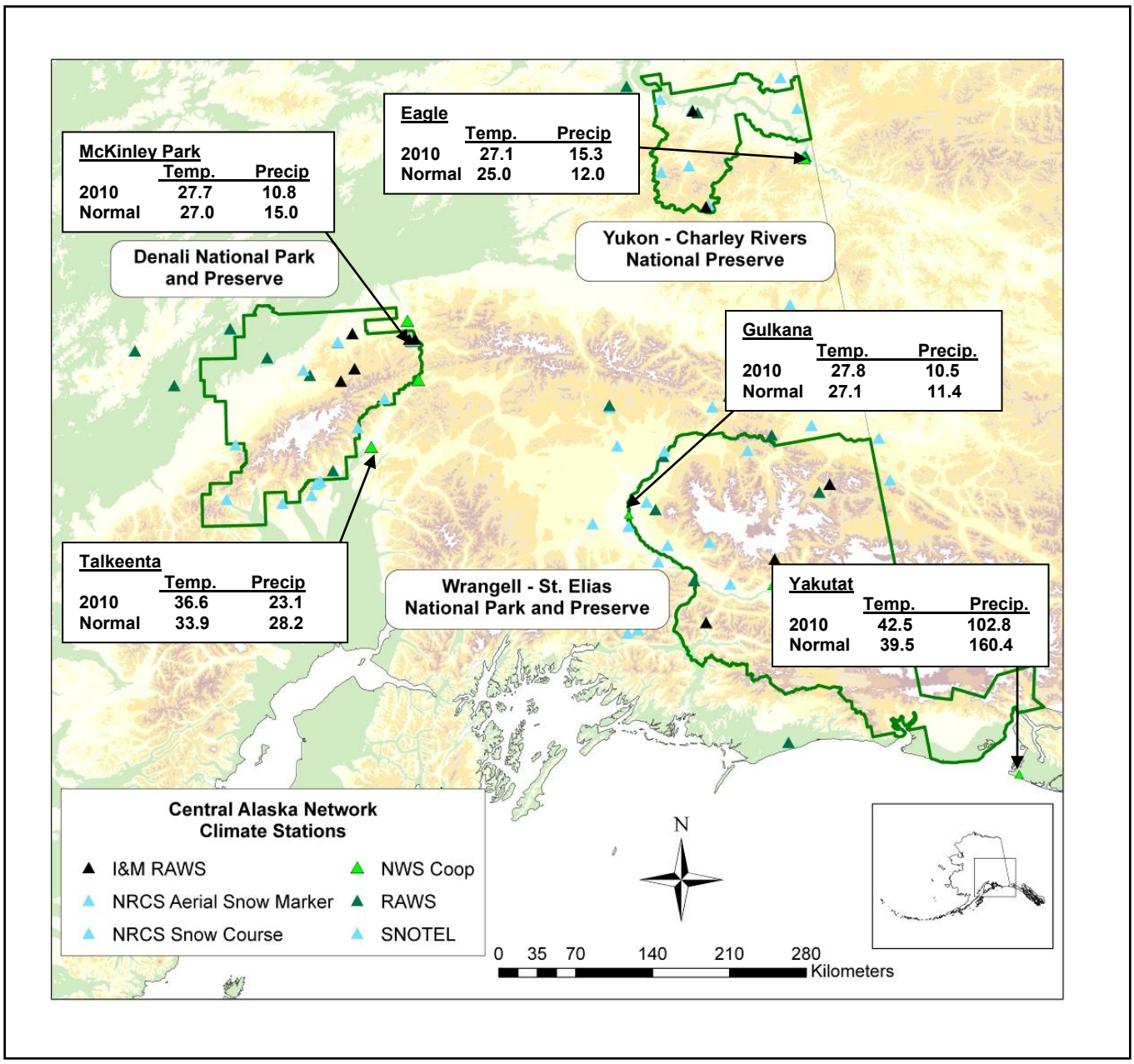


Figure 3. Mean annual temperature and precipitation totals for long-term sites in CAKN for 2010 compared with 1971-2000 normals.

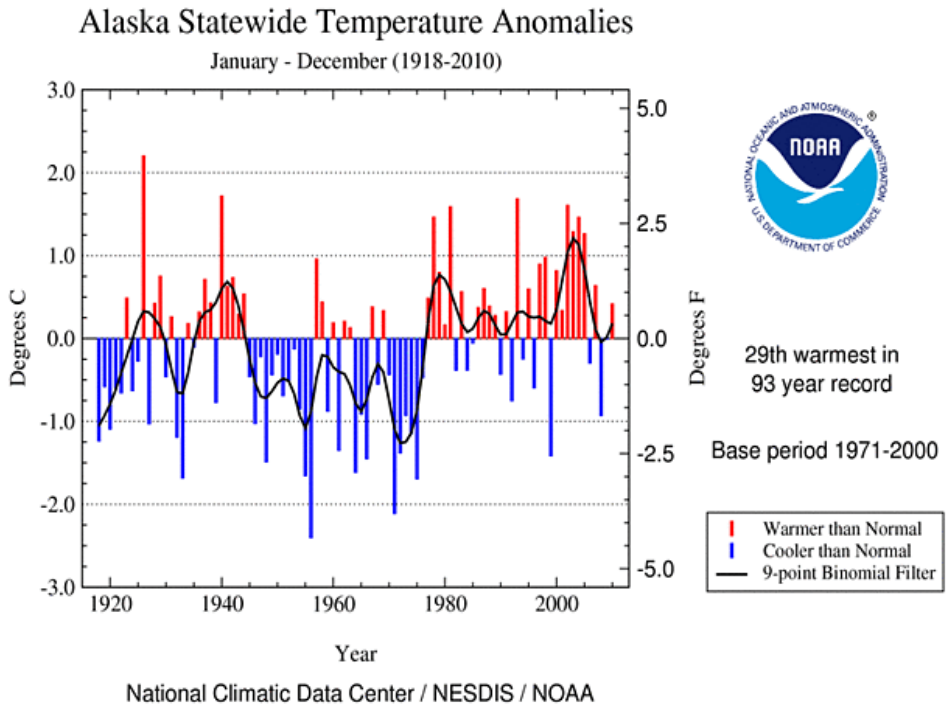
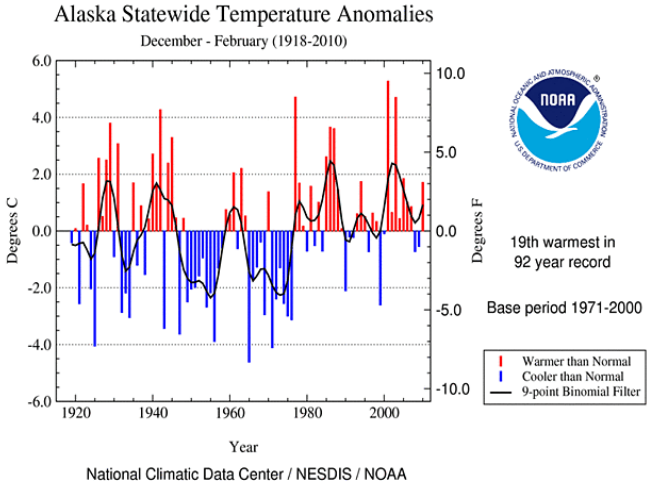
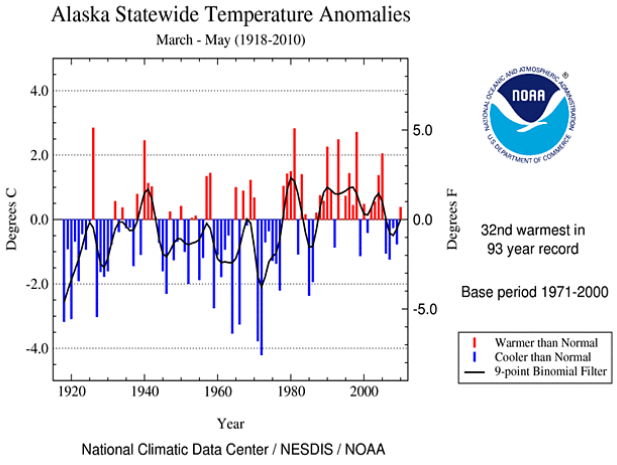


Figure 4. Average temperatures across Alaska were 0.7 ° F below the 1971-2000 mean (NOAA 2011). Figure retrieved from http://www.ncdc.noaa.gov/sotc/national/2010/13.





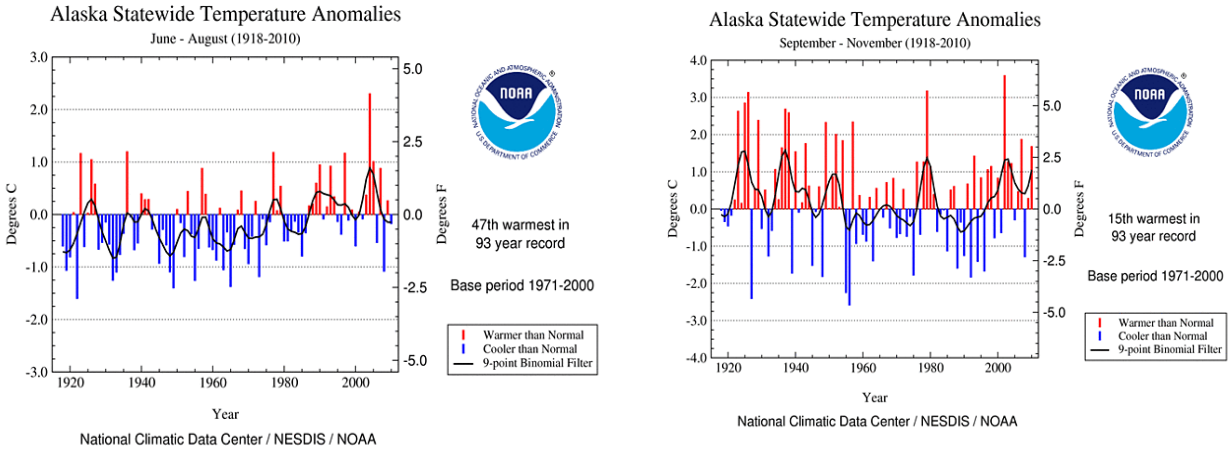


Figure 5. Seasonal statewide temperature anomalies 2010. Figures retrieved from http://www.ncdc.noaa.gov/sotc/national/2010/13.

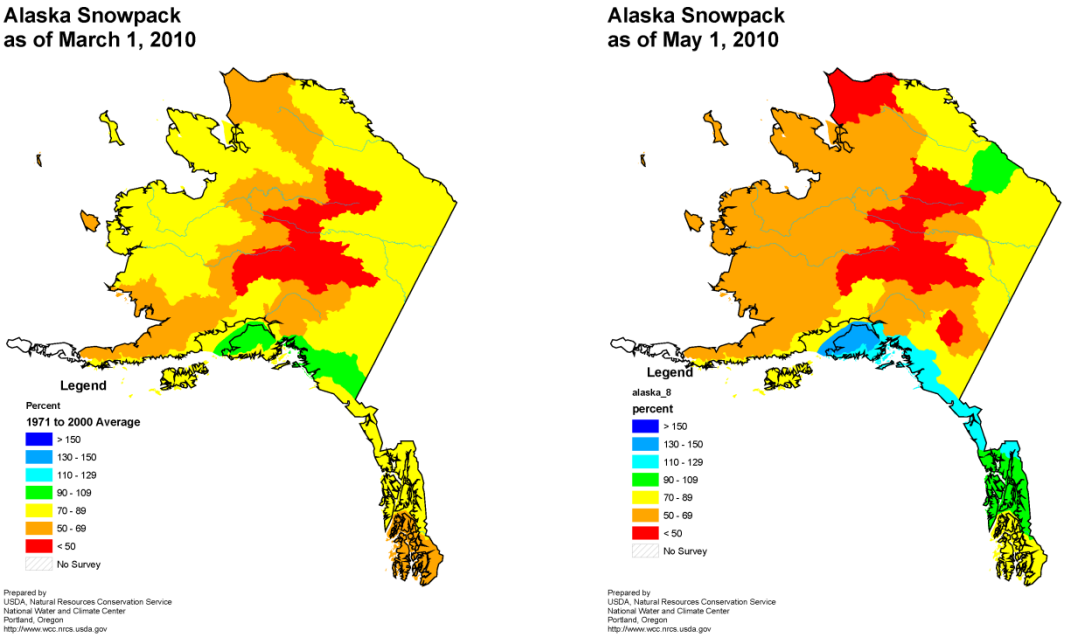


Figure 6. March 1 and May 1 snowpack depths for Alaska 2010 (NRCS 2011).

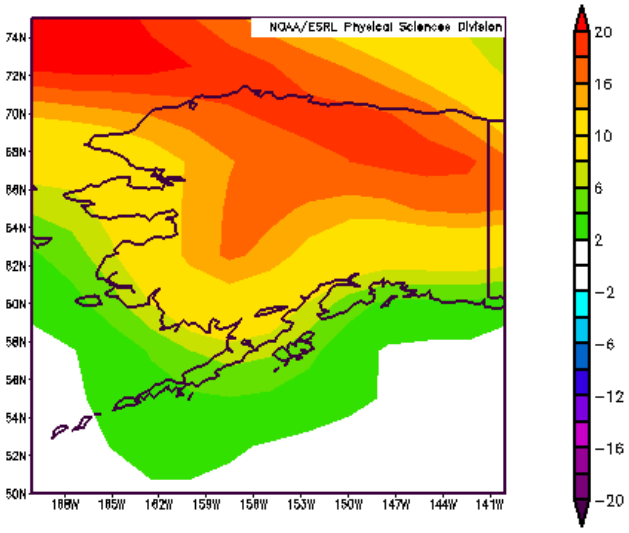


Figure 7. Alaska Temperature Departure Anomalies 22–24 November 2010. Graphic courtesy of the Earth System Research Laboratory.

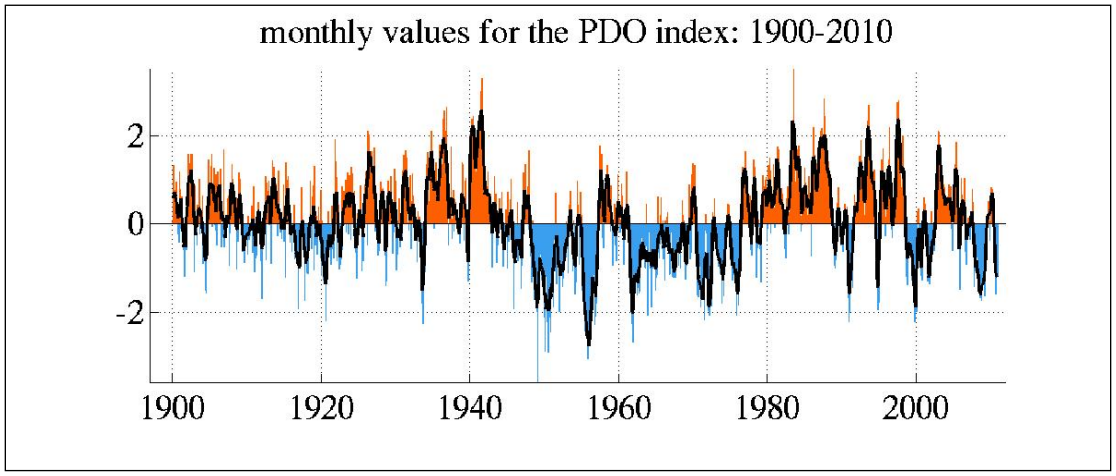


Figure 8. Pacific Decadal Oscillation index. Note the negative departure for 2010. Graph retrieved from http://jisao.washington.edu/pdo/ (JISAO 2011).

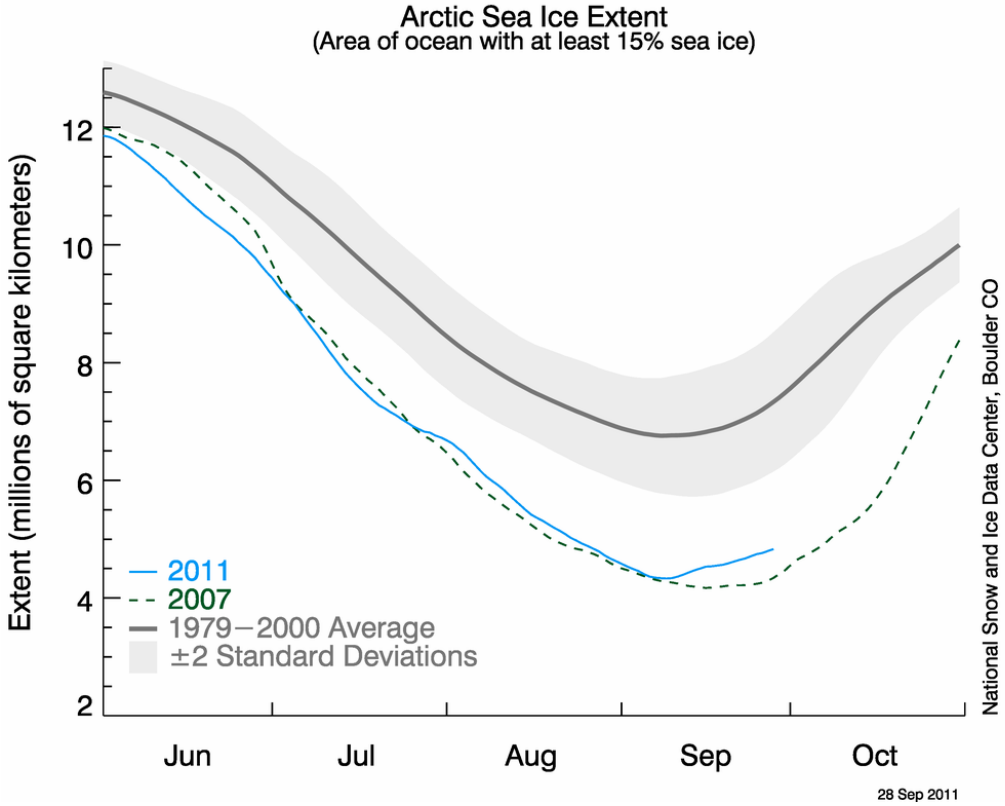


Figure 9. Arctic Sea Ice extent 2010. This was the third lowest on record. Graph retrieved from http://nsidc.org/data/seaice_index/images/daily_images/N_stddev_timeseries.png (NSIDC 2011)

Temperature

In 2010, the mean annual temperatures for the long-term sites around the CAKN region averaged 1.8° F above the 1971-2000 normal for all of the sites (Figure 10 and Table 3). The temperatures were quite variable through the seasons (Table 4). January temperatures varied between positive and negative departures from normal depending on the location in relation to the Alaska Range. The sites north of the range had strong negative departures, while those south were much warmer than normal. In February, all of the sites across the region were much warmer than normal, when a strong Chinook advected warm air across Alaska. The average monthly temperature in Eagle was 10 degrees warmer than normal. Temperatures remained above normal in all areas of the CAKN region except for Denali Park which was just at normal.

April and May were warm across the interior with temperatures about 3 degrees above normal for both months. The latter part of May had record setting temperatures at all of the long-term sites. Temperatures in June were close to 2 degrees F above normal at Eagle and Yakutat, but about 1 degree F below normal at Gulkana, Denali Park and Talkeetna. All of the sites had temperatures above normal in August, and this ushered in the warm fall where temperatures throughout the region were above normal to well above normal for September, October, and November. The one exception during this period was Eagle and Gulkana that had monthly September average temperatures that were just below normal. The ice storm in November was an

extreme and unusual event for interior Alaska. It rained for 39 consecutive hours in Fairbanks, the longest duration winter rainfall event on record, causing havoc on the highways and shutting down schools. The prolonged warm period ended in December when the interior went into a deep freeze. Interior sites had temperature departures that were 13 to 15 degrees cooler than normal for the month. Talkeenta was almost 5 degrees colder than normal, but Yakutat along the Gulf Coast was near normal. Figure 11 shows the monthly departure from normal at the long term sites around CAKN. See Appendix A for 'period of record' data for the long-term sites and Appendix B for individual site records and extremes.

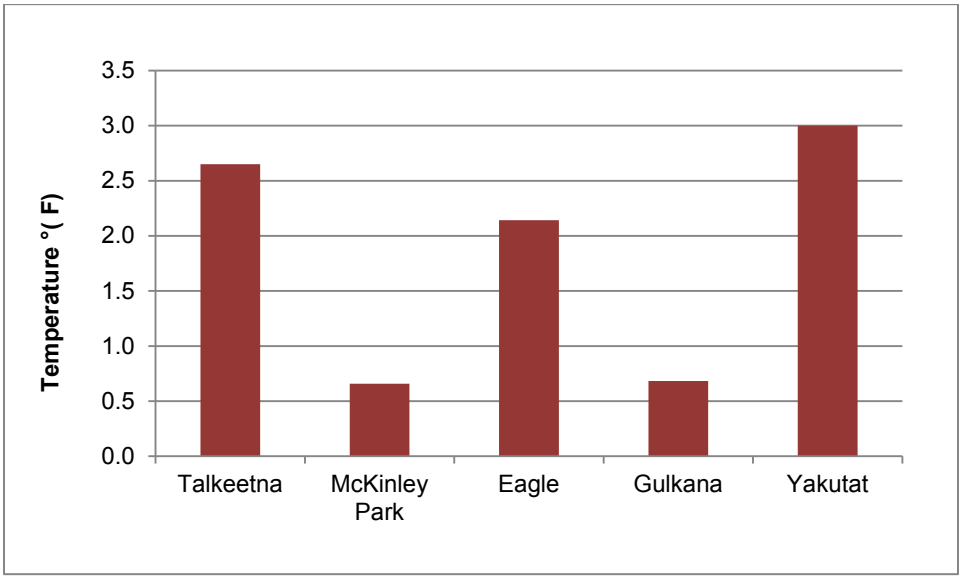


Figure 10. 2010 Mean annual temperature departure from normal at long-term CAKN sites.

Table 3. 2010 monthly average temperature departure from normal (1971-2000) for long-term sites in CAKN.

Site	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Talkeetna	6.3	9.7	3.7	2.3	3.7	-1.1	-2.2	1.5	2.4	5.6	4.4	-4.7	2.7
McKinley Park	-6.2	8.8	-0.1	3.8	3.5	-0.8	-2.0	2.3	1.8	5.5	6.5	-15.7	0.7
Eagle	-0.7	10.3	3.9	6.7	3.6	1.3	-1.3	1.3	-0.5	2.4	11.5	-13.0	2.1
Gulkana	-2.8	6.3	3.5	1.7	4.4	-0.8	-1.6	2.3	-0.5	1.6	7.4	-13.1	0.7
Yakutat	4.7	7.5	2.6	1.9	2.6	2.6	1.4	3.2	4.2	2.4	3.8	-0.2	3.0

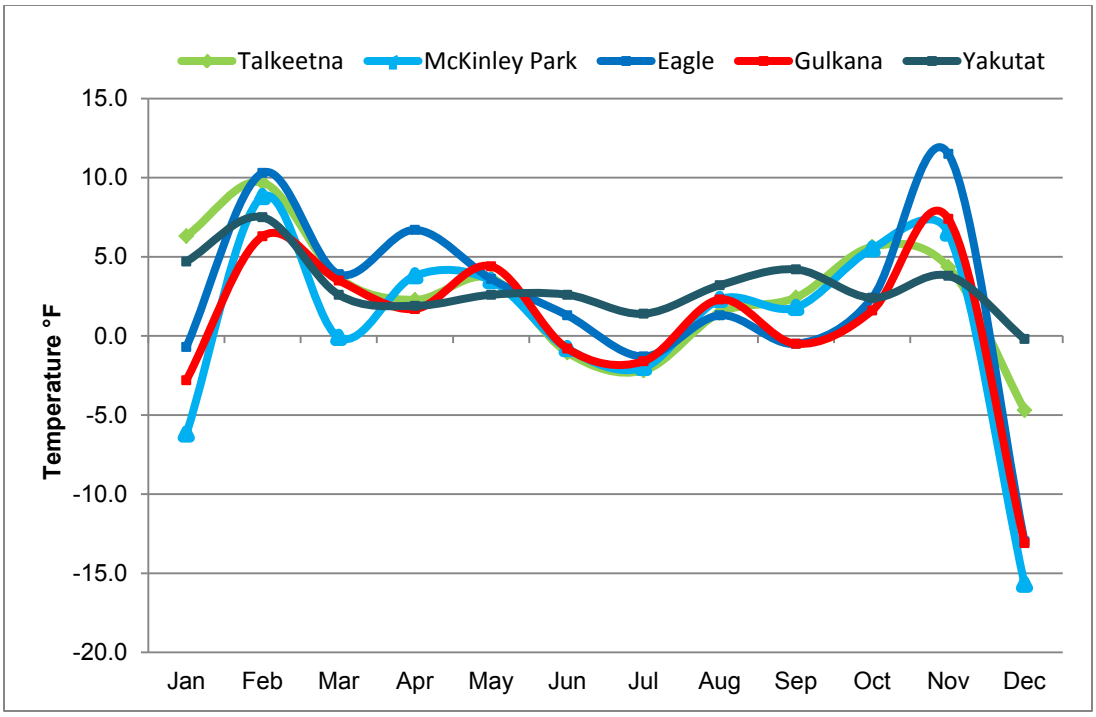


Figure 11. CAKN 2010 mean monthly temperatures departure from normal at long-term sites.

Table 4. Mean monthly and annual temperatures for 2010 from long-term sites compared with 1971-2000 normal period.

Site	*JAN*	*FEB*	*MAR*	*APR*	*MAY*	*JUN*	*JUL*	*AUG*	*SEP*	*OCT*	*NOV*	*DEC*	*ANN*
Talkeetna													
2010	17.3	25.1	26.3	36.6	49.5	54.3	56.7	57.1	48.6	37.0	21.9	8.3	36.6
1971-2000 normal	*11.0*	*15.4*	*22.6*	*34.3*	*45.8*	*55.3*	*58.9*	*55.6*	*46.2*	*31.4*	*17.5*	*13.0*	*33.9*
McKinley Park													
2010	-4.2	13.3	13.0	31.0	45.5	51.4	53.6	53.2	42.3	28.0	15.6	-10.8	27.7
1971-2000 normal	*2.0*	*4.5*	*13.1*	*27.2*	*42.0*	*52.2*	*55.6*	*50.9*	*40.5*	*22.5*	*9.1*	*4.9*	*27.0*
Eagle													
2010	-12.3	4.2	11.7	35.5	49.6	58.8	59.5	56.1	42.3	25.7	13.7	-19.8	27.1
1971-2000 normal	*-11.6*	*-6.1*	*7.8*	*28.8*	*46.0*	*57.5*	*60.8*	*54.8*	*42.8*	*23.3*	*2.2*	*-6.8*	*25.0*
Gulkana													
2010	-7.5	9.5	18.8	32.8	48.3	52.3	55.4	55.4	42.6	28.0	12.9	-14.7	27.8
1971-2000 normal	*-4.7*	*3.2*	*15.3*	*31.1*	*43.9*	*53.1*	*57.0*	*53.1*	*43.1*	*26.4*	*5.5*	*-1.6*	*27.1*
Yakutat													
2010	30.5	35.9	34.1	39.1	46.2	52.3	55.0	56.5	52.4	43.5	36.2	28.4	42.5
1971-2000 normal	*25.8*	*28.4*	*31.5*	*37.2*	*43.6*	*49.7*	*53.6*	*53.3*	*48.2*	*41.1*	*32.4*	*28.6*	*39.5*

Yellow – YUCH, Green – DENA, Blue – WRST

New CAKN Sites

Although the new CAKN climate stations and other Remote Automated Weather Stations (RAWS) around the CAKN parks do not have long records, the monthly and annual averages and totals fill in some of the large spatial gaps in the network and offer information on climate patterns related to elevation and topography. Table 5 lists the monthly and annual temperatures for these sites grouped by park and Figure 12 and 13 shows them graphically. The monthly average temperatures are warmer for the lower elevation interior sites during the summer months, while the winter monthly average temperatures are warmer at higher elevations, effectively smoothing the annual averages. See Appendix C for complete monthly summaries from the CAKN climate sites.

Table 5. Monthly mean temperatures from CAKN stations 2010.

	Jan	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*	*Annual*
Stampede	-11.2	5.1	8.0	32.1	47.2	52.3	54.6	52.3	40.0	23.6	13.3	-15.8	25.1
Toklat	2.1	14.2	11.0	29.5	45.0	48.2	51.0	50.0	39.2	26.1	17.0	-4.0	27.4
Eielson VC	20.2	20.5	16.8	29.3	43.1	46.7	49.2	48.4	42.9	29.3	20.4	9.5	31.4
Wonder Lake	-4.6	8.4	9.2	30.4	46.2	51.8	53.9	52.0	41.3	23.4	13.5	-11.3	26.2
Dunkle Hills	10.0	16.1	15.5	27.0	42.8	46.8	48.6	48.5	41.2	28.2	19.5	3.6	29.0
Denali VC	-9.6	10.9	12.8	33.4	48.5	53.7	56.3	54.5	41.2	27.4	12.8	-15.3	27.2
Coal Creek	-16.9	0.6	10.1	35.7	51.2	58.2	60.2	55.7	40.1	22.0	9.7	-24.7	25.1
Upper Charley	-3.1	10.6	11.7	29.0	44.2	48.8	51.8	49.5	37.8	22.2	15.0	-14.6	25.2
Chicken Creek	10.7	19.5	15.2	25.7	39.0	42.1	47.7	46.3	36.2	23.9	16.6	1.5	27.0
Chisana	-5.4[1]	8.0	11.6	29.0	44.0	49.6	54.1	50.8	36.3	17.0	6.0	-17.5	23.6
Chititu	16.2	25.8	19.7	27.6	40.6	41.6	46.2	46.4	39.5	28.0	19.8	5.7	29.7
May Creek	-3.8	15.2	22.8	35.0	48.2	52.9	55.2	54.7	42.1	27.1	13.5	-14.9	29.0
Gates Glacier	17.9	26.8	21.4	28.1	40.7	42.3	46.1	47.6	40.6	29.0	22.0	7.0	30.8
Klawasi	4.1	19.0	21.0	31.6	45.8	48.3	52.5	52.2	42.1	28.7	18.6	-3.6	30.0
Tebay	3.2	18.1	20.8	29.5	41.0	48.4	49.9	51.2	42.6	30.8	21.0	-1.3	28.8
Tana Knob	12.8	24.6	21.6	29.3	40.5	43.0[2]	48.3	49.5	42.9	30.2	22.3	1.2	30.5

Yellow – YUCH, Green – DENA, Blue – WRST

[1] Proxy temp from Nabesna COOP station

[2] Proxy temp based on surrounding stations

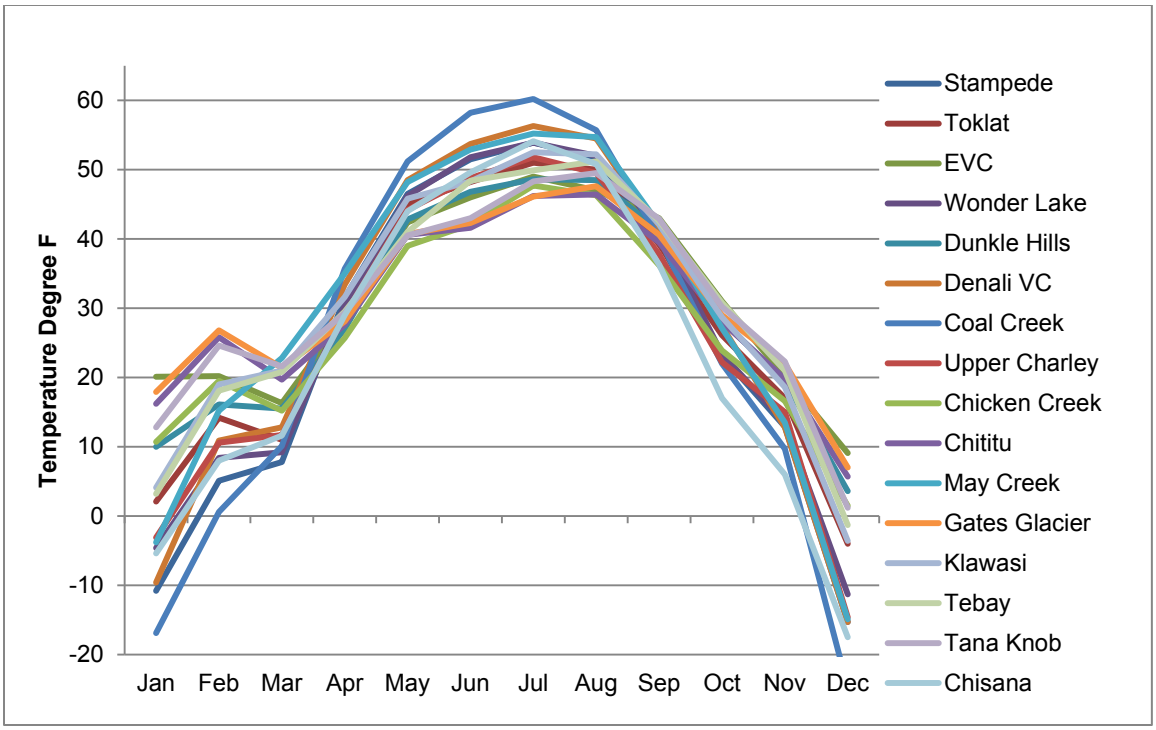


Figure 12. CAKN mean monthly temperatures

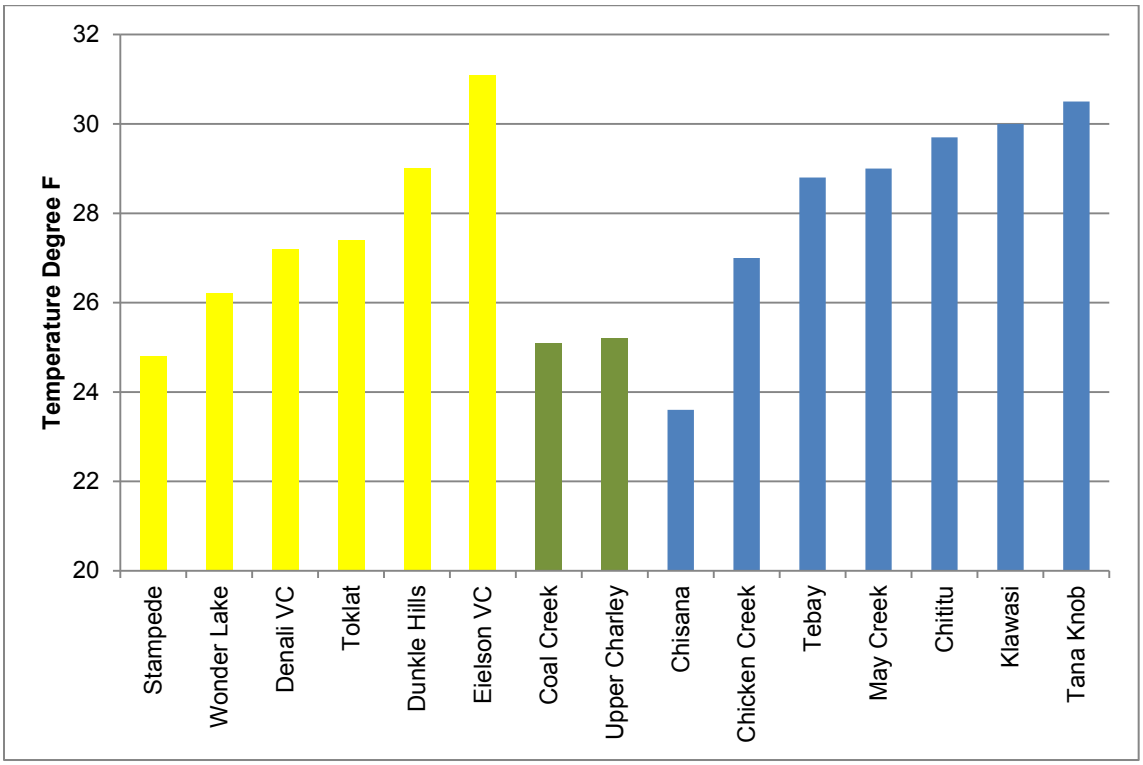


Figure 13. CAKN mean annual temperatures. Yellow sites are DENA, green YUCH, and blue WRST.

One of the objectives of the CAKN climate program was to instrument higher elevation sites to acquire information related to temperature gradients in complex topography. In many cases higher sites were deployed in the vicinity of existing lower elevation sites for comparison. Correlations between the paired high and low elevation sites are best described by monthly means rather than annual means. In the summer, the higher sites tend to be 5 to 10° colder depending on the elevation, but in the winter during cold spells, a persistent inversion can set up and the higher elevations can be 10 to 20° F warmer than the surrounding lowlands. The air is often still in the darker winter months due to the lack of solar radiation that generates the surface winds that are so common in the summer. However, if a storm system moves in from the Gulf of Alaska or Bering Sea, warm maritime winds (known as Chinooks) often funnel through the mountain passes, raising temperatures and mixing the air. The areas just north of these mountain passes often get winds in excess of 40 mph during these events.

The following tables show the monthly and annual variation between low and high elevation sites in the three CAKN parks. Table 6 shows Chicken Creek and Chisana, sites located in the continental interior region of northeastern WRST, north of the Chugach and Wrangell Mountain ranges. The annual temperature was 3.4 degrees warmer at Chicken Creek, the higher site. Table 6 also shows May Creek and Gates Glacier which are located between the Wrangell Mountain Range to the north and the Chugach Range to the south. The temperature at Gates Glacier was 1.8 degrees warmer than the lower elevation site at May Creek. The higher sites were warmer in the winter and cooler in the summer, but the winter differences were more extreme.

Table 6. Mean monthly temperatures for 2010 at high and low elevation paired sites in WRST.

Month	Chicken Creek Elev. - 5260'	Chisana Elev. – 3320'	Gates Glacier Elev. - 4060	May Creek Elev. – 1600'
Jan	10.7	-5.4	17.9	-3.8
Feb	19.5	8.0	26.8	15.2
Mar	15.2	11.6	21.4	22.8
Apr	25.7	29.0	28.1	35.0
May	39.0	44.0	40.7	48.2
Jun	42.1	49.6	42.3	52.9
Jul	47.7	54.1	46.1	55.2
Aug	46.3	50.8	47.6	54.7
Sep	36.2	36.3	40.6	42.1
Oct	23.9	17.0	29.0	27.1
Nov	16.6	6.0	22.0	13.5
Dec	1.5	-17.5	7.0	-14.9
Annual	**27.0**	**23.6**	**30.8**	**29.0**

Red = warmer temperatures; blue = colder temperatures.

Table 7 shows the high and low elevation sites in YUCH. The variation at these two sites is not as extreme as sites farther south. The mean annual temperature at Upper Charley, the higher elevation site, was only 0.1°F warmer than Coal Creek. The Upper Charley site was warmer for each of the winter months, but the spread between the two sites was not as extreme as the WRST examples. In Denali, Eielson Visitor Center is located at a high elevation site just north of the crest of the Alaska Range. This site is compared with Stampede which is located farther north and east, where the topography starts to flatten out. The mean annual temperature at Eielson was 6.3°F warmer than Stampede (Table 7). The monthly average temperatures were warmer in January, February, March, September, October, November, and December, or 7 out of 12 months. This site is subject to the warm Chinook winds that come through the passes in the

winter; this site had the warmest annual temperature of the higher elevation interior sites. Figure 15 highlights the differences in seasonal temperatures at both high and low elevation sites.

Table 7. Mean monthly temperatures for 2010 at high and low elevation paired sites in YUCH and DENA

Month	***Upper Charley*** Elev. - 3654'	***Coal Creek*** Elev. - 802'	***Eielson VC*** Elev. - 3730'	***Stampede*** Elev. - 1800'
Jan	-3.1	-16.9	20.1	-10.8
Feb	10.6	0.6	20.2	5.1
Mar	11.7	10.1	16.3	7.8
Apr	29.0	35.7	28.7	31.5
May	44.2	51.2	42.4	46.5
Jun	48.8	58.2	46.0	51.5
Jul	51.8	60.2	49.0	53.9
Aug	49.5	55.7	47.0	51.7
Sep	37.8	40.1	43.0	39.6
Oct	22.2	22.0	31.0	23.1
Nov	15.0	9.7	20.1	12.9
Dec	-14.6	-24.7	9.1	-15.3
Annual	25.2	25.1	31.1	24.8

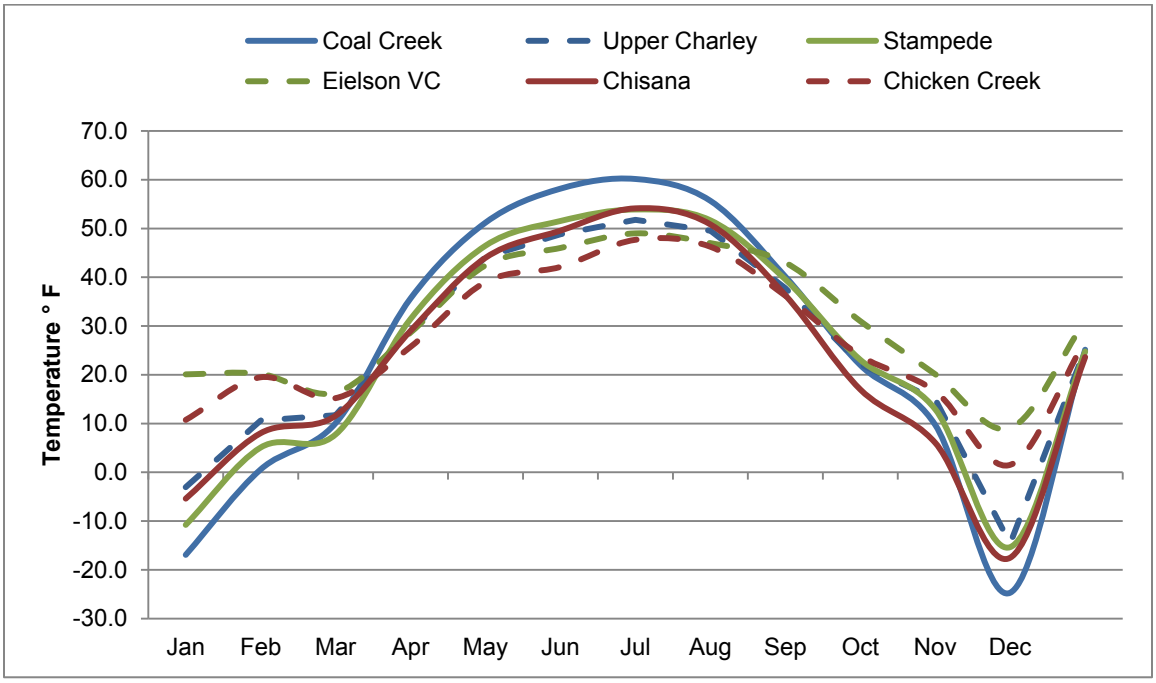


Figure 14. CAKN mean monthly temperatures – Paired high and low elevation sites for 2010.

Precipitation

Annual precipitation totals were below normal for most of the CAKN long-term sites in 2010, except for Eagle which was well above normal (Table 8 and Figure 13). September and October were particularly dry months with the average departure about 1 inch below normal (Figure 16). Eagle had the wettest summer on record with 10.09 inches of rain for June, July, and August, including multiple daily records in July and August. Both Talkeetna and McKinley Park were

71-81% below normal for the year. Gulkana was closest to normal out of the long-term sites in the region, but still about an inch below normal. The precipitation amounts for Yakutat are generally five times greater, on average, than the other sites in the network; because of this difference, Yakutat is not included in the figures due to scale issues. Annual precipitation totals for Yakutat were about 64% of normal for 2010; every month was below normal except for July. See Appendix B for records for all long-term sites.

Table 8. Annual precipitation totals - departure from normal 2010.

Site	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Talkeetna	-0.83	-0.37	-0.99	0.18	-0.94	-0.29	1.24	0.3	-2.78	-2.07	2.00	-0.54	**-5.09**
McKinley Park	-0.37	-0.34	0	-0.11	-0.53	1.01	-0.71	-0.68	-1.26	-0.87	-0.11	-0.25	**-4.22**
Eagle	0.26	0.00	-0.11	0.34	-0.43	0.14	2.32	1.87	-0.8	-0.61	0.63	-0.31	**3.30**
Gulkana	0.16	-0.09	-0.1	-0.06	-0.48	0.57	0.54	-0.94	0.2	-0.54	0.16	-0.3	**-0.88**
Yakutat	-6.33	-2.89	-0.66	-5.9	-6.54	-1.53	1.43	-8.34	-11.14	-6.95	-1.82	-6.96	**-57.6**

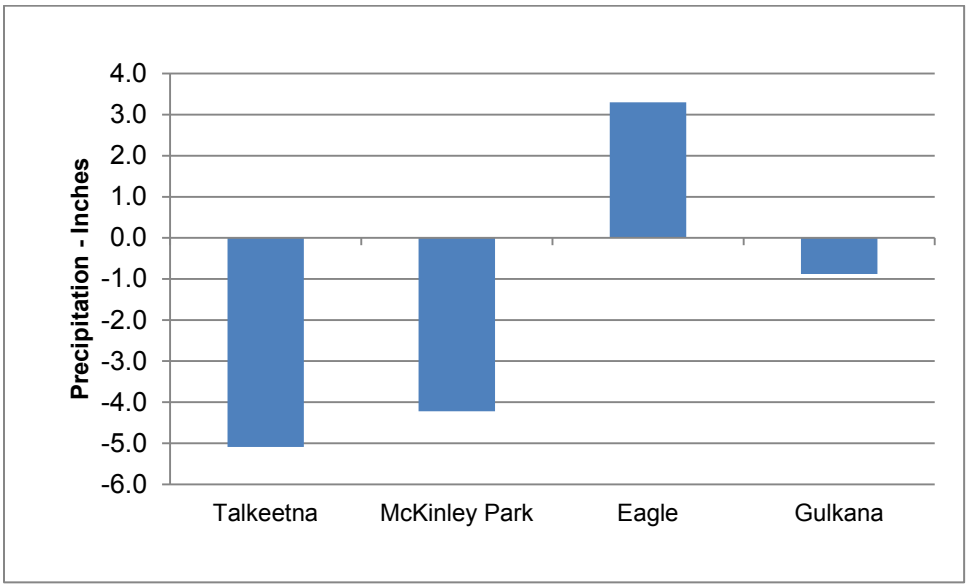


Figure 15. Annual precipitation totals departure from normal for long-term CAKN sites – 2010.

Table 9. Total monthly precipitation at long-term CAKN sites for 2010 compared with 1971-2000 normals

Site	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
Talkeetna													
2010	0.62	0.91	0.27	1.4	0.7	2.12	4.48	4.83	1.57	0.99	3.78	1.42	**23.09**
1971-2000 normal	*1.45*	*1.28*	*1.26*	*1.22*	*1.64*	*2.41*	*3.24*	*4.53*	*4.35*	*3.06*	*1.78*	*1.96*	***28.18***
McKinley Park													
2010	0.33	0.2	0.38	0.16	0.14	3.23	2.38	1.94	0.50	0.18	0.67	0.64	**10.75**

1971-2000 normal	*0.7*	*0.54*	*0.38*	*0.27*	*0.67*	*2.22*	*3.09*	*2.62*	*1.76*	*1.05*	*0.78*	*0.89*	***14.97***
Eagle													
2010	0.7	0.47	0.2	0.64	0.74	1.92	4.45	3.72	0.37	0.36	1.3	0.44	**15.31**
1971-2000 normal	*0.44*	*0.47*	*0.31*	*0.3*	*1.17*	*1.78*	*2.13*	*1.85*	*1.17*	*0.97*	*0.67*	*0.75*	***12.01***
Gulkana													
2010	0.61	0.43	0.26	0.16	0.11	2.11	2.36	0.86	1.64	0.48	0.83	0.67	**10.52**
1971-2000 normal	*0.45*	*0.52*	*0.36*	*0.22*	*0.59*	*1.54*	*1.82*	*1.8*	*1.44*	*1.02*	*0.67*	*0.97*	***11.4***
Yakutat													
2010	6.85	8.1	10.75	4.9	3.24	5.64	9.31	4.93	9.74	17.05	13.35	8.89	**102.75**
1971-2000 normal	*13.2*	*11*	*11.4*	*10.8*	*9.78*	*7.17*	*7.88*	*13.3*	*20.9*	*24*	*15.2*	*15.9*	***160.4***

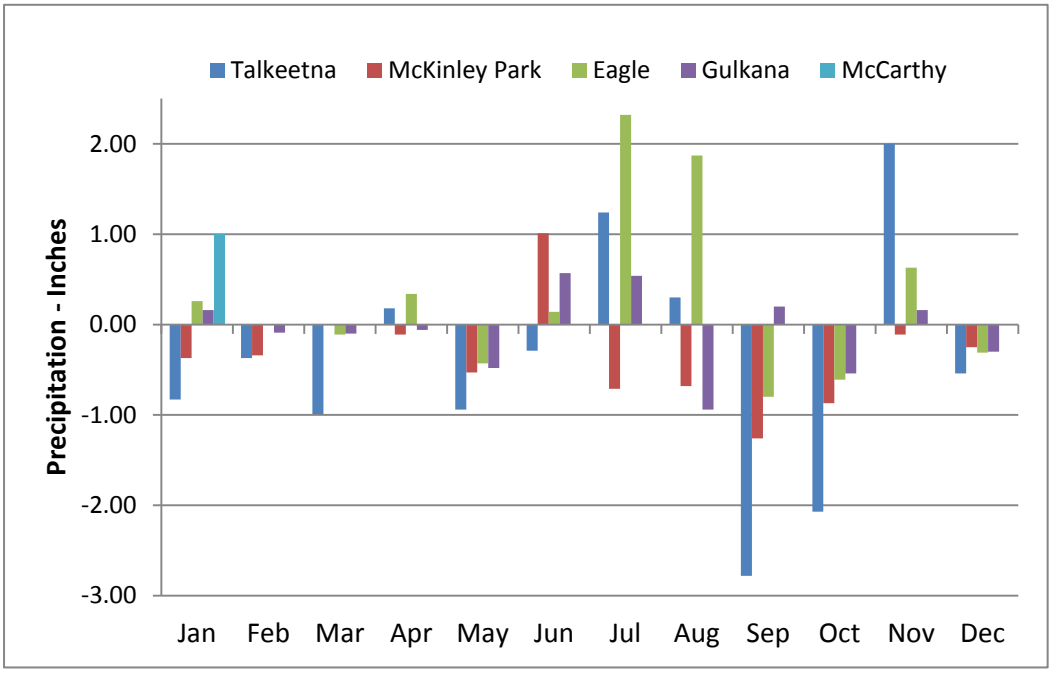


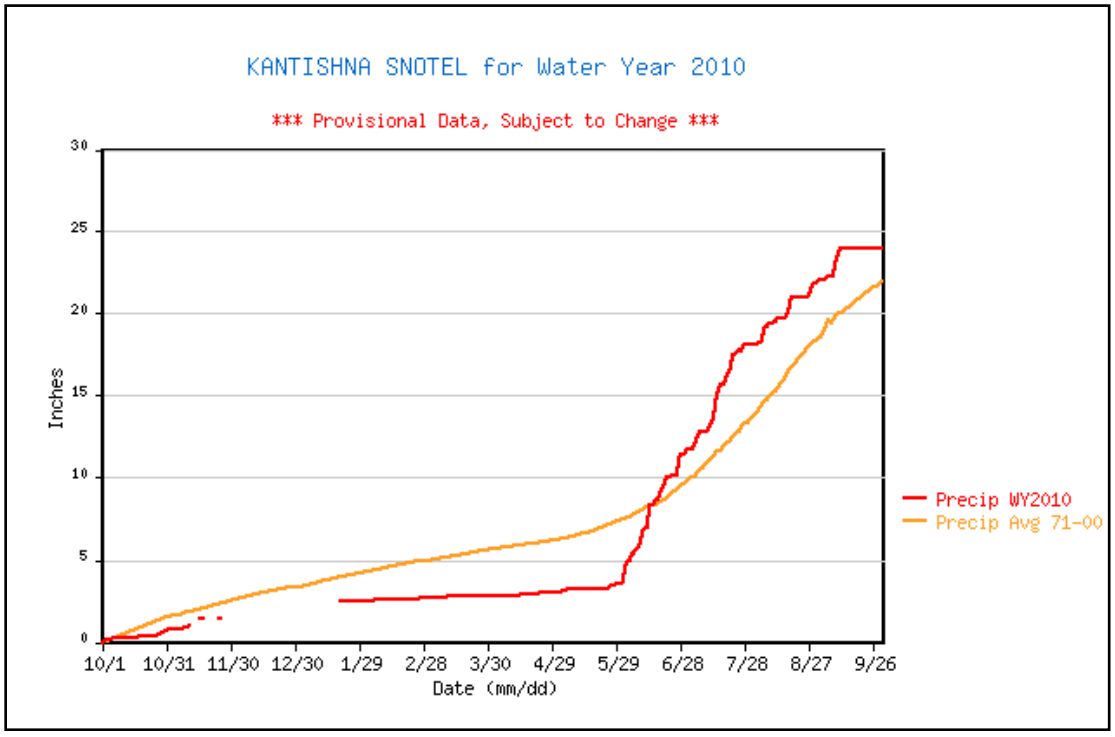
Figure 16. Monthly precipitation totals departure from normal for 2010.

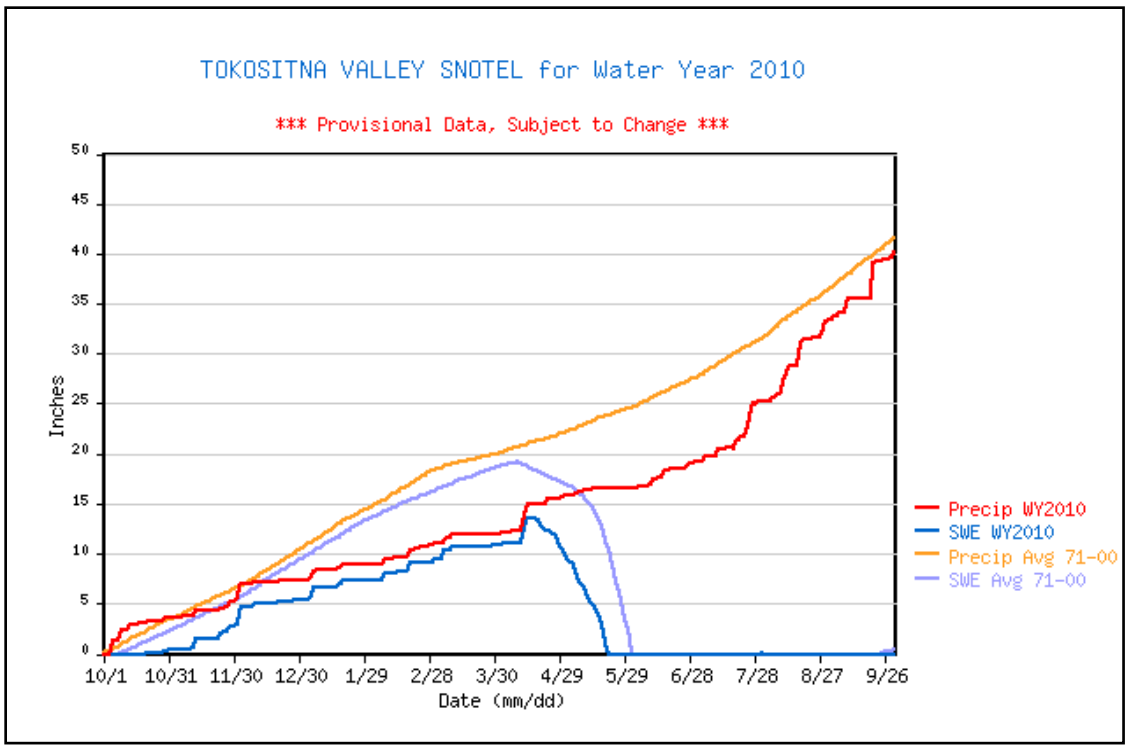
Year round precipitation is recorded at the new snow telemetry (SNOTEL) sites deployed in Denali and Wrangell-St. Elias as part of the CAKN climate and snow program. The Mission Creek SNOTEL near Eagle was destroyed in the Yukon River flood in May 2009. The site has been relocated to higher ground and is now called American Creek. The site was installed in the summer of 2011. The SNOTEL sites provide an accurate representation of winter snow water equivalent at remote sites as well as summer rainfall. The data from these sites, along with the snow courses and aerial markers, surveyed monthly throughout the winter season, are based on the 'water year' running from October 1 through September 30. An annual report summarizing

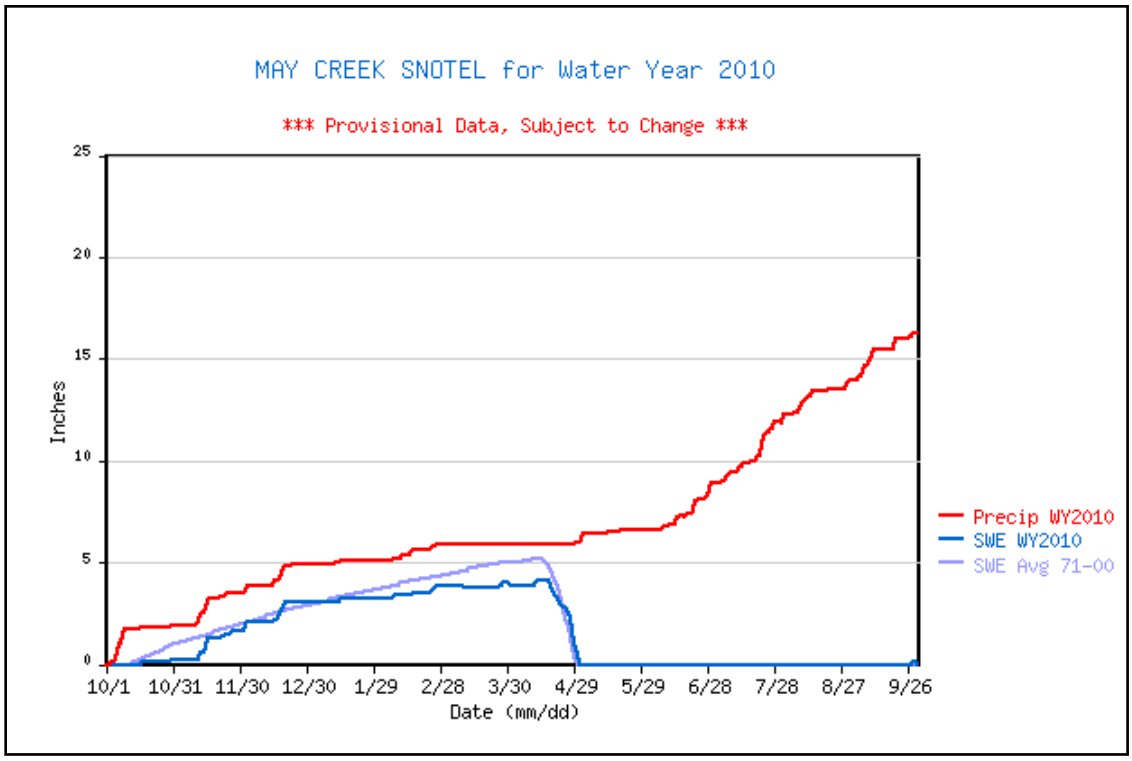
the snow and precipitation data from snow courses, aerial markers, and SNOTEL sites around the network is produced in the late fall of each year (Sousanes, 2010).

The Kantishna SNOTEL site located on the north side of the Alaska Range in Denali, recorded 3.0 inches of total winter precipitation (snow water equivalent) from October 1, 2009 through May 1, 2010, 12.5% of the total annual precipitation of 24.0 inches. The precipitation gage at Tokositna Valley, on the south side of the Alaska Range, recorded 15.8 inches of precipitation from October 1, 2009 through May 1, 2010, which is 6.3 inches below the 1971-2000 normal. This is 39% of the total annual precipitation of 40.2 inches for the 2010 water year.

The SNOTEL site at May Creek, between the Chugach and Wrangell Mountain Ranges in Wrangell-St. Elias, reported precipitation, snow water equivalent, and cumulative precipitation. There was 6.0 inches of snow water equivalent on May 1st; the annual total precipitation was 16.3 inches, so the winter snowfall accounted for 37% of the total precipitation for the year. The snow off date was April 29, 2010. The SNOTEL site at Chisana recorded 3.5 inches of snow water equivalent as of May 1st; the annual precipitation total was 13.9 inches. The winter snowfall accounted for 25% of the total annual precipitation. Snow off date was around April 29th. Cumulative precipitation graphs for the four SNOTEL sites are presented in Figure 18 (note the differences in scale).




TOKOSITNA VALLEY SNOTEL for Water Year 2010
*** Provisional Data, Subject to Change ***
Inches
50
45
40
35
30
25
20
15
10
5
0
10/1 10/31 11/30 12/30 1/29 2/28 3/30 4/29 5/29 6/28 7/28 8/27 9/26
Date (mm/dd)
Precip WY2010
SWE WY2010
Precip Avg 71-00
SWE Avg 71-00


MAY CREEK SNOTEL for Water Year 2010
*** Provisional Data, Subject to Change ***
Inches
25
20
15
10
5
0
10/1 10/31 11/30 12/30 1/29 2/28 3/30 4/29 5/29 6/28 7/28 8/27 9/26
Date (mm/dd)
Precip WY2010
SWE WY2010
SWE Avg 71-00

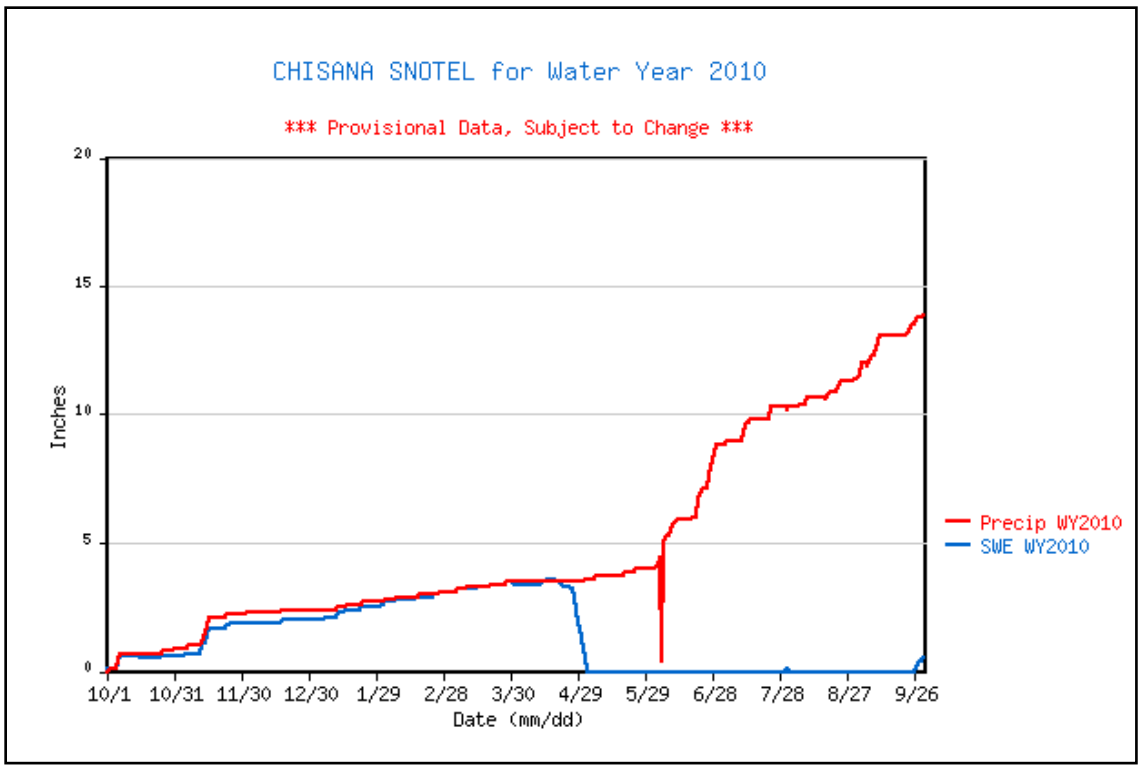


Figure 17. Cumulative precipitation for Water Year 2010 (Oct. 1 – Sep.30) for four SNOTEL sites.

Summary

The 2010 field season marked the fourth year of operational climate monitoring within CAKN. Annual maintenance was performed on all climate and snow monitoring instruments in the three CAKN parks. Maintenance included sensor replacement, troubleshooting, upgrades, data downloads, and sensor calibrations. Station maintenance logs were used to keep track of the climate station inventory for DENA, WRST, and YUCH which includes; sensors, data loggers, towers, solar panels, and batteries. Sensor and power performance was tracked and instrumentation was replaced as necessary.

The data from long-term sites are available at the Western Regional Climate Center (http://www.wrcc.dri.edu/CLIMATEDATA.html) and the National Climatic Data Center (http://www.ncdc.noaa.gov/oa/climateresearch.html). The CAKN climate stations transmit data via satellite and are available on the web at http://www.wrcc.dri.edu/NPS.html. Data products that are available include daily and monthly summaries, time series graphs, wind rose graphs, data inventories, and station metadata for all of the automated stations. The data are downloaded from the stations each year and are QA/QC by network staff and sent to WRCC to fill in any gaps from missed satellite transmissions. The raw data are also available for download through the 'data lister' tool on the WRCC website. These data are also ingested by multiple other networks and agencies and displayed in various formats. The University of Utah provides a well organized link to all of the Alaska data on their web site at http://mesowest.utah.edu/index.html.

An interagency agreement is in place for the maintenance, data archiving, and data dissemination for the four SNOTEL sites in the network. The data from the stations are transmitted hourly via meteor burst communication and are on-line at http://www.ak.nrcs.usda.gov/snow/.

This annual report provided a climate summary for the CAKN region in 2010 with brief references to the Alaska regional climate and the global climate. For a graphic display of worldwide significant climate anomalies for 2010 see Appendix D.

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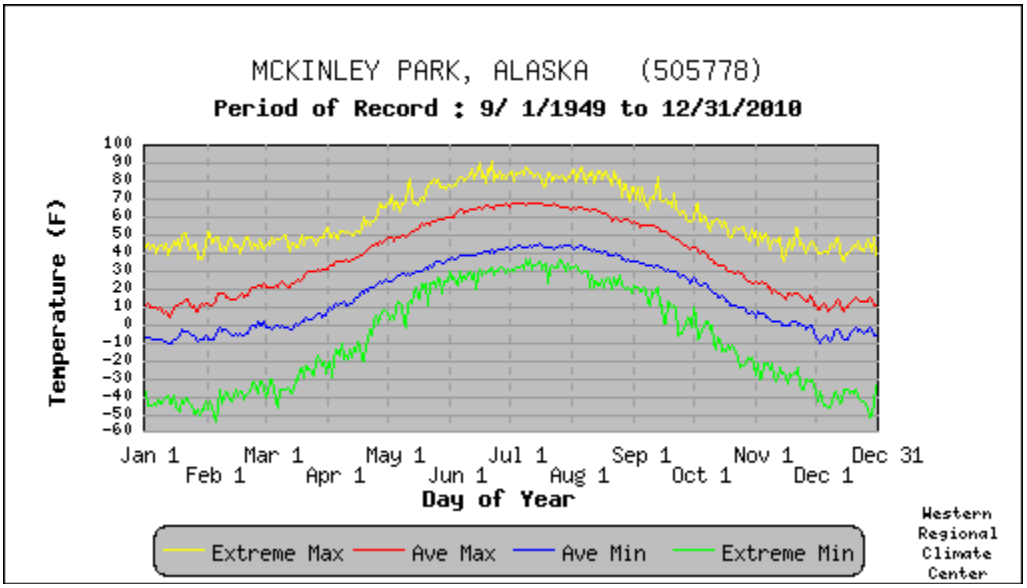
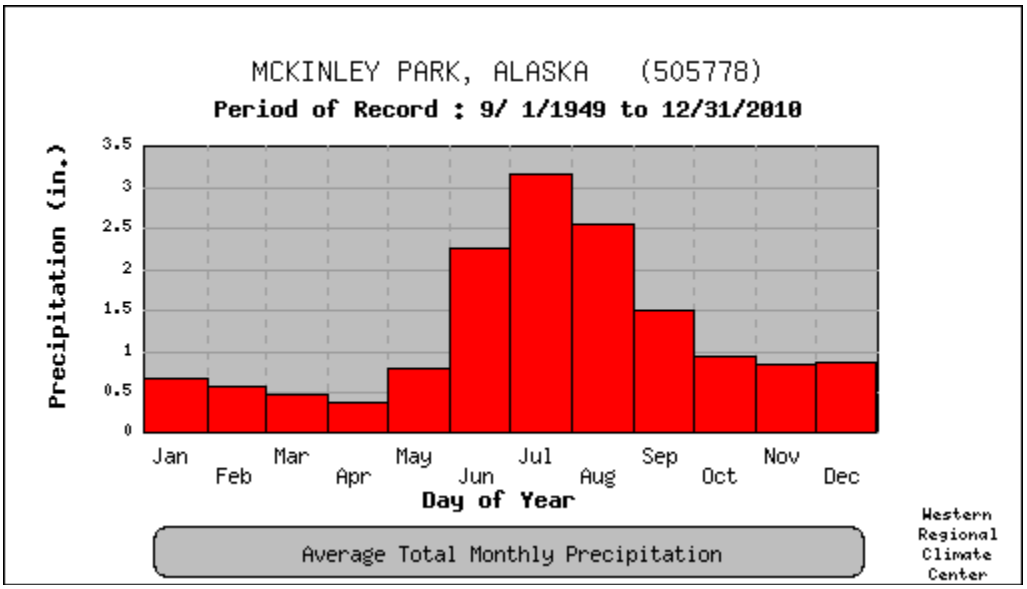
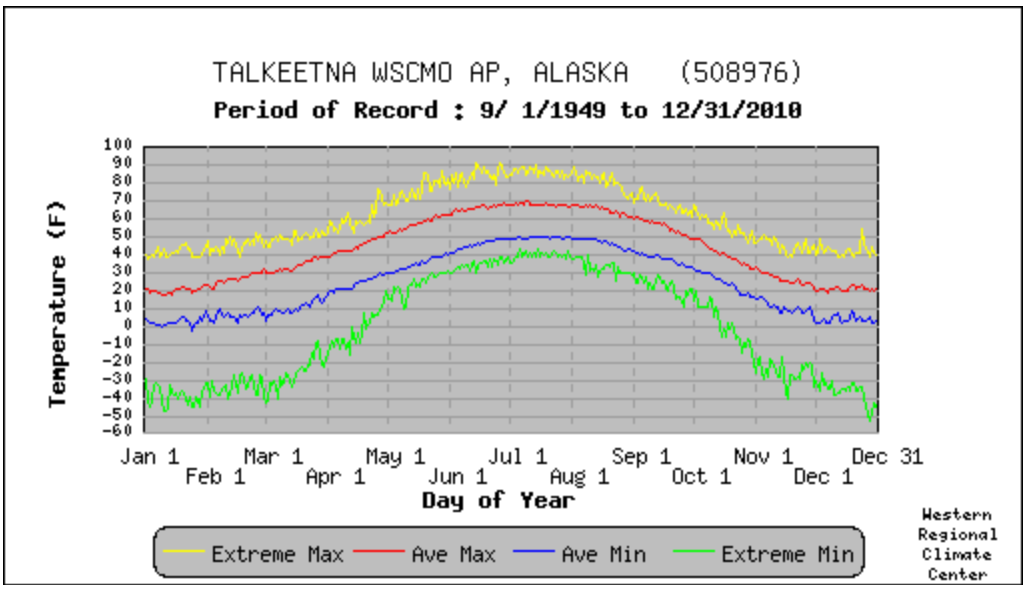
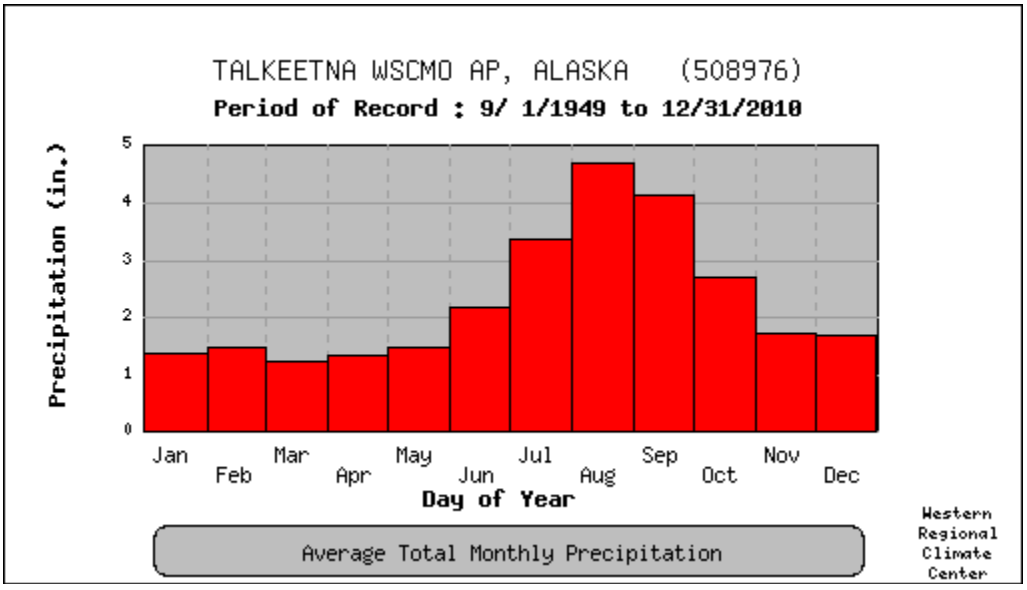
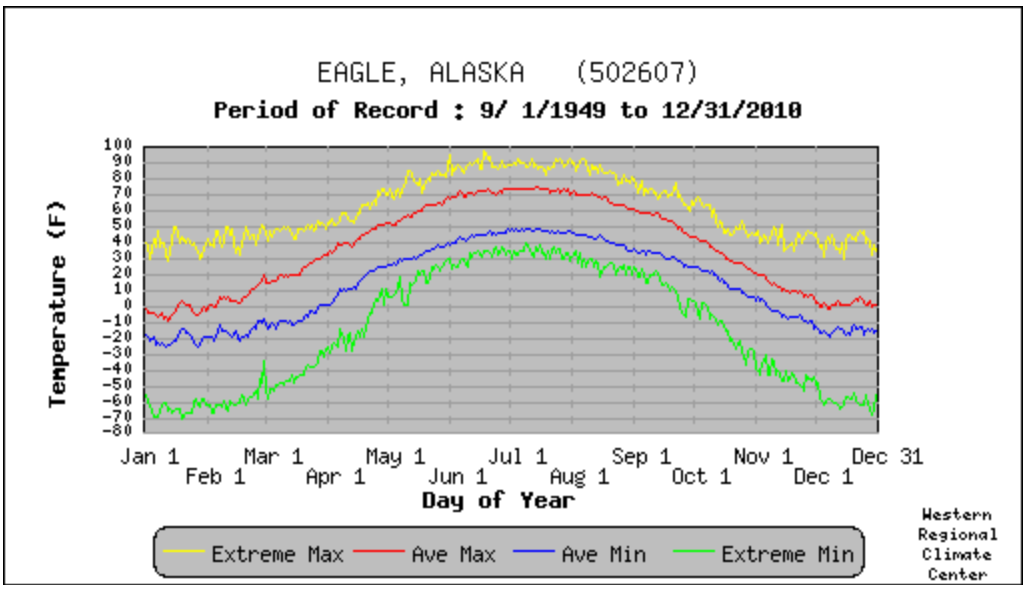
Appendix A. Period of Record Means at Long-term Sites

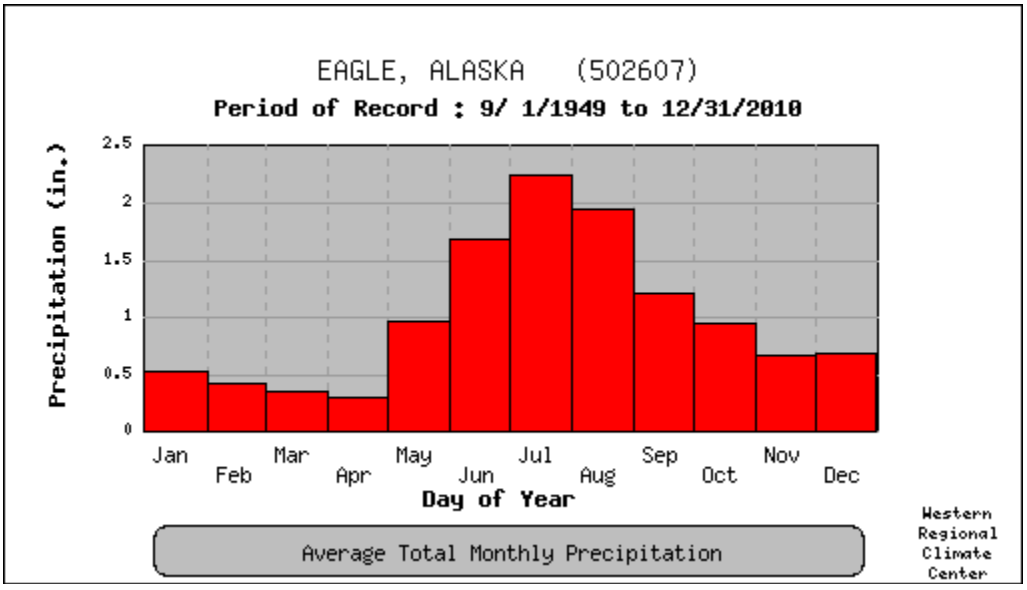


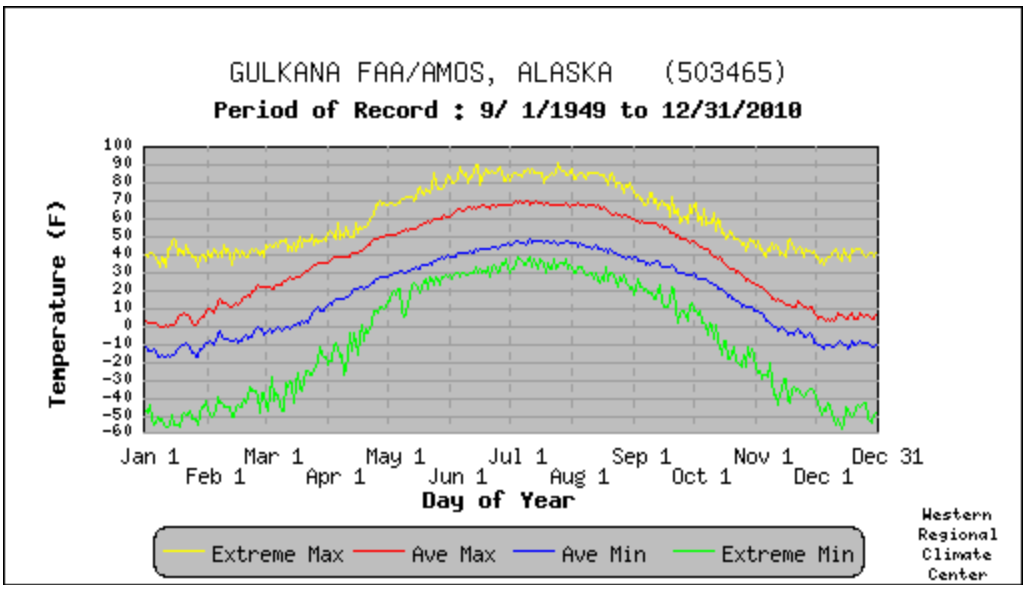


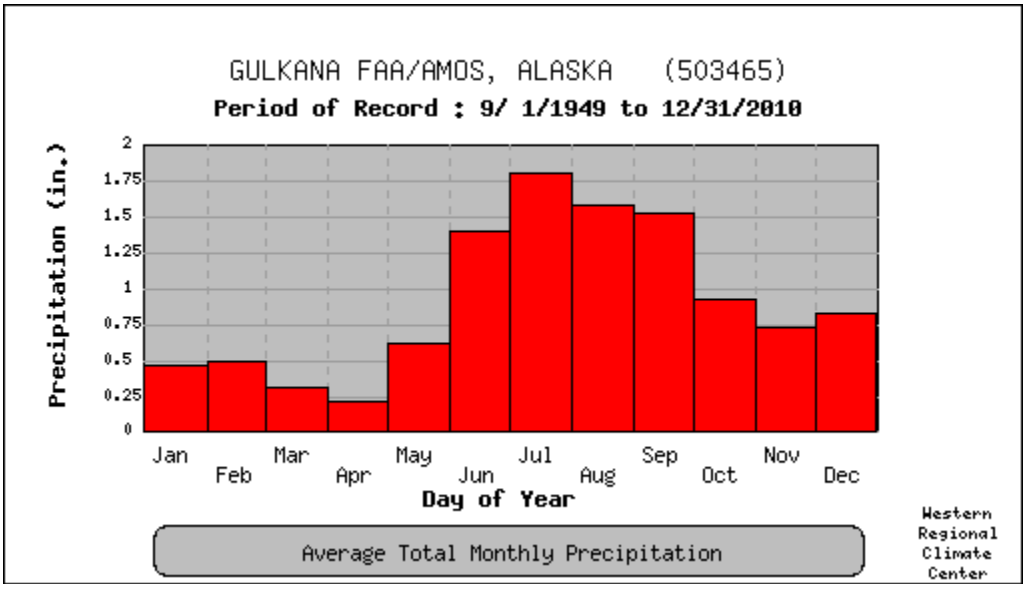

TALKEETNA WSCMO AP, ALASKA (508976)
Period of Record : 9/ 1/1949 to 12/31/2010
Temperature (F)
100
90
80
70
60
50
40
30
20
10
0
-10
-20
-30
-40
-50
-60
Jan 1
Feb 1
Mar 1
Apr 1
May 1
Jun 1
Jul 1
Aug 1
Sep 1
Oct 1
Nov 1
Dec 1
Dec 31
Day of Year
Extreme Max
Ave Max
Ave Min
Extreme Min
Western Regional Climate Center

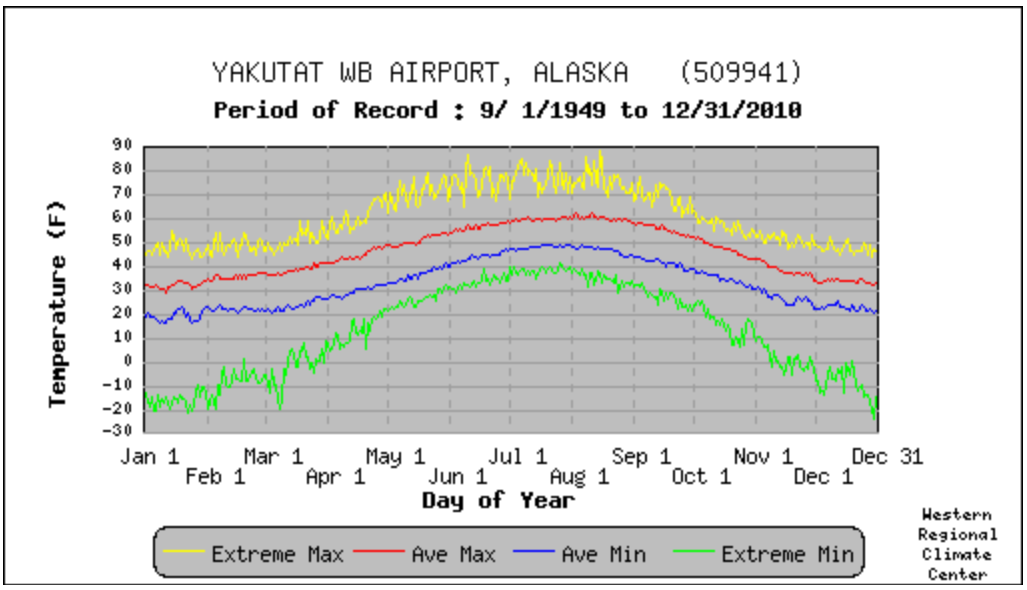

TALKEETNA WSCMO AP, ALASKA (508976)
Period of Record : 9/ 1/1949 to 12/31/2010
Precipitation (in.)
5
4
3
2
1
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Day of Year
Average Total Monthly Precipitation
Western Regional Climate Center

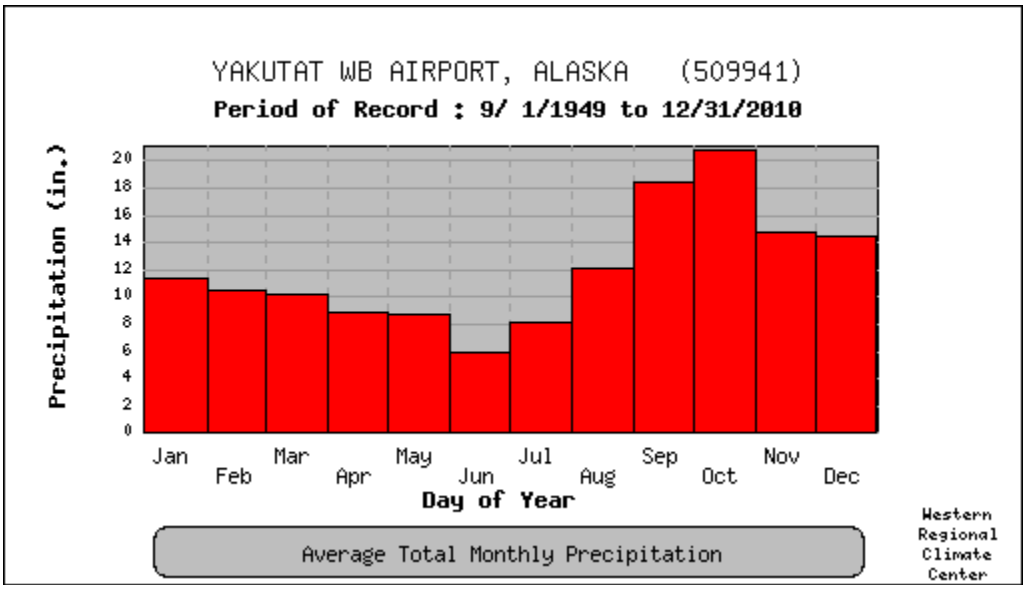

EAGLE, ALASKA (502607)
Period of Record : 9/ 1/1949 to 12/31/2010
Temperature (F)
100
90
80
70
60
50
40
30
20
10
0
-10
-20
-30
-40
-50
-60
-70
-80
Jan 1
Feb 1
Mar 1
Apr 1
May 1
Jun 1
Jul 1
Aug 1
Sep 1
Oct 1
Nov 1
Dec 1
Dec 31
Day of Year
Extreme Max
Ave Max
Ave Min
Extreme Min
Western Regional Climate Center


EAGLE, ALASKA (502607)
Period of Record : 9/ 1/1949 to 12/31/2010
Precipitation (in.)
2.5
2
1.5
1
0.5
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Day of Year
Average Total Monthly Precipitation
Western Regional Climate Center


GULKANA FAA/AMOS, ALASKA (503465)
Period of Record : 9/ 1/1949 to 12/31/2010
Temperature (F)
100
90
80
70
60
50
40
30
20
10
0
-10
-20
-30
-40
-50
-60
Jan 1
Feb 1
Mar 1
Apr 1
May 1
Jun 1
Jul 1
Aug 1
Sep 1
Oct 1
Nov 1
Dec 1
Dec 31
Day of Year
Extreme Max
Ave Max
Ave Min
Extreme Min
Western Regional Climate Center


GULKANA FAA/AMOS, ALASKA (503465)
Period of Record : 9/ 1/1949 to 12/31/2010
Precipitation (in.)
2
1.75
1.5
1.25
1
0.75
0.5
0.25
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Day of Year
Average Total Monthly Precipitation
Western Regional Climate Center


YAKUTAT WB AIRPORT, ALASKA (509941)
Period of Record : 9/ 1/1949 to 12/31/2010
Temperature (F)
90
80
70
60
50
40
30
20
10
0
-10
-20
-30
Jan 1
Feb 1
Mar 1
Apr 1
May 1
Jun 1
Jul 1
Aug 1
Sep 1
Oct 1
Nov 1
Dec 1
Dec 31
Day of Year
Extreme Max
Ave Max
Ave Min
Extreme Min
Western Regional Climate Center


YAKUTAT WB AIRPORT, ALASKA (509941)
Period of Record : 9/ 1/1949 to 12/31/2010
Precipitation (in.)
20
18
16
14
12
10
8
6
4
2
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Day of Year
Average Total Monthly Precipitation
Western Regional Climate Center

Appendix B. 2010 Climate Extremes at Long-term Sites

Daily summary stats retrieved from:
http://www.wrcc.dri.edu/cgi-bin/cliMAIN.pl?ak5778

Monthly summary stats retrieved from:
http://www.wrcc.dri.edu/cgi-bin/cliMAIN.pl?ak5778

McKinley Park - 2010 Records – 86 years

Record High Temperatures °F	45	Feb 19
	69	May 19
	75	May 30
	81	Aug 16
	67	Sept 7
Record Low Temperatures °F	4	Sep 28*

*** Tied with September 28 1956 and 1992.

Talkeetna – 2010 Records – 61 years

Record High Temperatures °F	39	Feb 17
	46	Feb 20
	44	Mar 2,3
	78	May 27
	74, 70, 67	Sep 12, 13, 14
	68	Oct 3
	53	Oct 18

Eagle – 2010 Records -55 years

Record High Temperatures °F	52	Mar 29
	61	Apr 22
	70	Apr 30
	82, 83, 83	May 27, 28, 29
	85, 84	Aug 16, 17
	67	Sep 13
	45	Nov 5
Record Precipitation – in.	0.21	Apr 8
	0.42	Apr 21
	0.55	Jun 19
	0.97	Jul 12
	0.55	Jul 23
	1.14	Aug 7
	0.17	Nov 16
	0.28	Nov 21
	0.16	Dec 11
Wettest Summer on Record – in.	10.09	Jun, Jul, & Aug

Gulkana 2010 records – 60 years of data

Record High temperatures °F	54	Apr 18
	76, 76, 78	May 27, 28, 29
	67, 70	Sep 14, 15
	68	Sep 17, 18
Record Low Temperatures °F	22	Sep 20
	3	Sep 28
Record precipitation – Inches	0.28	Jan 12
	0.18	Feb 25
	0.09	Mar 24
	0.14	Apr 30
	0.22	Nov 28

Yakutat 2010 records – 61 years of data

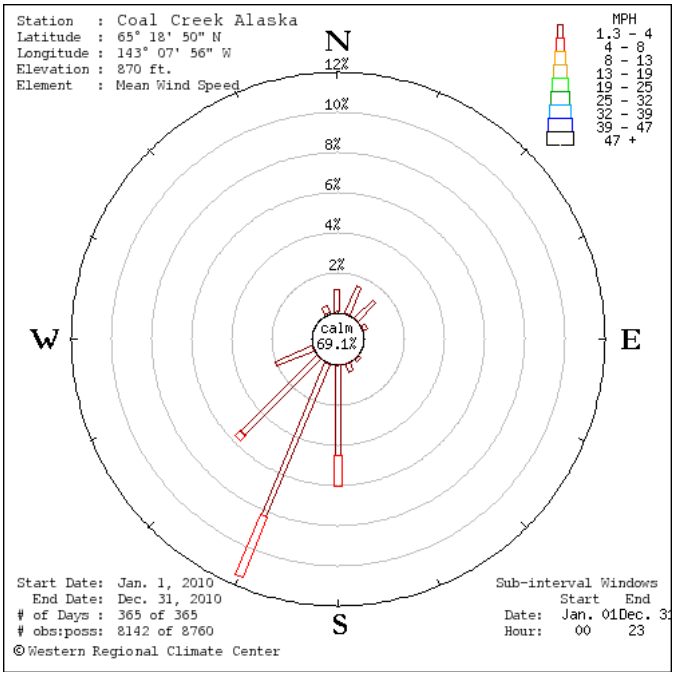
Record High temperatures °F:	45	Jan 8
	49, 54	Feb 18, 19
	46	Feb 22
	73, 75	May 27, 28
	75, 73, 74	Sep 14, 15, 16
	72, 71	Sep 18, 19
	56	Oct 24
	55	Nov 3
Record precipitation – Inches	2.37	Jul 6

Appendix C. 2010 CAKN Climate Station Monthly Data

Coal Creek Alaska

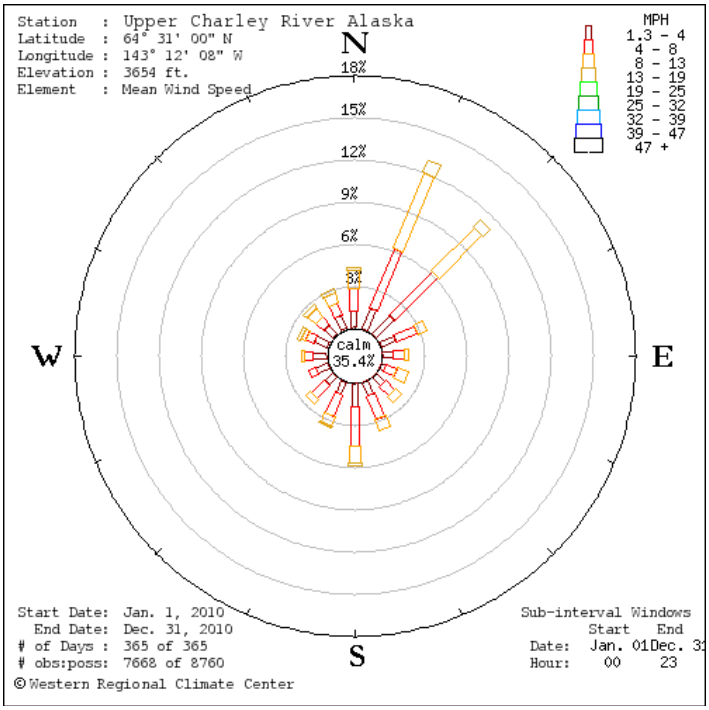
	Solar Radiation	Wind Speed	Wind Direction	Wind Gust	Air Temperature			Average Soil Temperature Inches			Relative Humidity	Snow Depth	Summer Precip*
Date	ly	mph	Deg	mph	Deg F			Deg F			%	in	in
	Total	Ave.	Ave.	Max.	Ave.	Max.	Min.	10 cm	20 cm	50 cm	Ave.	Ave.	Total
Jan-10	124	1	199	24	-17	14	-57	8.6	20	22	73	11	
Feb-10	1420	1	201	20	1	42	-45	12	19	20	77	13	
Mar-10	7212	2	217	20	10	44	-24	15	19	20	66	15	
Apr-10	15684	2	219	21	36	65	-5	26	24	23	58	9	
May-10	21834	2	221	29	51	80	27	37	30	29	52	1	
Jun-10	16759	1	197	10	58	75	37	46	31	30	61	1	1.59
Jul-10	11693	1	195	30	60	83	40	50	32	31	69	1	3.90
Aug-10	9086	1	208	9	56	86	35	47	33	31	75	2	2.48
Sep-10	6162	1	221	9	40	67	1	36	32	32	76	3	
Oct-10	1602	1	214	31	22	60	-9	29	32	32	89	5	
Nov-10	105	1	186	31	10	40	-41	28	32	32	91	12	
Dec-10	5	1	189	10	-25	17	-53	13	32	32	73	20	

* Ben Creek RAWS used as proxy for Coal Creek precip.



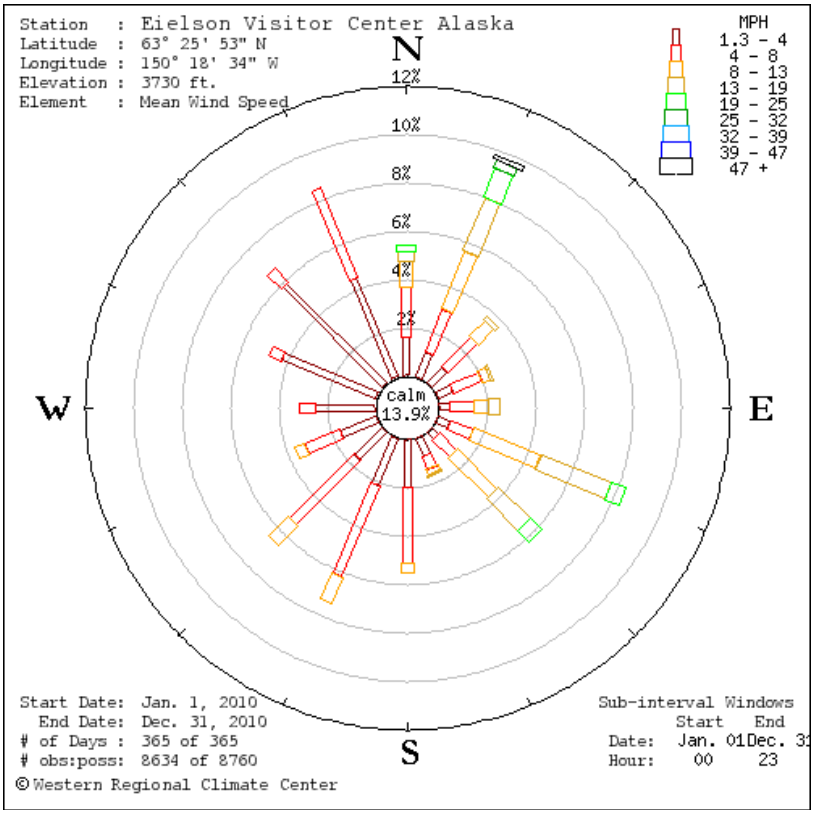
Upper Charley River Alaska

	Solar Radiation	Wind Speed	Wind Direction	Wind Gust	Air Temperature			Average Soil Temperature			Relative Humidity	Snow Depth	Summer Precip
Date	ly	mph	Deg	mph	Deg F			Deg F			%	in	in
	Total	Ave.	Ave.	Max.	Ave.	Max.	Min.	10 cm	20 cm	50 cm	Ave.	Ave.	Total
Jan-10	74.6	0.3	4.0	11.0	-3.1	19.0	-32.0	13.7	21.5	m	84.7	12.3	
Feb-10	869.6	4.3	16.8	23.0	10.6	30.0	-25.0	17.8	22.3	m	87.4	23.0	
Mar-10	5542.0	5.6	357.1	25.0	11.7	36.0	-7.0	20.2	22.9	m	71.7	16.3	
Apr-10	10918.0	6.5	51.7	22.0	29.0	51.0	7.0	27.0	25.6	m	64.9	12.2	
May-10	13662.0	5.9	342.9	28.0	44.2	68.0	27.0	45.4	32.9	m	57.3	0.1	
Jun-10	10918.0	4.4	185.2	23.0	48.8	63.0	0.0	51.3	40.0	m	71.4	0.2	2.30
Jul-10	11060.0	5.0	175.8	28.0	51.8	80.0	39.0	53.9	45.2	m	71.2	0.3	4.29
Aug-10	10101.0	1.3	4.6	22.0	49.5	74.0	35.0	55.6	46.3	m	48.0	3.7	1.59
Sep-10	6512.0	4.8	339.8	22.0	37.8	62.0	9.0	38.4	38.8	38.4	71.4	8.4	
Oct-10	2218.0	4.6	34.6	21.0	22.2	47.0	3.0	28.3	31.0	31.4	90.6	13.3	
Nov-10	362.5	3.8	46.1	27.0	15.0	30.0	-18.0	26.4	29.1	29.1	90.2	18.0	
Dec-10	2.0	0.1	9.6	1.0	-14.6	-1.0	-26.0	20.1	24.4	23	81.5	24.7	



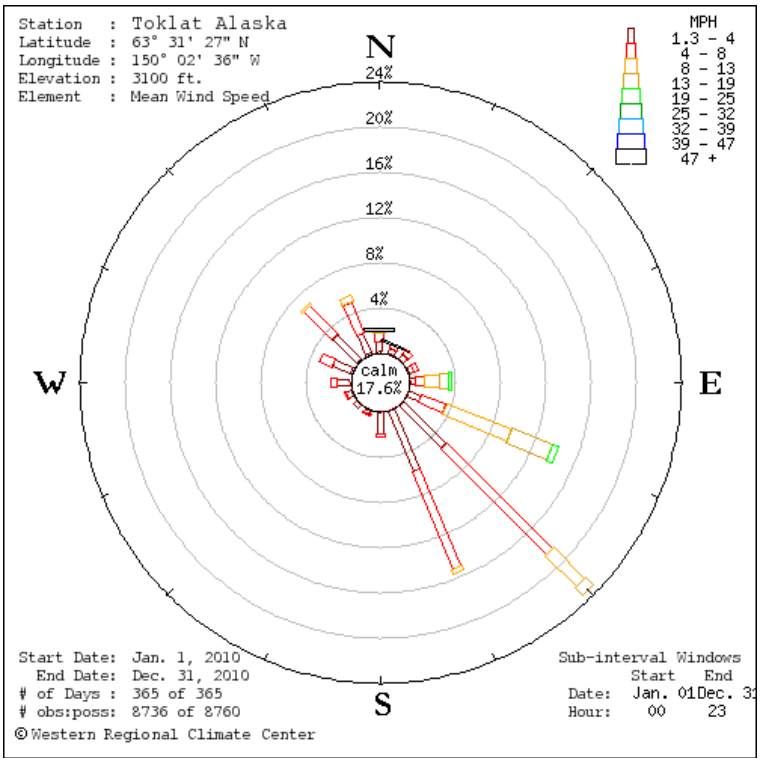
Eielson Visitor Center

	Solar Radiation	Wind Speed	Wind Direction	Wind Gust	Air Temperature			Relative Humidity	Summer Precip
Date	ly	mph	Deg	mph	Deg F			%	In.
	Total	Ave.	Ave.	Max.	Ave.	Max.	Min.	Ave.	Total
Jan-10	693	7	200	34	20	38	-9	55.17	
Feb-10	2287	7	189	38	21	45	-15	59.48	
Mar-10	7462	6	185	32	17	37	-19	59.31	
Apr-10	11509	8	171	32	29	54	7	56.09	
May-10	15688	7	174	30	43	65	22	57.07	
Jun-10	11442	5	193	23	47	63	36	77.84	7.07
Jul-10	11853	6	185	24	49	67	37	78.22	7.59
Aug-10	9385	6	183	31	48	71	36	72.49	5.63
Sep-10	7610	6	176	30	43	63	14	79.76	
Oct-10	3168	7	163	30	29	52	6	m	
Nov-10	831	5	216	26	20	48	-5	m	
Dec-10	206	6	225	42	9	36	-22	m	



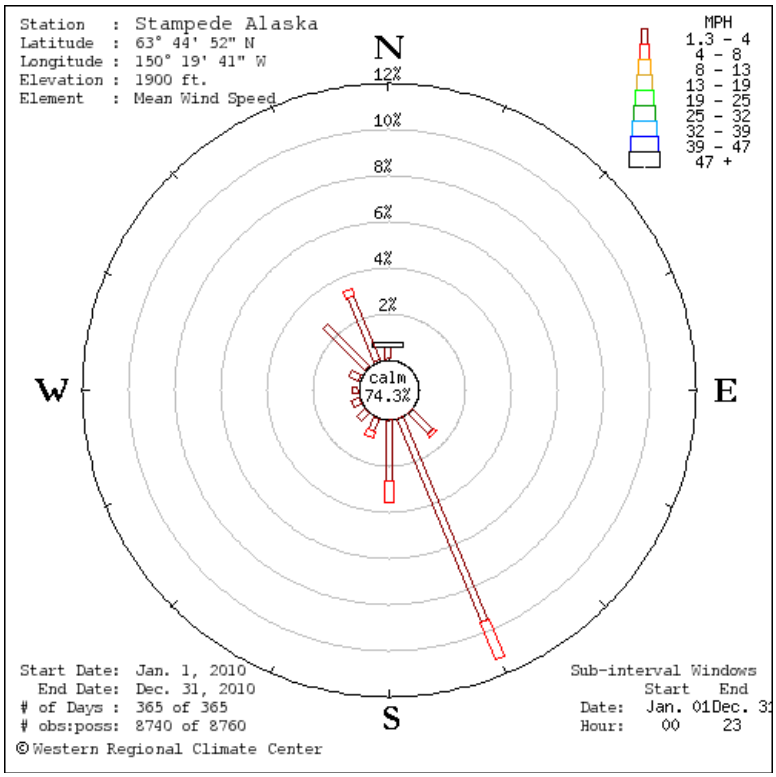
Toklat Alaska

	Solar Radiation	Wind Speed	Wind Direction	Wind Gust	Air Temperature			Average Soil Temperature			Relative Humidity	Snow Depth	Summer Precip
Date	ly	mph	Deg	mph	Deg F			Deg F			%	in	in
	Total	Ave.	Ave.	Max.	Ave.	Max.	Min.	10cm	20cm	50cm	Ave.	Ave.	Total
Jan-10	406	4	154	25	2	37	-39	22	21.9	23.3	77	7	
Feb-10	1551	7	136	37	14	45	-35	24	24.2	25.1	67	6	
Mar-10	4959	6	139	33	11	36	-29	23	22.9	24	68	6	
Apr-10	10039	8	125	31	30	55	-1	30	30.0	29.5	57	2	
May-10	13893	6	131	43	45	68	21	45	45.0	41.6	55	1	
Jun-10	11192	4	137	47	48	65	32	52	51.9	49.8	73	0	5.72
Jul-10	11297	6	116	54	51	70	36	54	53.6	52.0	71	0	4.04
Aug-10	8304	5	131	47	50	72	34	51	50.8	49.6	77	0	3.53
Sep-10	6309	5	196	44	39	62	7	40	39.6	39.8	72	0	
Oct-10	2606	5	140	31	26	55	-6	27	27.2	28.3	74	2	
Nov-10	781	4	149	26	17	44	-26	26	26.0	27.2	75	5	
Dec-10	134	4	148	27	-4	36	-31	19	19.1	21.4	76	8	



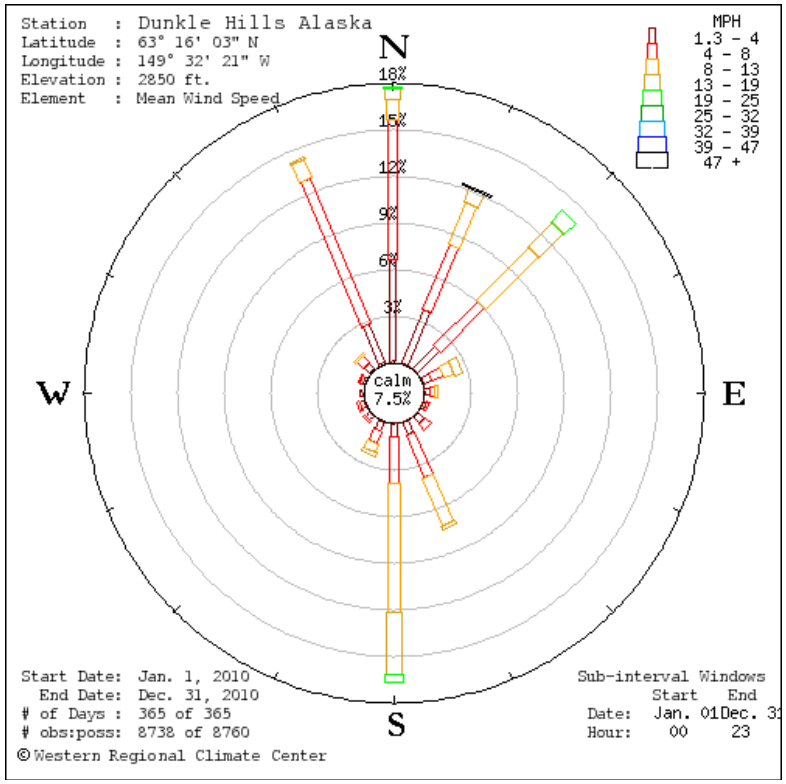
Stampede Alaska

	Solar Radiation	Wind Speed	Wind Direction	Wind Gust	Air Temperature			Average Soil Temperature			Relative Humidity	Snow Depth	Summer Precip
Date	ly	mph	Deg	mph	Deg F			Deg F			%	in	
	Total	Ave.	Ave.	Max.	Ave.	Max.	Min.	10cm	20cm	50cm	Ave.	Ave.	
Jan-10	144.8	0	177	4	-11	18	-49	13	16	19	80	9	
Feb-10	1005	1	210	11	5	57	-37	14	16	18	79	10	
Mar-10	6298	2	195	11	8	43	-33	13	16	18	68	12	
Apr-10	9961	2	190	13	32	63	-8	27	27	25	59	7	
May-10	13529	2	206	14	47	77	20	48	46	39	58	0	
Jun-10	12107	2	194	13	52	73	34	56	55	50	73	0	3.63
Jul-10	11239	2	208	12	55	80	32	58	58	54	73	0	2.64
Aug-10	8464	1	194	11	52	82	29	55	55	53	77	0	1.65
Sep-10	6426	2	201	9	40	69	2	41	42	44	75	0	
Oct-10	2170	1	189	15	24	59	-10	27	30	32	83	2	
Nov-10	230.9	1	155	13	13	39	-28	25	28	29	83	5	
Dec-10	76.86	0	0	0	-16	25	-42	17	21	23	78	8	



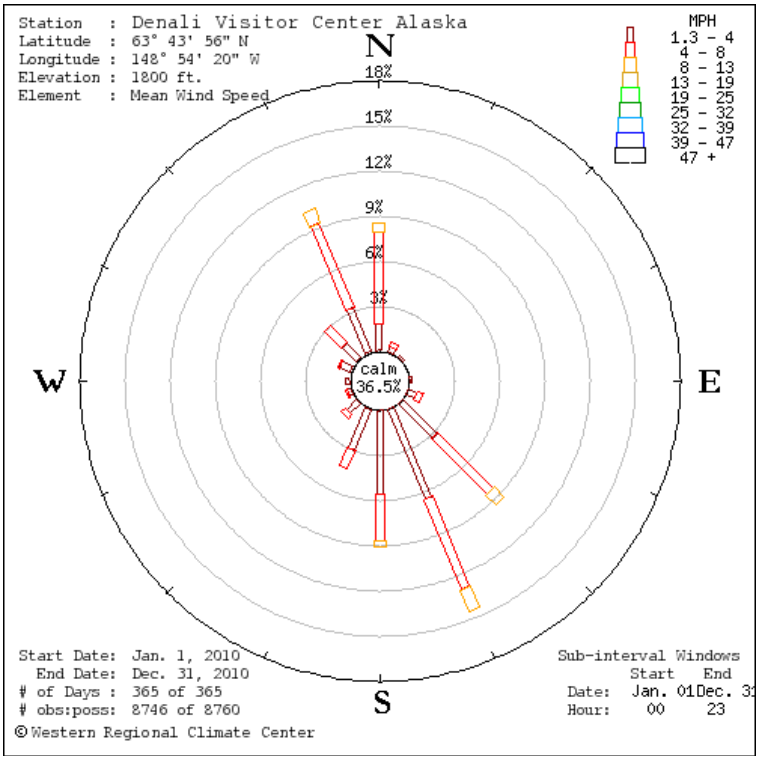
Dunkle Hills

	Solar Radiation	Wind Speed	Wind Direction	Wind Gust	Air Temperature			Average Soil Temperature			Relative Humidity	Snow Depth
Date	ly	mph	Deg	mph	Deg F			Deg F			%	in
	Total	Ave.	Ave.	Max.	Ave.	Max.	Min.	10cm	20cm	50cm	Ave.	Ave.
Jan-10	787	7	15	30	10	29	-25	18	19	27	77	7
Feb-10	2379	5	14	34	16	39	-19	18	19	24	76	8
Mar-10	7592	6	18	22	16	42	-14	21	22	25	73	11
Apr-10	12828	7	3	36	27	48	2	25	25	26	72	9
May-10	16223	6	347	30	43	70	23	39	38	31	63	0
Jun-10	12208	9	170	24	47	65	33	48	46	36	80	0
Jul-10	9630	8	169	24	49	72	34	50	49	41	85	0
Aug-10	8407	7	144	22	49	71	32	50	49	44	84	0
Sep-10	7467	6	12	25	41	68	8	42	42	42	69	0
Oct-10	3319	4	20	24	28	51	1	31	32	36	78	1
Nov-10	779	6	16	27	20	35	-6	29	30	33	77	7
Dec-10	441	10	24	32	4	30	-20	26	26	32	71	14



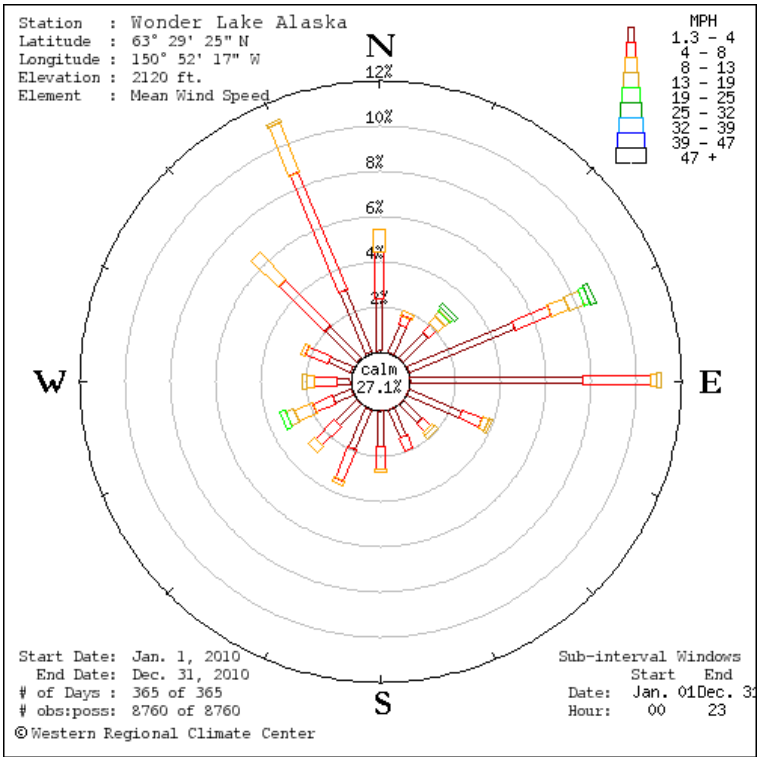
Denali Visitor Center

	Solar Radiation	Wind Speed	Wind Direction	Wind Gust	Air Temperature			Fuel Temp			Relative Humidity			Precipitation
Date	ly	mph	Deg	mph	Deg F			Deg F			%			in
	Total	Ave.	Ave.	Max.	Ave.	Max.	Min.	Ave.	Max.	Min.	Ave.	Max.	Min.	Total
Jan-10	113	1	166	14	-10	35	-50	-11	34	-52	76	93	57	
Feb-10	1496	3	171	24	11	51	-41	8	51	-41	68	92	22	
Mar-10	5391	4	156	24	13	47	-26	11	52	-28	64	92	27	
Apr-10	11151	4	158	26	33	69	-3	32	80	-7	57	94	21	
May-10	15653	3	154	24	48	80	20	47	86	14	55	94	17	
Jun-10	14078	3	152	22	54	80	31	53	88	25	66	93	20	3.59
Jul-10	12307	3	157	20	56	84	35	55	92	30	65	87	18	2.08
Aug-10	9717	3	156	22	55	85	26	53	91	20	73	100	0	1.90
Sep-10	7273	3	159	28	41	73	-4	38	75	-10	74	100	25	
Oct-10	2633	3	174	23	27	58	-1	25	59	-8	78	100	25	
Nov-10	167	2	167	21	13	39	-30	11	38	-32	88	100	53	
Dec-10	35	1	174	21	-15	33	-42	-16	32	-43	77	100	57	



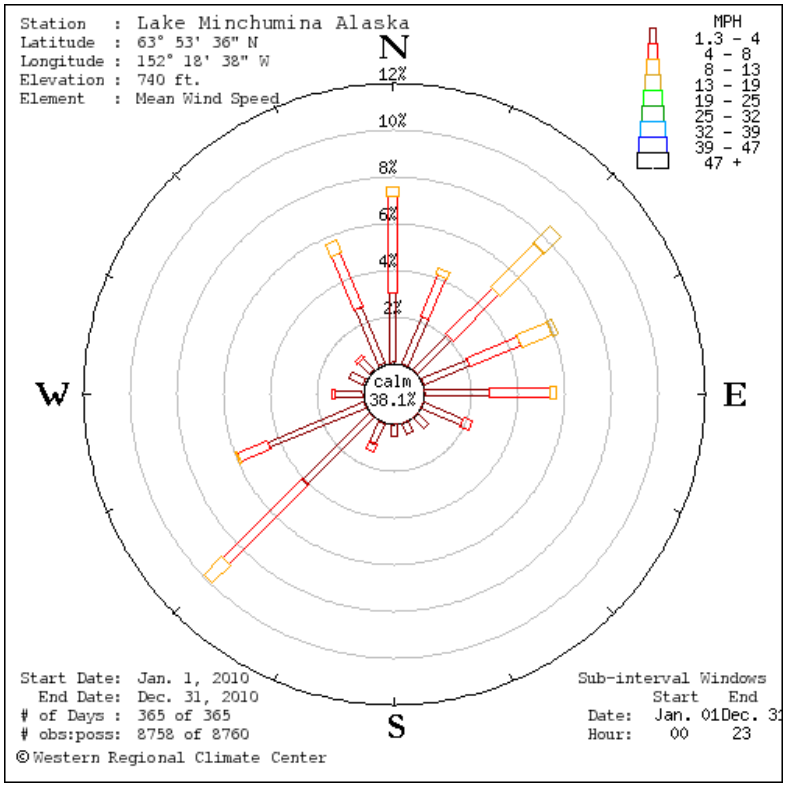
Wonder Lake Alaska

	Solar Radiation	Wind Speed	Wind Direction	Wind Gust	Air Temperature			Fuel Temp			Relative Humidity			Precipitation
Date	ly	mph	Deg	mph	Deg F			Deg F			%			in
	Total	Ave.	Ave.	Max.	Ave.	Max.	Min.	Ave.	Max.	Min.	Ave.	Max.	Min.	Total
Jan-10	504	4	35	45	-5	29	-29	-5	27	-29	61	88	29	
Feb-10	1942	3	66	33	8	44	-32	8	47	-33	62	100	33	
Mar-10	7593	4	37	34	9	43	-25	10	51	-26	53	88	18	
Apr-10	11826	4	95	31	30	63	-1	31	73	-2	53	100	19	
May-10	14859	5	59	28	46	74	20	48	84	19	54	100	15	
Jun-10	14260	5	40	32	52	71	35	53	82	33	75	100	21	3.99
Jul-10	12818	5	322	39	54	80	33	55	86	32	77	100	15	1.69
Aug-10	10433	4	3	31	52	78	33	53	87	32	82	100	32	2.19
Sep-10	7870	5	38	48	41	68	5	42	76	4	69	100	27	
Oct-10	3181	3	44	41	23	58	2	24	65	-1	76	100	25	
Nov-10	517	3	90	36	14	42	-22	13	38	-23	76	100	18	
Dec-10	102	2	70	30	-11	27	-36	-12	26	-37	65	98	38	



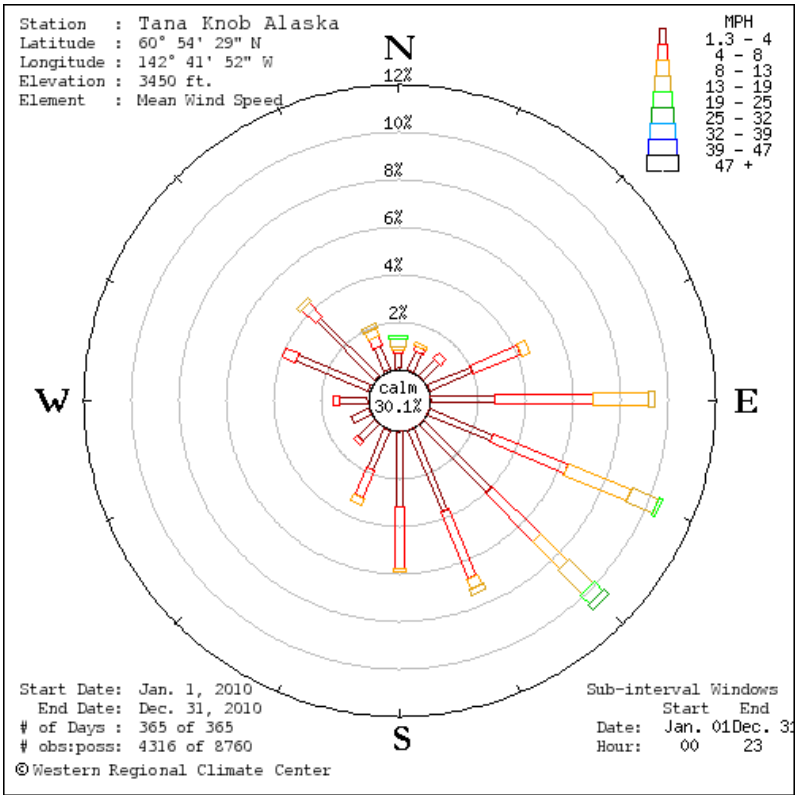
Lake Minchumina

	Solar Radiation	Wind Speed	Wind Direction	Wind Gust	Air Temperature			Fuel Temp			Relative Humidity			Precipitation
Date	ly	mph	Deg	mph	Deg F			Deg F			%			in
	Total	Ave.	Ave.	Max.	Ave.	Max.	Min.	Ave.	Max.	Min.	Ave.	Max.	Min.	Total
Jan-10	360	4	29	38	-5	15	-34	2	14	-15	75	93	41	
Feb-10	1287	2	350	17	5	31	-31	7	26	-16	81	100	51	
Mar-10	5850	4	11	32	12	40	-19	10	30	-13	63	96	27	
Apr-10	9937	3	290	29	36	69	5	35	80	7	58	100	16	
May-10	14901	3	2	25	52	83	28	54	96	23	46	98	14	
Jun-10	14210	3	256	23	58	83	39	59	101	35	70	100	21	3.68
Jul-10	11246	3	242	26	59	85	42	59	98	39	76	100	27	3.09
Aug-10	9066	2	270	22	57	83	40	57	98	37	81	100	34	2.16
Sep-10	6913	4	29	31	47	71	18	46	78	11	66	100	23	
Oct-10	1873	3	29	36	28	54	8	27	60	3	79	100	32	
Nov-10	157.2	2	325	24	15	37	-17	14	36	-18	85	100	48	
Dec-10	58.32	3	29	21	-10	8	-34	-10	9	-31	67	82	47	



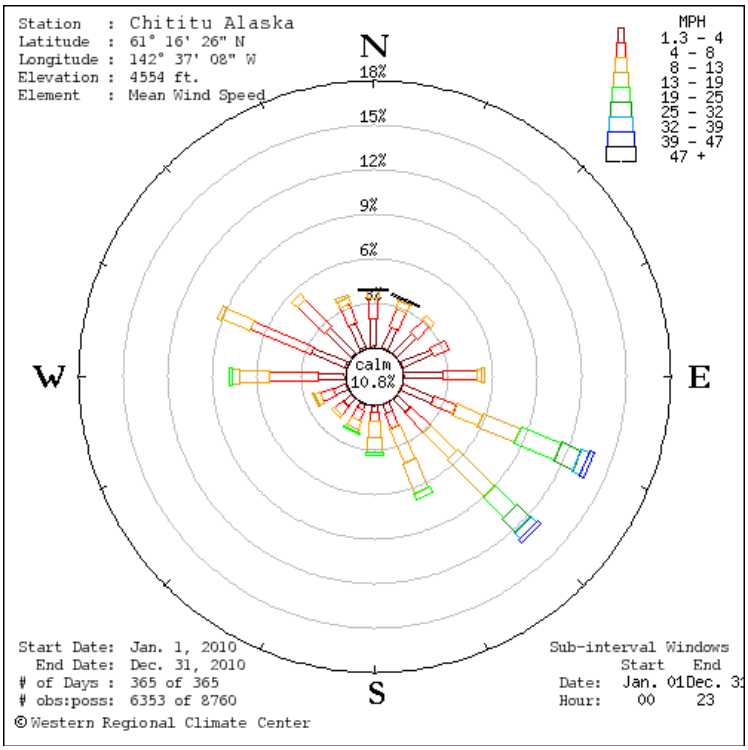
Tana Knob

	Solar Radiation	Wind Speed	Wind Direction	Wind Gust	Air Temperature			Average Soil Temperature			Relative Humidity	Snow Depth
Date	ly	mph	Deg	mph	Deg F			Deg F			%	in
	Total	Ave.	Ave.	Max.	Ave.	Max.	Min.	10cm	20cm	50cm	Ave.	Ave.
Jan-10	763	2	172	21	13	36	-18	31	32	m	84	52
Feb-10	2402	5	151	39	25	48	-2	31	32	m	79	64
Mar-10	6158	6	151	43	22	38	7	31	32	m	86	69
Apr-10	11793	5	155	33	29	64	12	31	32	m	69	70
May-10	16961	4	193	27	41	64	26	32	32	m	55	47
Jun-10	14441	4	180	17	m	m	m	46	41	m	70	0
Jul-10	11863	5	157	22	48	66	39	54	52	m	77	0
Aug-10	10959	4	146	21	50	72	39	52	51	m	77	0
Sep-10	6668	4	170	28	43	62	22	39	42	m	73	0
Oct-10	2908	5	152	42	30	50	18	32	34	m	82	8
Nov-10	1009	6	199	38	22	41	-6	32	33	m	79	27
Dec-10	186	3	156	42	1	35	-27	31	32	m	85	36



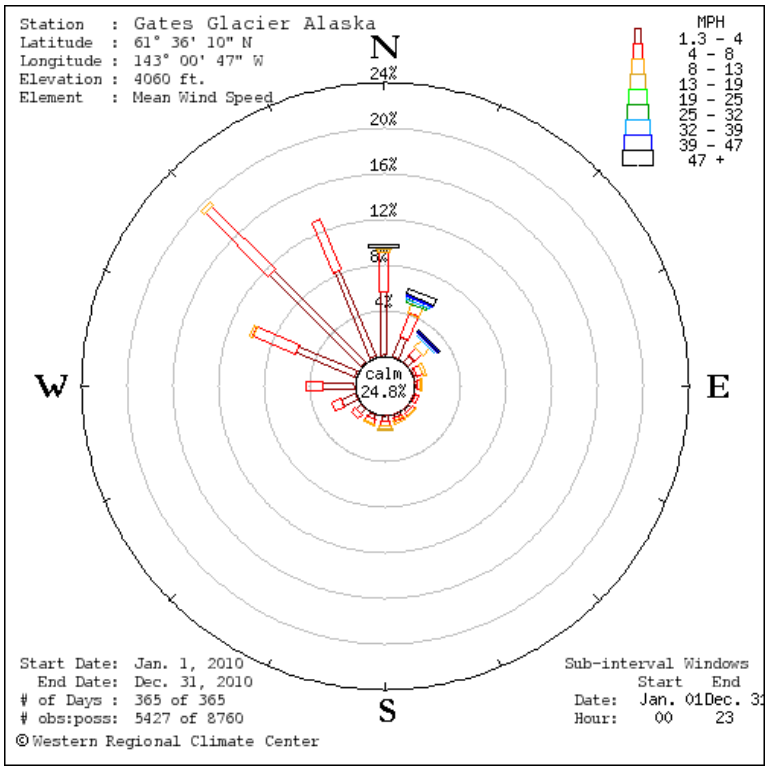
Chititu

	Solar Radiation	Wind Speed	Wind Direction	Wind Gust	Air Temperature			Average Soil Temperature			Relative Humidity	Snow Depth	Summer Precip
Date	ly	mph	Deg	mph	Deg F			Deg F			%	in	in
	Total	Ave.	Ave.	Max.	Ave.	Max.	Min.	10cm	20cm	50cm	Ave.	Ave.	Total
Jan-10	761	7	155	38	16	37	-23	13	17	19	71	2	
Feb-10	2629	10	131	61	26	45	3	20	20	21	63	3	
Mar-10	6576	11	136	66	20	33	2	17	19	21	68	3	
Apr-10	10454	11	174	53	28	49	11	27	25	24	66	1	
May-10	14299	10	198	41	41	64	23	42	33	29	55	2	
Jun-10	9039	8	209	35	42	63	32	45	36	32	81	0	3.33
Jul-10	8454	9	172	34	46	64	35	49	38	41	83	1	4.95
Aug-10	8032	10	192	47	46	70	37	48	41	45	81	1	2.36
Sep-10	5887	7	213	47	39	57	18	38	37	40	53	2	
Oct-10	761	12	133	51	28	44	16	27	32	33	0	6	
Nov-10	2629	11	155	67	20	42	-12	24	31	30	0	7	
Dec-10	6576	7	166	60	6	34	-17	15	22	22	0	6	



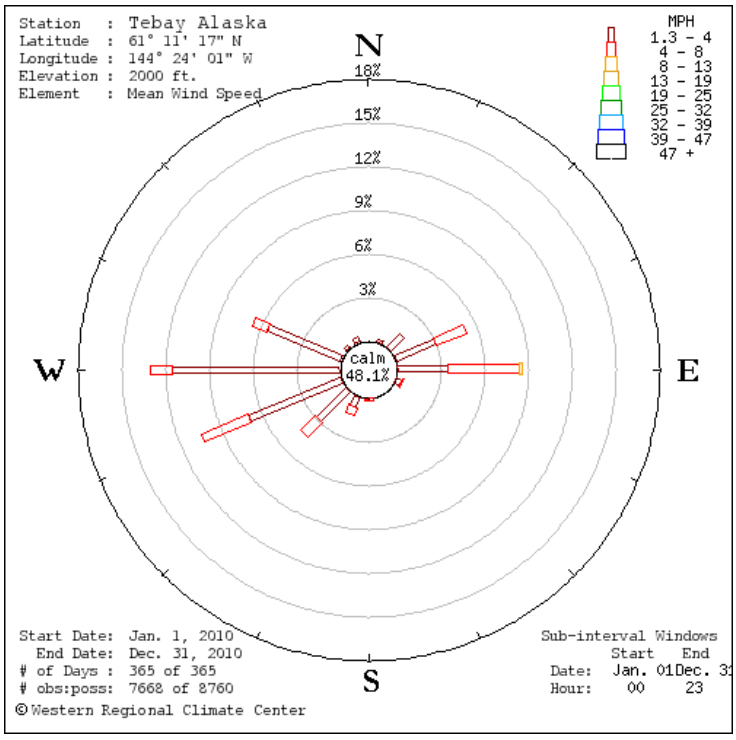
Gates Glacier

	Solar Radiation	Wind Speed	Wind Direction	Wind Gust	Air Temperature			Average Soil Temperature			Relative Humidity	Snow Depth	Summer Precip
Date	ly	mph	Deg	mph	Deg F			Deg F			%	in	in
	Total	Ave.	Ave.	Max.	Ave.	Max.	Min.	10cm	20cm	50cm	Ave.	Ave.	Total
Jan-10	715	3	241	18	18	40	-19	30	31	32	75	32	
Feb-10	2230	4	262	26	27	49	0	31	31	32	66	34	
Mar-10	7286	5	252	34	21	42	2	30	31	32	66	42	
Apr-10	12093	4	240	30	28	48	14	31	31	32	62	47	
May-10	17103	4	225	30	41	62	24	36	33	32	54	24	
Jun-10	12832	3	201	21	42	61	32	49	47	40	79	3	3.29
Jul-10	10180	3	220	21	46	63	34	50	51	46	70	0	5.70
Aug-10	10483	3	211	17	48	70	37	51	53	49	43	0	3.27
Sep-10	5728	3	231	23	41	58	19	39	44	44	22	12	
Oct-10	265	3	236	23	29	50	17	30	33	36	0	17	
Nov-10	93	4	255	35	22	39	-7	31	32	34	0	25	
Dec-10	19	2	205	21	7	35	-14	30	32	33	0	54	



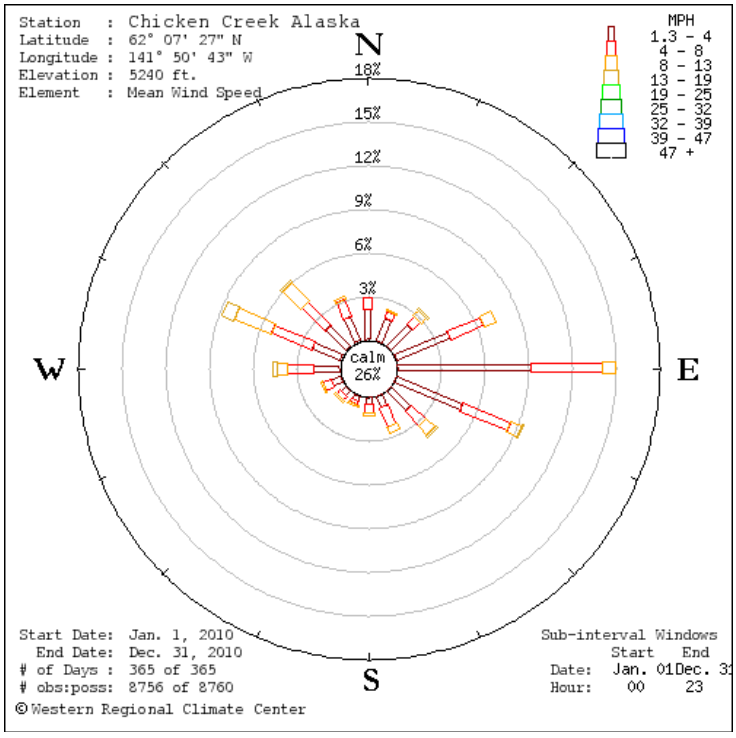
Tebay

	Solar Radiation	Wind Speed	Wind Direction	Wind Gust	Air Temperature			Average Soil Temperature			Relative Humidity	Snow Depth	Summer Precip
Date	ly	mph	Deg	mph	Deg F			Deg F			%	in	in
	Total	Ave.	Ave.	Max.	Ave.	Max.	Min.	10cm	20cm	50cm	Ave.	Ave.	Total
Jan-10	99	0	2	4	3	22	-22	m	m	m	88	37	
Feb-10	896	1	211	8	18	40	-1	m	m	m	87	44	
Mar-10	5788	1	304	10	21	43	-8	m	m	m	81	53	
Apr-10	11713	2	188	19	29	54	1	m	m	m	75	51	
May-10	16880	2	221	13	41	67	21	m	m	m	71	20	
Jun-10	14537	3	257	13	48	69	33	m	m	m	75	4	m
Jul-10	10537	3	261	12	50	70	38	53	52	48	85	0	2.33
Aug-10	9845	2	222	11	51	70	37	54	53	50	85	0	1.44
Sep-10	7305	2	137	11	43	69	20	45	45	45	82	6	
Oct-10	2520	1	136	11	31	55	14	34	34	36	89	6	
Nov-10	381	3	125	12	21	38	0	32	32	33	87	19	
Dec-10	133	3	83	15	-1	33	-28	31	32	32	82	27	



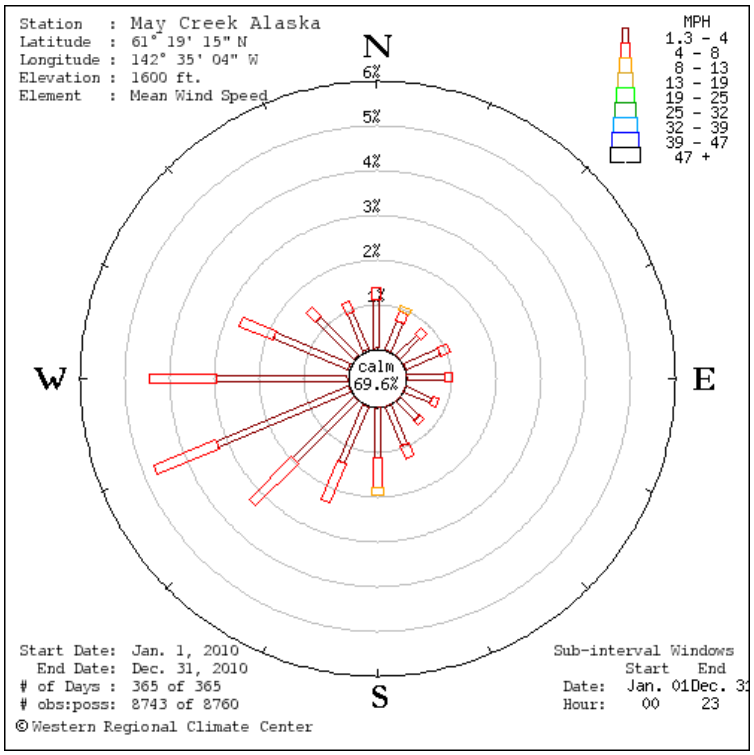
Chicken Creek

	Solar Radiation	Wind Speed	Wind Direction	Wind Gust	Air Temperature			Average Soil Temperature			Relative Humidity	Snow Depth	Summer Precip
Date	ly	mph	Deg	mph	Deg F			Deg F			%	in	in
	Total	Ave.	Ave.	Max.	Ave.	Max.	Min.	10cm	20cm	50cm	Ave.	Ave.	Total
Jan-10	554	2	100	16	11	32	-29	12	18	23	73	3	
Feb-10	2830	3	105	20	19	45	-11	-31	-18	-16	63	6	
Mar-10	6759	4	136	28	15	38	-3	-64	-64	-64	64	6	
Apr-10	11661	5	160	24	26	46	8	-64	-64	-64	61	6	
May-10	14269	6	173	34	39	62	24	-64	-64	-64	56	3	
Jun-10	11861	6	212	41	42	57	32	-61	-57	-62	76	0	6.73
Jul-10	13230	6	200	36	48	65	-93	22	37	25	66	0	4.46
Aug-10	10832	5	186	24	46	73	34	45	46	42	70	0	2.94
Sep-10	7091	4	174	23	36	60	11	36	38	38	73	0	
Oct-10	3758	4	138	27	24	43	9	31	31	32	69	1	
Nov-10	1145	4	150	27	17	44	-17	26	25	28	70	3	
Dec-10	172	2	140	43	2	34	-27	20	19	23	75	5	



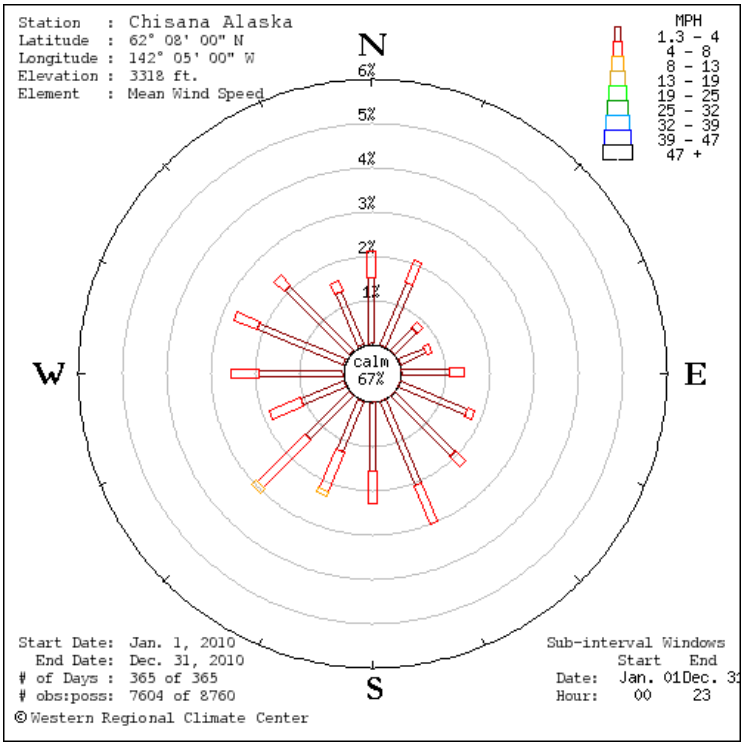
May Creek

	Solar Radiation	Mean Wind Speed	Mean Wind Direction	Maximum Wind Gust	Average Air Temperature			Ave Fuel Temp			Average Relative Humidity			Snow Depth	Precipitation
Date	ly	mph	Deg	mph	Deg F			Deg F			%			in	in
mm/yyyy	Total	Ave.	Ave.	Max.	Ave.	Max.	Min.	Ave.	Max.	Min.	Ave.	Max.	Min.	Ave.	Total
Jan-10	78	0	92	3	-4	15	-35	7	16	-15	83	92	70		
Feb-10	1672	0	168	16	15	51	-11	18	26	7	84	99	34		
Mar-10	7882	2	196	22	23	51	-16	21	31	5	64	99	22		
Apr-10	11780	2	204	25	35	63	0	31	71	10	59	99	21		
May-10	18176	3	208	24	48	80	19	49	92	18	52	99	15		
Jun-10	13230	2	226	19	53	78	28	54	86	25	69	99	19		2.34
Jul-10	12044	1	225	19	55	81	32	56	92	31	76	100	17		3.53
Aug-10	12150	1	196	20	55	84	28	56	96	27	75	100	27		1.54
Sep-10	7868	1	207	31	42	74	16	43	82	14	79	99	26		
Oct-10	3304	1	179	19	27	54	-1	26	60	-2	80	99	33		
Nov-10	900	1	183	24	14	45	-19	11	48	-23	84	99	38		
Dec-10	210	0	118	20	-15	35	-48	-7	26	-37	79	99	64		



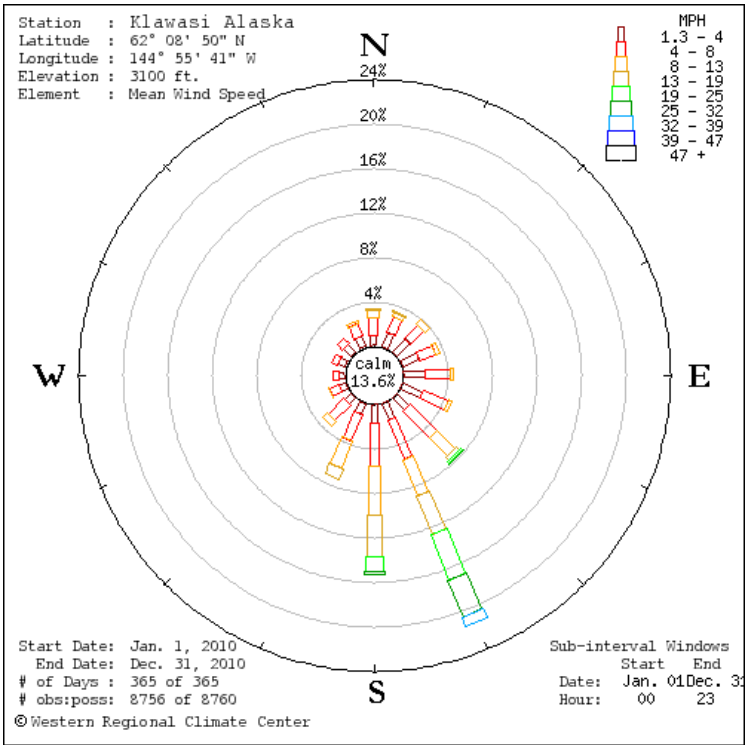
Chisana

	Solar Radiation	Mean Wind Speed	Mean Wind Direction	Maximum Wind Gust	Average Air Temperature			Ave Fuel Temp			Average Relative Humidity			Snow Depth	Precipitation
Date	ly	mph	Deg	mph	Deg F			Deg F			%			in	in
mm/yyyy	Total	Ave.	Ave.	Max.	Ave.	Max.	Min.	Ave.	Max.	Min.	Ave.	Max.	Min.	Ave.	Total
Jan-10	m	m	m	m	m	m	m	m	m	m	m	m	m	m	
Feb-10	862	1	113	9	8	43	-20	8	29	-9	71	88	33	12	
Mar-10	6750	1	120	24	12	45	-23	11	40	-10	58	88	16	13	
Apr-10	12583	2	141	19	29	57	-9	28	69	-15	53	98	17	10	
May-10	16763	2	116	28	44	76	13	46	89	9	53	100	14	0	
Jun-10	15253	2	86	21	50	71	26	51	87	24	67	100	21	0	4.52
Jul-10	15702	2	159	25	54	78	25	56	92	22	61	100	21	0	1.48
Aug-10	12651	2	131	22	51	85	23	52	99	20	68	100	17	0	1.16
Sep-10	6865	1	134	15	36	68	-5	37	82	-10	78	100	24	2	
Oct-10	3569	1	120	14	17	51	-11	17	68	-13	75	100	27	1	
Nov-10	329	1	109	13	6	38	-31	4	39	-36	79	97	44	5	
Dec-10	129	0	114	16	-18	32	-43	-15	28	-43	67	94	51	11	



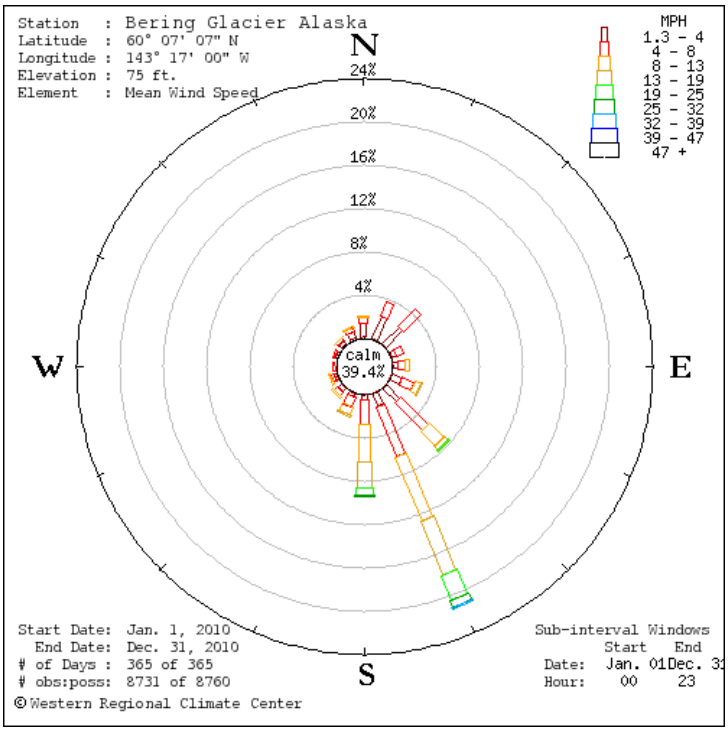
Klawasi

	Solar Radiation	Mean Wind Speed	Mean Wind Direction	Maximum Wind Gust	Average Air Temperature			Ave Fuel Temp			Average Relative Humidity			Precipitation
Date	ly	mph	Deg	mph	Deg F			Deg F			%			in
mm/yyyy	Total	Ave.	Ave.	Max.	Ave.	Max.	Min.	Ave.	Max.	Min.	Ave.	Max.	Min.	Total
Jan-10	848	2	139	40	4	27	-25	16	26	5	80	88	48	
Feb-10	2464	5	104	48	19	46	-11	23	32	16	69	89	27	
Mar-10	7742	9	144	51	21	44	1	22	32	12	63	88	33	
Apr-10	13202	11	154	63	32	56	9	31	62	11	54	88	24	
May-10	17035	9	156	48	46	71	23	48	92	18	50	89	19	
Jun-10	13617	9	176	39	48	70	34	50	97	30	67	89	28	2.70
Jul-10	14135	11	178	45	53	73	39	54	99	35	67	89	23	3.18
Aug-10	12072	10	156	53	52	76	34	53	94	28	68	89	31	2.32
Sep-10	8368	7	134	54	42	65	14	44	94	13	68	89	30	
Oct-10	3838	8	141	63	29	54	9	28	61	8	67	89	35	
Nov-10	965	7	134	60	19	41	-15	25	32	14	72	89	40	
Dec-10	271	4	132	57	-4	40	-25	23	28	18	76	88	47	

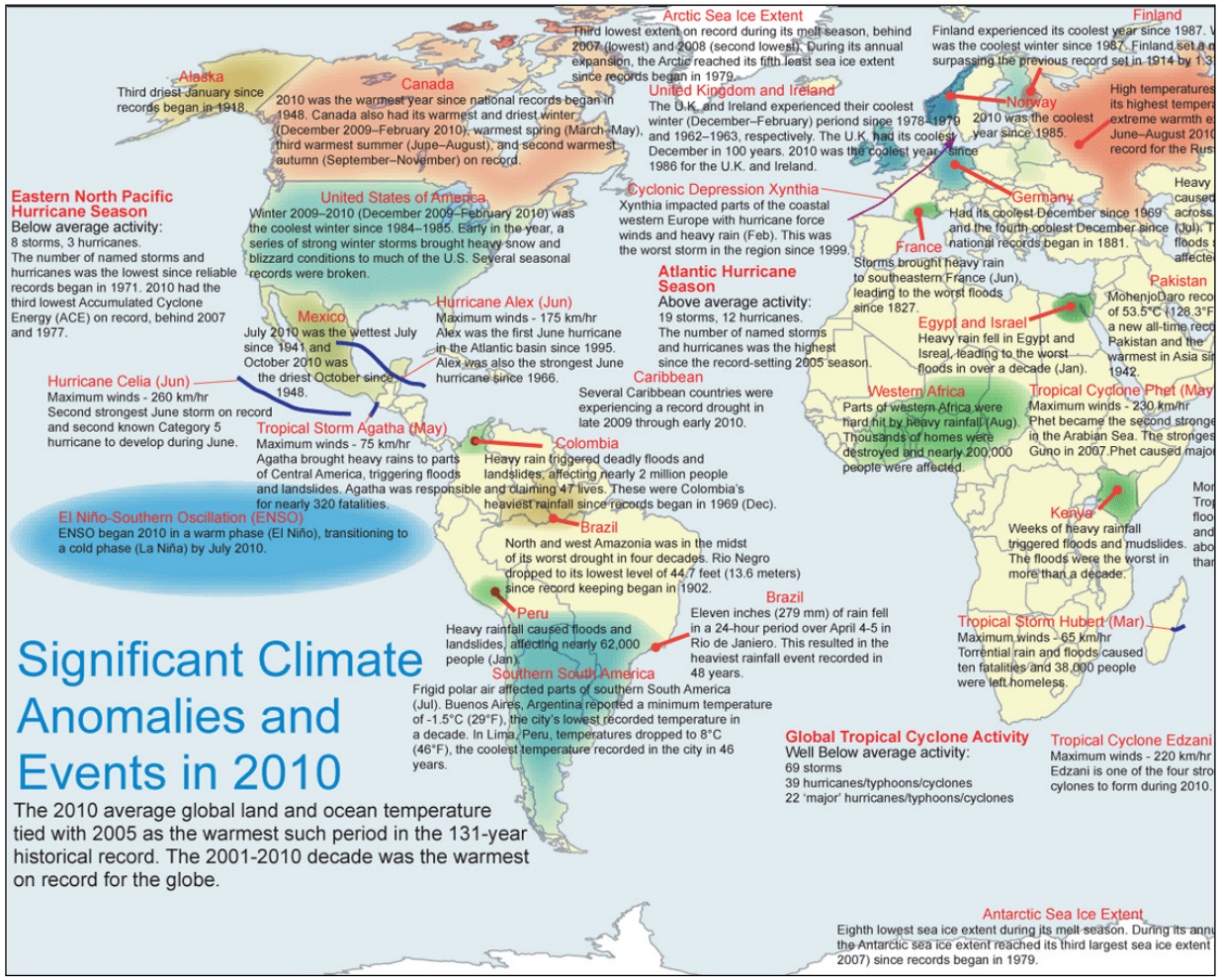


Bering Glacier

	Solar Radiation	Mean Wind Speed	Mean Wind Direction	Maximum Wind Gust	Average Air Temperature			Ave Fuel Temp			Average Relative Humidity			Precipitation
Date	ly	mph	Deg	mph	Deg F			Deg F			%			in
mm/yyyy	Total	Ave.	Ave.	Max.	Ave.	Max.	Min.	Ave.	Max.	Min.	Ave.	Max.	Min.	Total
Jan-10	741	5	142	183	33	44	10	31	43	5	92	100	38	
Feb-10	1141	4	147	182	36	53	13	34	60	5	92	100	39	
Mar-10	3005	9	153	194	34	50	15	33	48	19	90	100	43	
Apr-10	5292	7	150	187	39	64	14	39	74	1	84	100	31	
May-10	9030	6	60	187	47	69	30	51	93	24	81	100	37	2.89
Jun-10	6832	4	44	184	49	70	33	51	86	30	89	100	39	4.43
Jul-10	4572	5	120	188	50	63	35	51	81	32	97	100	66	6.54
Aug-10	5265	2	27	184	50	68	35	52	86	33	94	100	62	
Sep-10	4515	3	44	194	45	65	29	47	81	24	92	100	41	
Oct-10	1492	7	150	192	41	55	26	39	56	22	95	100	38	
Nov-10	723	7	146	197	35	50	16	33	47	9	93	100	22	
Dec-10	593	4	94	197	25	40	-4	21	38	-10	87	100	36	



Appendix D. Worldwide Significant Climate Anomalies



Graph courtesy of the National Oceanic and Atmospheric Administration (NOAA). Retrieved from http://www.ncdc.noaa.gov/sotc/global/2010/13.

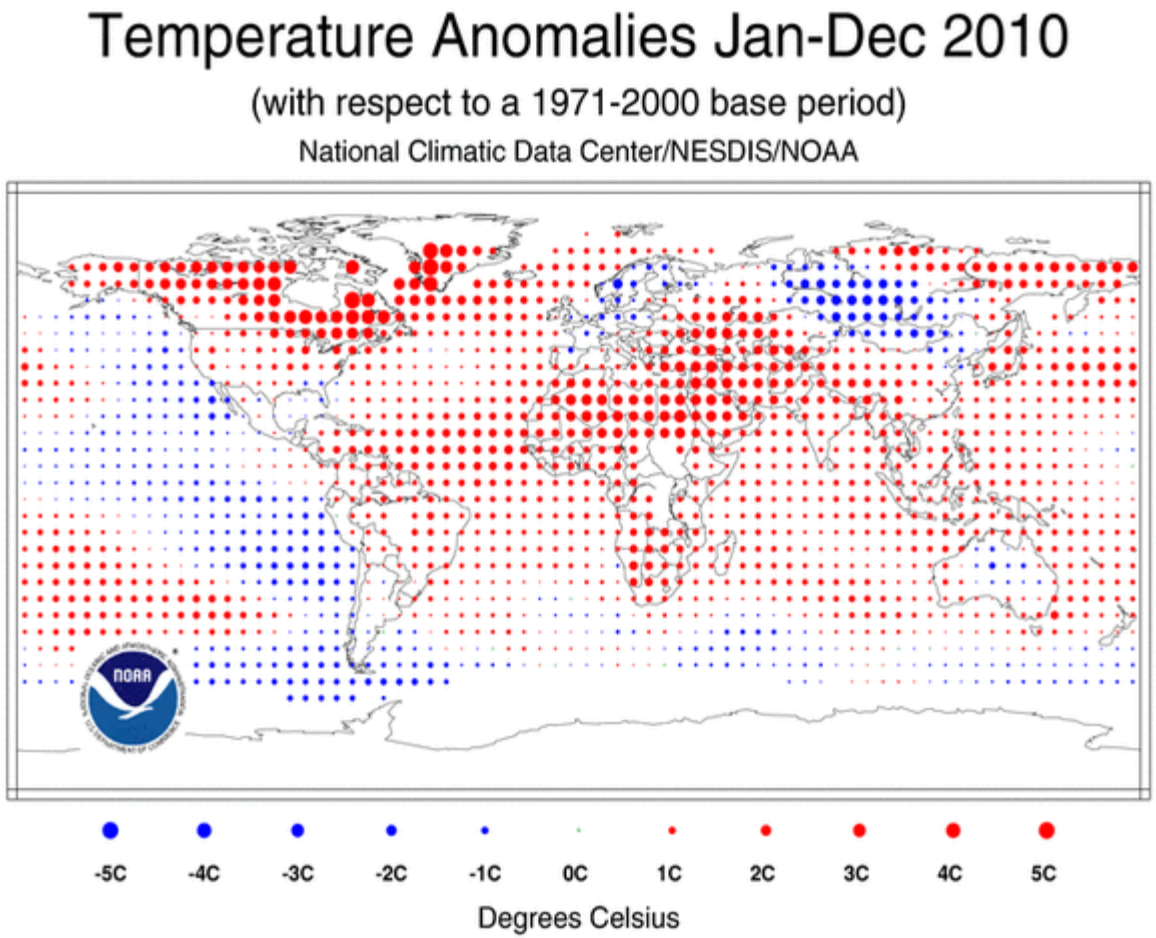


Figure courtesy of NOAA. Retrieved from http://www.ncdc.noaa.gov/sotc/service/global/map-land-sfc-mntp/201001-201012.gif

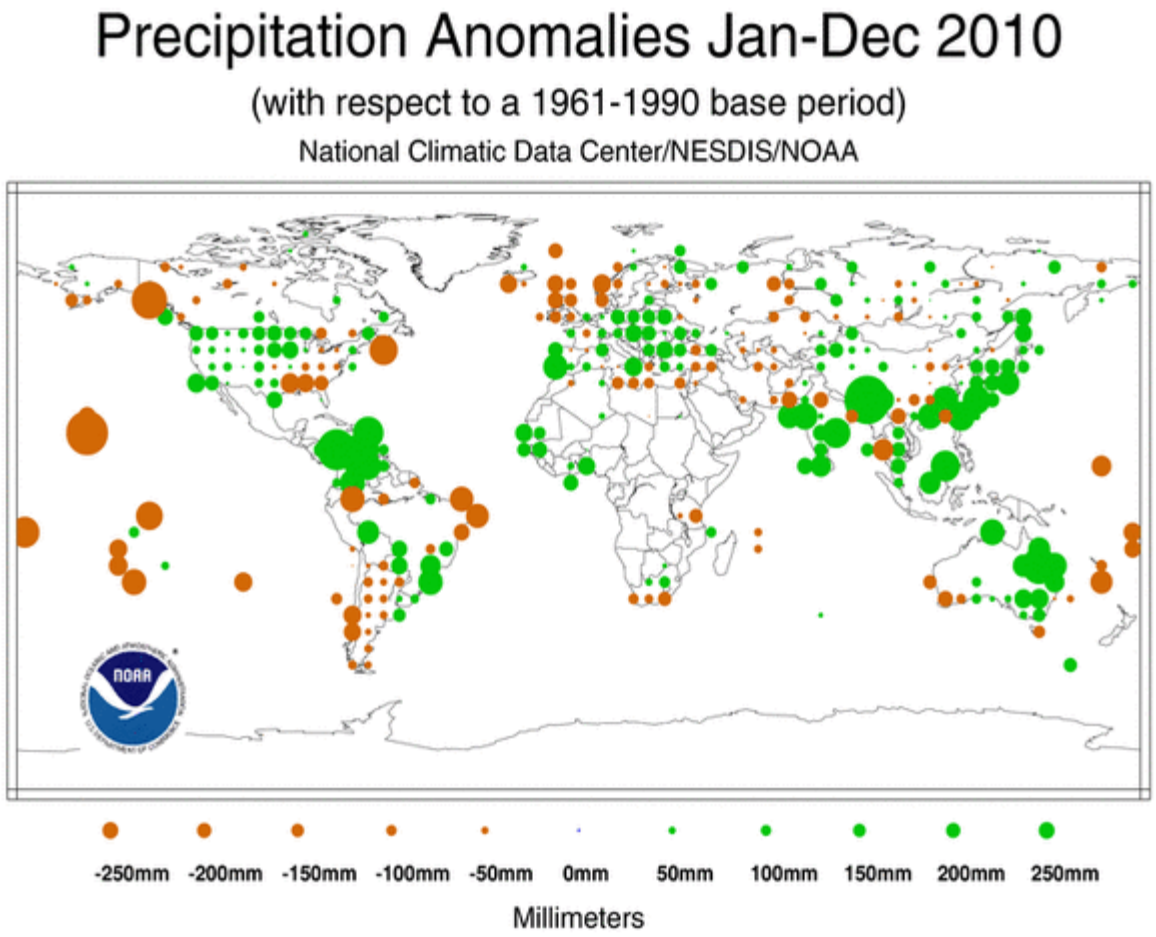


Figure courtesy of NOAA. Retrieved from http://www.ncdc.noaa.gov/sotc/global/2010/13.

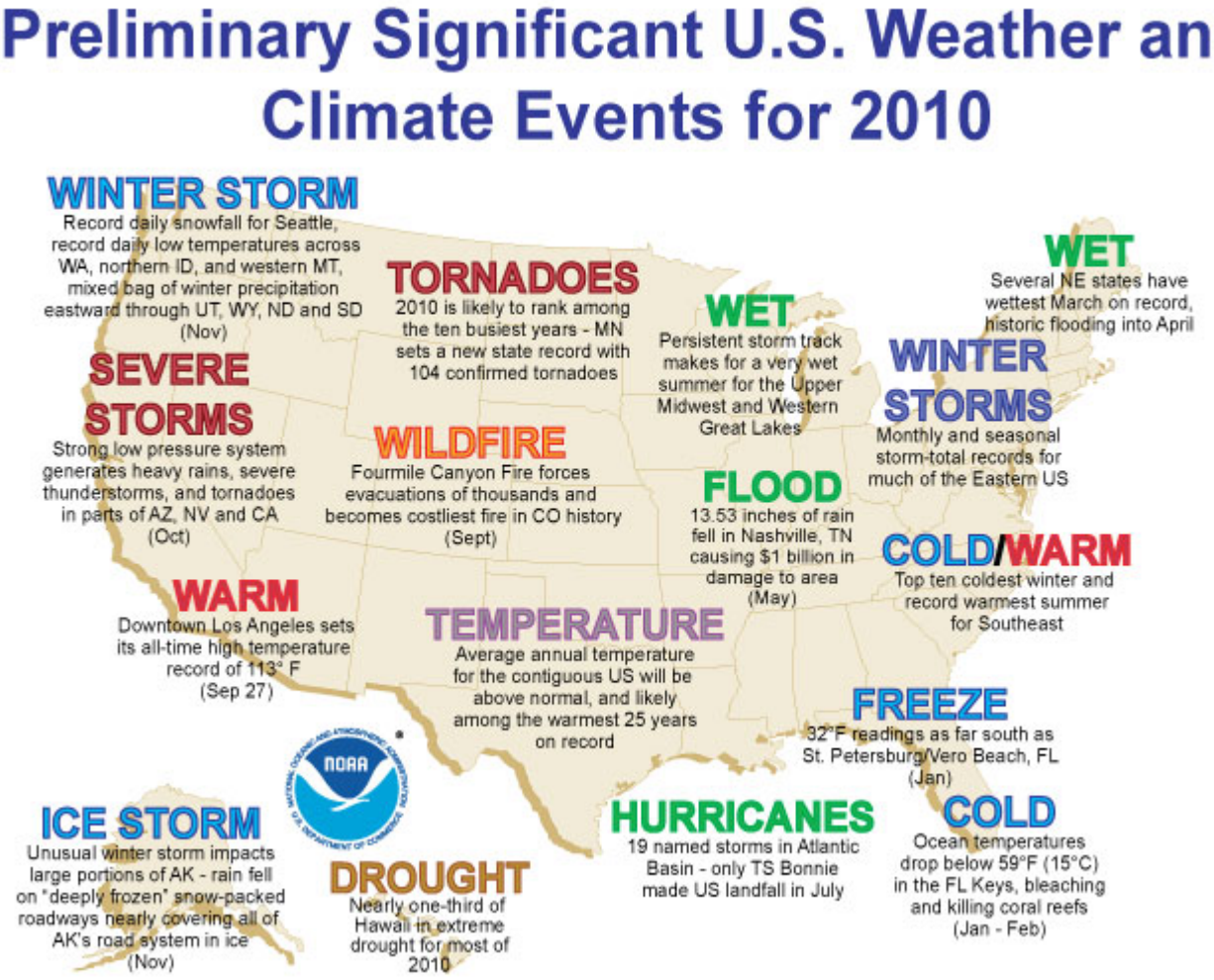
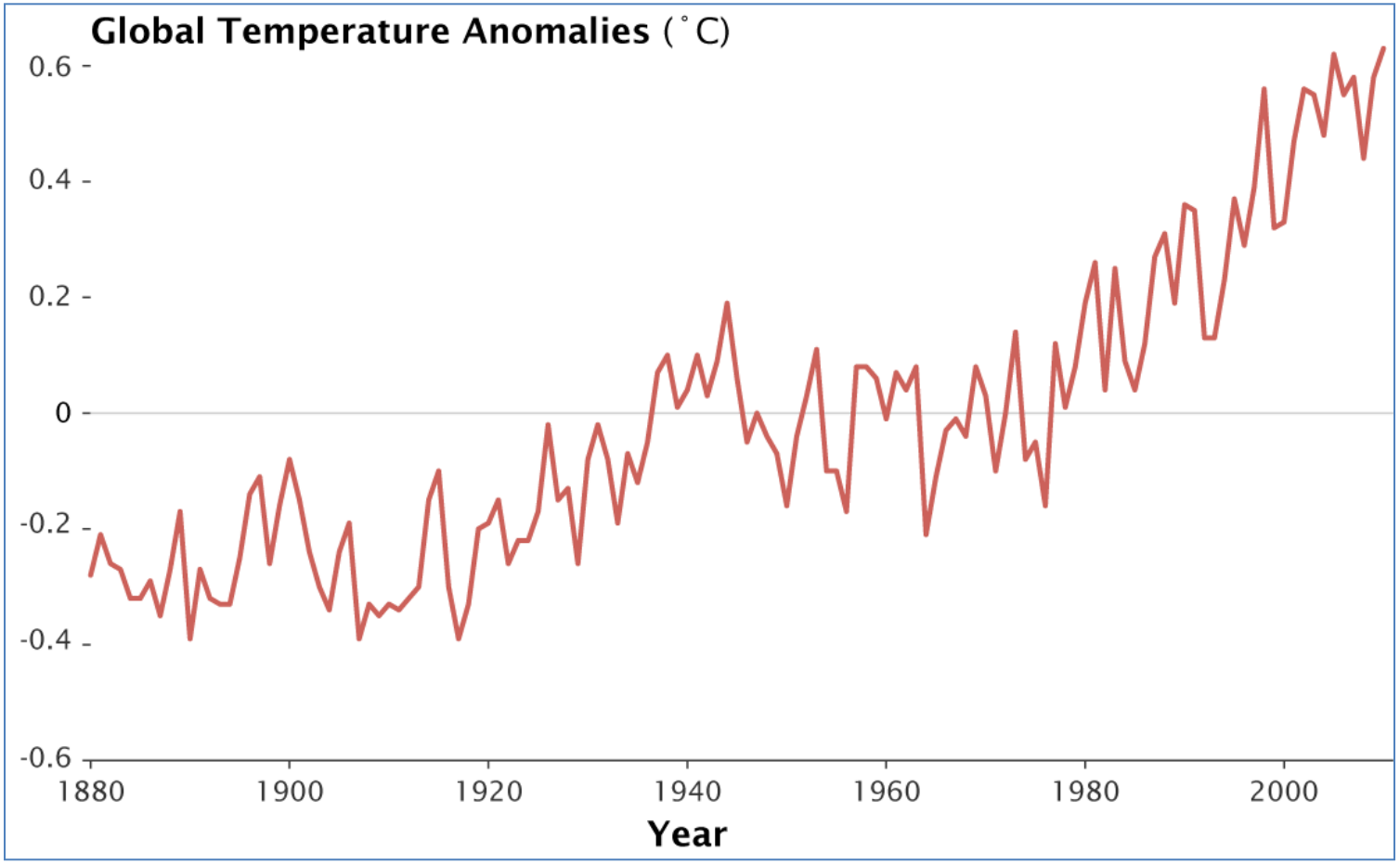


Figure courtesy of NOAA. Retrieved from http://www.ncdc.noaa.gov/oa/climate/research/2010/sig-events-2010.html.

2010: Tied for Warmest Year on Record



Graph courtesy of NASA Goddard Institute for Space Studies (GISS). Retrieved from http://www.giss.nasa.gov/research/news/20110112/509796main_GISS_annual_temperature_anomalies.gif.