Annual Climate Monitoring Report for Denali National Park and Preserve, Wrangell-St-Elias National Park and Preserve and Yukon-Charley Rivers National Preserve

Pamela J. Sousanes

Denali National Park and Preserve
P.O. Box 9
Denali Park, AK 99755

2005

Central Alaska Network

NPS Report Series Number: NPS/AKCAKN/NRTR-2006/0xx
Project Number: CAKN-xxxxxx

Funding Source:
Central Alaska Network
Denali National Park and Preserve

File Name: Sousanes_P_2006_ClimateMonitoringCAKN_0315.doc

Recommended Citation:
Sousanes, Pamela J. 2006. Annual Climate Monitoring Report for Denali National Park and Preserve, Wrangell-St. Elias National Park and Preserve, and Yukon-Charley Rivers National Preserve. NPS/AKCAKN/NRTR-2006/xx. National Park Service. Denali Park, AK. 75 pg.

Acronyms:

I&M	Inventory and Monitoring
CAKN	Central Alaska Network
DENA	Denali National Park and Preserve
WRST	Wrangell-St. Elias National Park and Preserve
YUCH	Yukon-Charley Rivers National Preserve
NPS	National Park Service
WRCC	Western Regional Climate Center
NRCS	Natural Resources Conservation Service
NWS	National Weather Service
RAWS	Remote Automated Weather Station
NCDC	National Climatic Data Center
AWOS	Automated Weather Observation Station
SNOTEL	Snow Telemetry

Table of Contents

List of Figures

List of Tables

EXECUTIVE SUMMARY

Climate is one of the primary drivers of ecological change. In the Central Alaska Network, which includes Denali National Park and Preserve, Wrangell – St. Elias National Park and Preserve, and Yukon-Charley Rivers National Preserve, there is evidence of possible significant long term change underway. By using data from existing climate stations and new data from stations strategically placed within the three parks, we can track climate through time, thus relating climate changes to other ecological and community events. This annual report will describe the synoptic climate of 2005 and compare it to long-term records.

Major climate events of 2005 include:

- 2005 mean annual temperature at all long-term stations was warmer than normal
- Record warm spring for Gulkana and Eagle
- Warmest May on record for Eagle
- Record warm daily temperatures the last week of April
- May was wet in the southern Interior region
- Green-up was about a week early
- Record number of lightning strikes in June in the Interior
- Widespread smoke from fires in June and July
- Driest summer on record for Eagle
- 2nd largest fire season on record – 4 million acres burned
- July precipitation in Gulkana was 200% of normal
- November was cold and precipitation was above normal
- December was more than 5°C warmer than normal at all long-term stations and precipitation was below normal.

We completed the initial development of the climate monitoring program in 2005 for the Central Alaska Network. Specific accomplishments include:

- The draft protocols were reviewed and comments incorporated.
- Six new climate stations were added to the three parks. Maintenance and calibrations were performed at all stations during annual site visits. Data were downloaded on site and were transferred to the Western Regional Climate Center for data archiving.
- The real-time data from the stations are available on the web at http://wrcc.dri.edu/NPS.
- The goal of the 2006 field season is to ensure consistency among all stations including design, data flow, and equipment and to continue with the development of web analysis tools and data packaging.

Key words:
Alaska, Central Alaska Network, Denali National Park and Preserve, DENA, Wrangell-St. Elias National Park and Preserve, WRST, Yukon-Charley Rivers National Preserve, YUCH, climate, monitoring

INTRODUCTION

Climate is widely recognized as one of the most fundamental drivers of ecological condition. The Central Alaska Network (CAKN) encompasses strong climate gradients, from the maritime climates in the southern parts of Wrangell – St. Elias National Park and Preserve (WRST) where it borders the North Pacific Ocean, to the strongly continental climates found in northern parts of Denali National Park and Preserve (DENA) and Yukon–Charley Rivers National Preserve (YUCH). These climate gradients are intrinsic to the ecosystem patterns, and vegetative and faunal communities found in CAKN parks. Future changes in climate will, in turn, have tremendous impacts on these patterns and communities.

The objectives of CAKN climate monitoring are to monitor and record weather conditions at representative locations in order to identify long and short-term trends, provide reliable climate data to other researchers, and to participate in larger scale climate monitoring and modeling efforts.

Over the past three years we have completed a comprehensive site evaluation, deployed new climate stations based on expert recommendations, completed protocols for climate and snowpack, deployed additional climate stations in the three CAKN parks, and initiated cooperative agreements with the Western Regional Climate Center (WRCC) and the Natural Resources Conservation Service (NRCS). Late in 2005, the National Park Service (NPS) Inventory and Monitoring (I&M) Program entered into a contract with WRCC to complete a program wide inventory of climate stations for all networks which will incorporate work done by CAKN.

As of March 2006, there are 52 climate stations and snow survey sites within the parks and another 52 sites in the surrounding areas. DENA has 24 stations in the park (16 climate stations, 8 snow courses/aerial snow markers) and 14 stations in the surrounding area; WRST has 19 stations in the park (10 climate stations, 9 snow courses/ aerial snow markers) and 33 sites in the surrounding area; and YUCH has 9 stations in the park (3 climate stations, 6 snow courses/aerial markers) and 5 sites in the surrounding area.

This report will describe the 2005 field season and summarize the data from the stations within the network and compare those results to the 1971-2001 normal climate period. This will be the first report in the technical report series CAKN XXX.XXX.XXX

METHODS AND MATERIALS

In 2005 we installed new climate stations, performed annual maintenance on existing sites, and downloaded and archived data according to the Climate Monitoring Protocol. Specifically, standard operating procedures # 10 – 21 for Climate Monitoring were followed for these tasks (Sousanes, 2004). High priority stations that were

planned for the network have now been installed; additional stations will be incrementally added over the next five years to complete the development of the climate monitoring plan. See Appendix A for a detailed description of the field accomplishments for 2005.

Study Area

The three CAKN parks together cover more than 21 million acres of land and span an enormous area measuring approximately 650 km from north to south and 650 km from east to west. Elevations range from sea level to the peak of Mt. McKinley at 6194 m (20,320'); latitudes reach to more than 65 degrees north. Figure 1 shows the distribution of climate stations within CAKN.

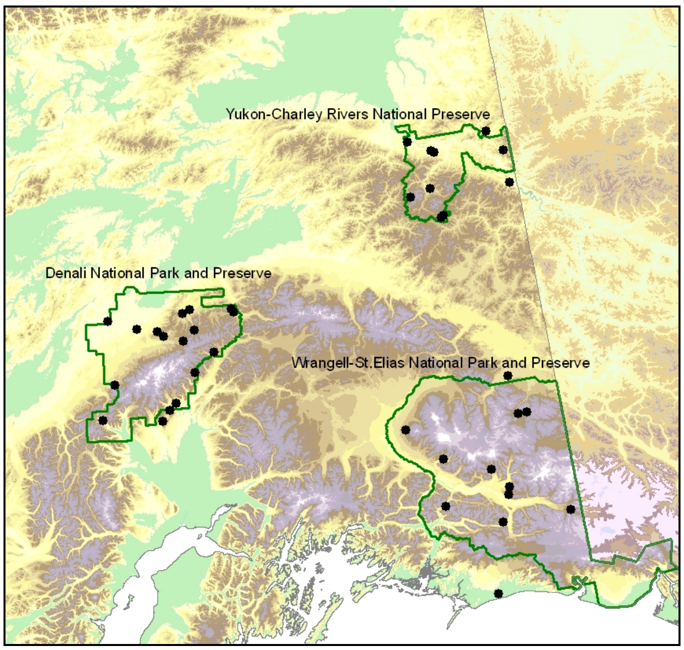


Figure 1 Distribution of climate stations and snow survey locations within the three CAKN parks.

Denali General Climate Summary and Station Locations--

The climate of DENA is characterized by great spatial variability, and includes both transitional maritime (influenced by the ocean) and continental (influenced by the Alaska Range) climate subtypes. On the north side of the range, where park headquarters is located, temperatures are typical of a continental climate with strong seasonal variations. There is also less precipitation on the north side because of its location on the leeward side of a major mountain range. The maritime climate on the south side of the Alaska Range is influenced by the prevailing weather patterns of the Gulf of Alaska, with milder air temperatures with less seasonal variation and more precipitation. Temperatures in the northwest area of the park, recorded at Lake Minchumina and McKinley River, are typical of the interior climate with very warm summers and cold winters. Stations in the transitional zone between the northern

flanks of the Alaska Range and the Interior have slightly cooler summers and warmer winters. The stations south of the range have more moderate temperatures and less variation from summer to winter.

With the addition of new climate stations at higher elevations and in areas where we have had no prior data, we will be able to more accurately describe the climate variation within the park. Figure 2 shows the distribution of climate stations in Denali.

Wrangell – St. Elias General Climate Summary and Station Locations--
Wrangell-St. Elias NP&P contains both coastal and interior climatic regimes as well a transition zone. Two high elevation mountain ranges disrupt movement of weather systems, resulting in numerous localized climatic conditions. The "dry" season for the southern coastal region is in the summer, with storms increasing in late summer and peaking in early winter. The transition zone between the coastal climate zone and the interior climate zone is not well defined. Temperatures and precipitation amounts from the McCarthy and May Creek area are more typical of an interior climate than a transitional zone; i.e. moderate temperatures and more precipitation. The new stations at Tana Knob and Tebay, in the Chugach Mountains, may provide data indicative of a transitional climate. The high plateau in the northeastern region of the park adds to the intense cold typical of an interior climate. The elevation of the river valleys starts at 1000 m.

Because of the immensity of Wrangell-St. Elias NP&P, the extensive amount of high elevation terrain and large number of climatic regimes, the method used to characterize the area is based on a transect of sites perpendicular to the coast. This transect contains south and north facing mountain range aspects, sites at high and low elevation, sites in both the coastal and interior regimes and the transition zones (Figure 3).

Yukon-Charley Rivers General Climate Summary and station locations--
The climate of YUCH is typical of the Alaskan Interior continental climate. It is both the warmest and coldest zone and has huge swings in temperature due to the distance and mountain ranges between it and the coast. This is the area where most of the thunderstorms in Alaska occur, and therefore the area in which we see the most fires. The Yukon-Tanana upland has no existing representative climate station, so potential siting in that area was a priority. A small scale climate station transect traverses the YUCH topography from the riparian zone along the Yukon River to the uplands in the southern portions of the park (Figure 4).

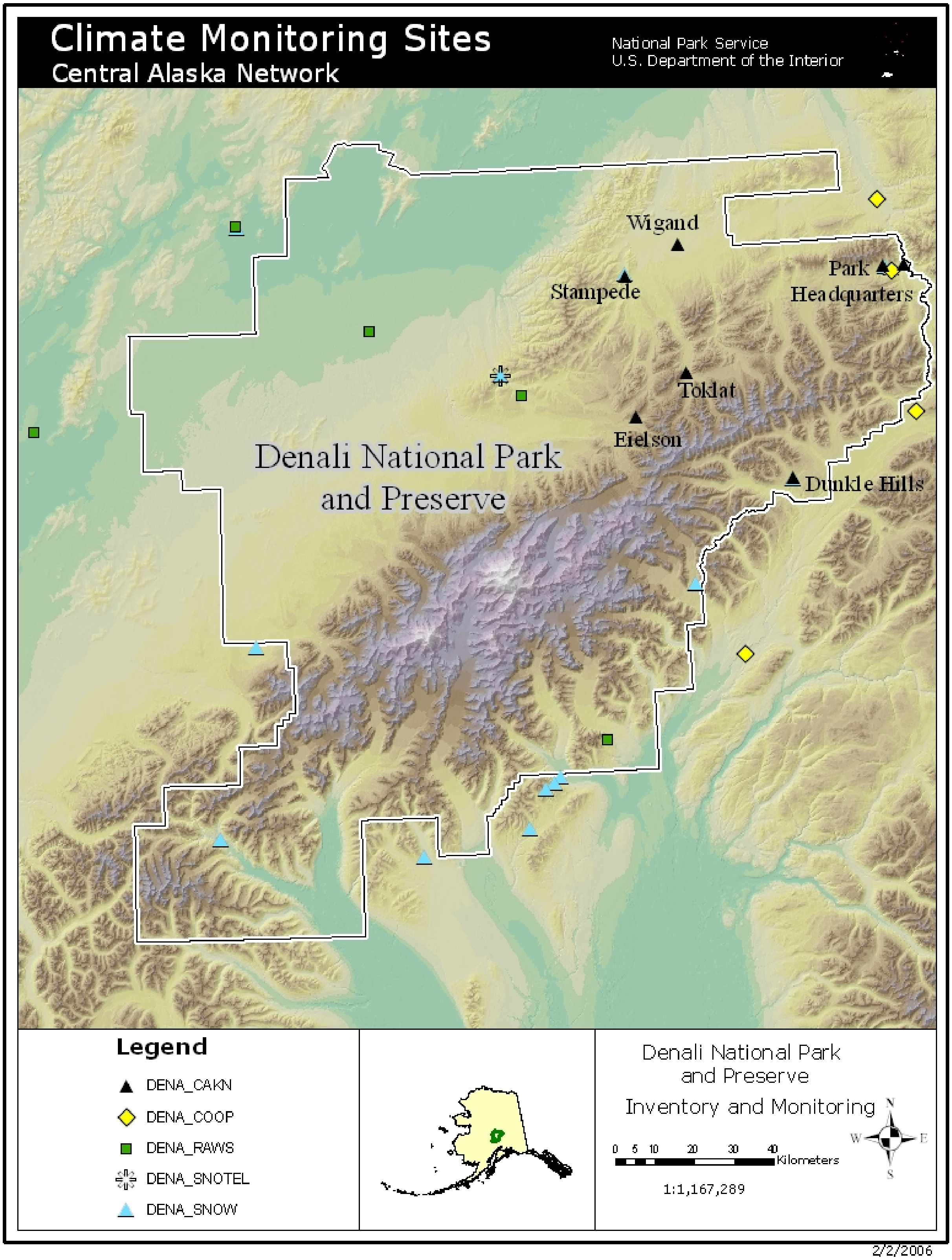


Figure 2 Climate stations and snow survey locations in Denali National Park and Preserve

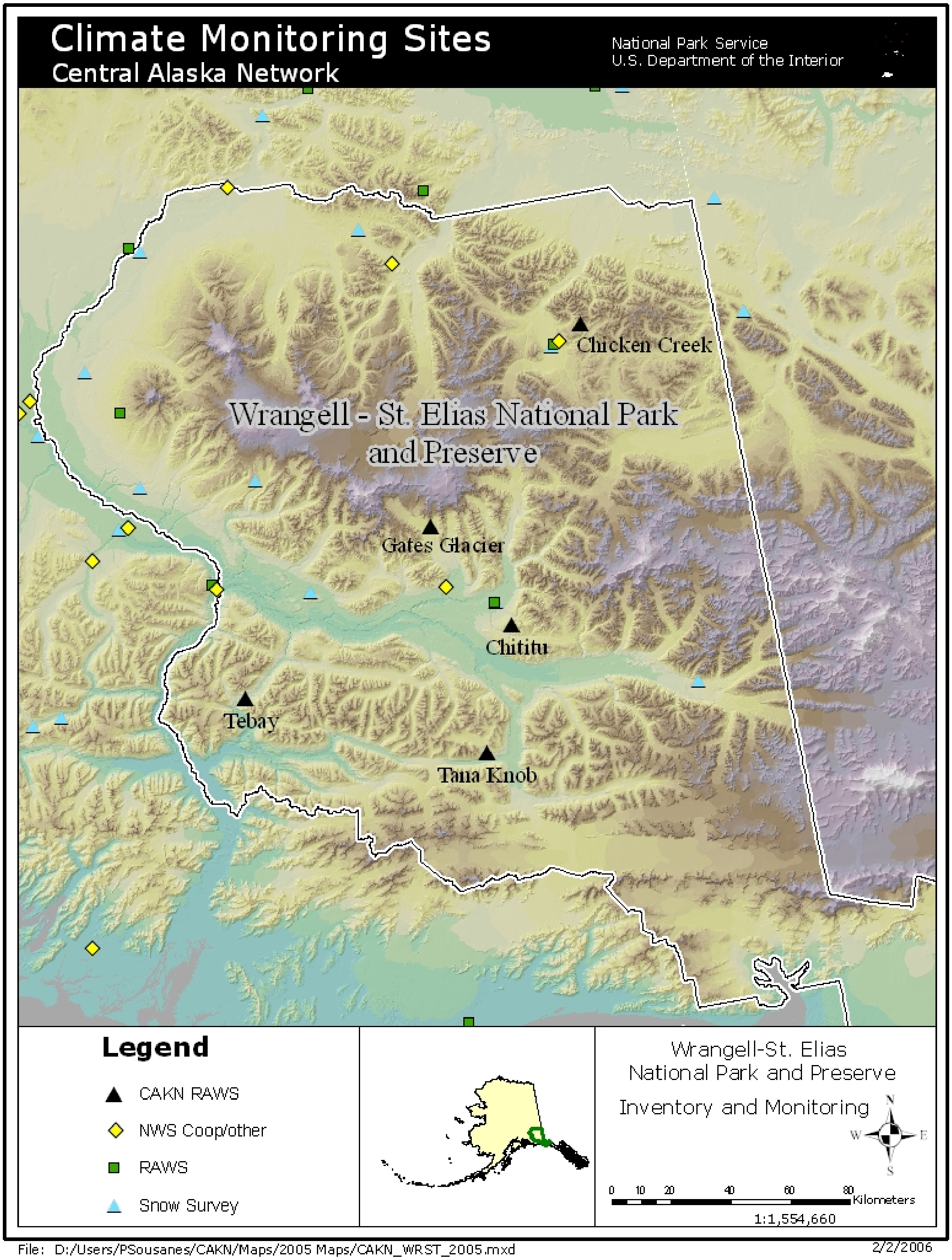


Figure 3 Climate stations and snow survey locations in Wrangell - St. Elias National Park and Preserve.

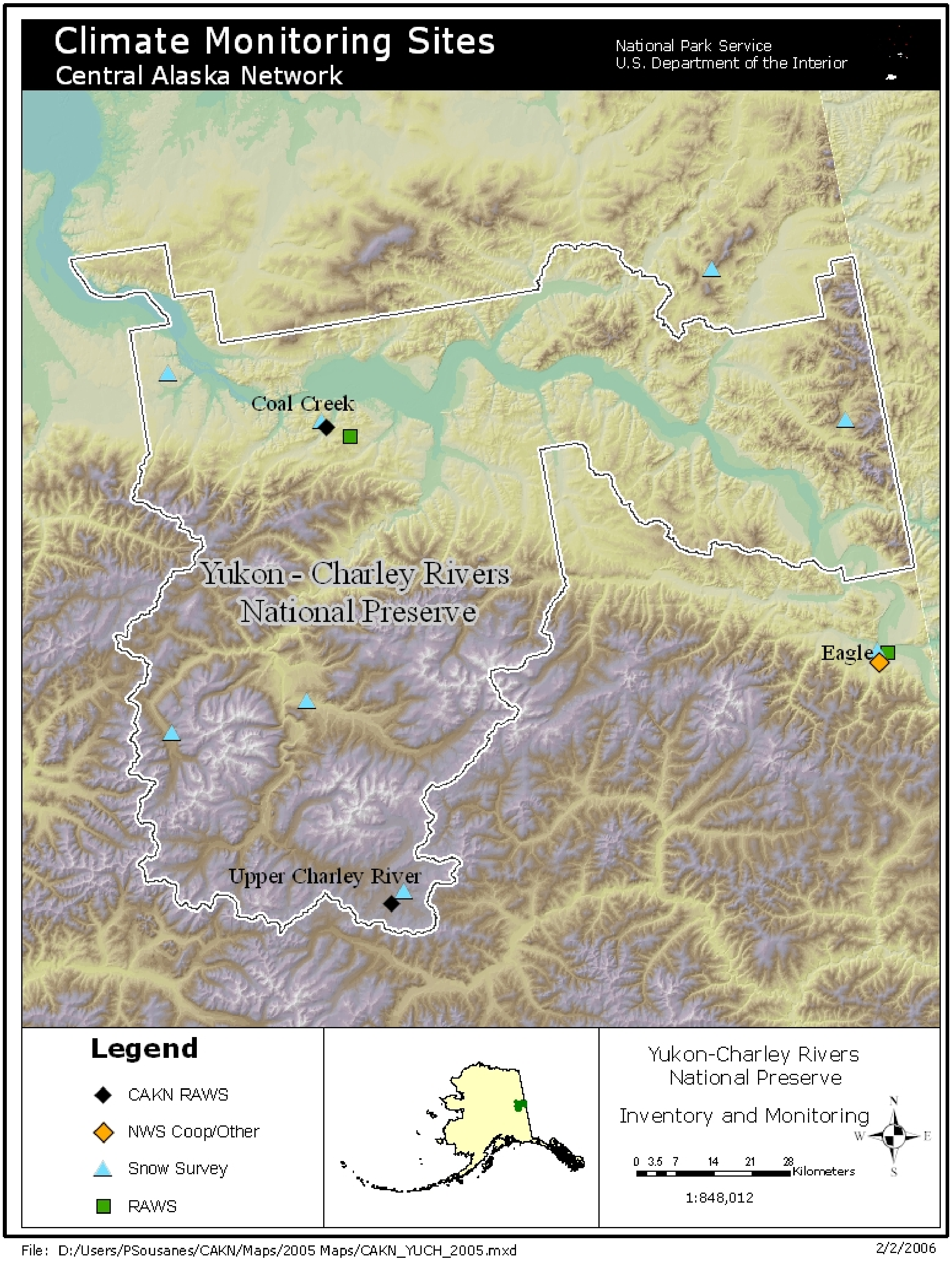


Figure 4 Climate stations and snow survey sites in Yukon-Charley Rivers National Preserve

Data Archive

Data were downloaded from each datalogger in the field during the annual site visit. These files were downloaded via laptop or Palm. The files were then converted from the satellite transmission output by running the text file through a Visual Basic program (named Parse and written by Jon Paynter at DENA) that shifts columns and lines so that one record equals one row in the file. This file was then imported into Microsoft Excel or Microsoft Access (or some other database or graphing software) for initial QA/QC and then transferred to the WRCC for final archiving. This step was not identified in the protocols and will be added as a revision in SOP #21 Data Access/Archive.

Metadata

A separate climate monitoring metadata report was compiled that includes information about the station (location, instrumentation, type, etc.) the instrumentation (sensor heights, sensor types, datalogger model, etc.) and finally the data themselves (units, sampling frequency, processing, output, etc.). This dynamic document contains all of the details (that are currently known) about the climate stations included in the CAKN climate analyses. It will be posted on the CAKN website under climate monitoring so that those accessing these data via the web can use it as a reference (Sousanes, 2006)

Protocols Revisions

The following revisions were made to the protocol during the 2005 season:

SOP# 6-modification of the datalogger program details, entry into protocol revision table and documented within program.

SOP#7 – Added additional GOES IDs obtained in 2005.

SOP#21 – Additional step added to archiving process between data download and archive at WRCC.

Analyses

Climate and weather have been monitored for more than 50 years in the three parks. Existing stations are managed by various federal agencies and private entities; this means that the data are processed differently. The National Weather Service cooperative data has a six to eight month lag because it is a manual observation and needs to go through QA/QC at the National Climatic Data Center (NCDC). Data from the automated stations, including the CAKN stations, are available in near real –time on the internet from the WRCC (WRCC, 2006). For this report, all of the available data were used to describe the overall climate of the parks.

For 2005, we looked at the data from the new stations and the RAWS sites and compared those data to existing long term records. The average value of a meteorological element over 30 years is defined as a climatological normal. The 'normal climate' is used as a base to which current conditions can be compared. Every ten years, the NCDC computes new thirty-year climate normals for selected temperature and precipitation elements for a large number of U.S. climate and weather stations, including McKinley Park, Eagle, and Gulkana. These three long-term stations provide a reference for the three CAKN parks. The other stations in the park cannot be used to compute normals because they have not been around for thirty-six years.

We are still waiting on the completion of the data analysis contract in order to fully develop the procedures for compilation, statistics, summary and analysis of these data. To summarize information for this report we used information available from the WRCC, NCDC, NRCS, and the Alaska Climate Research Center at the University of Alaska Fairbanks. These summaries include mean annual air temperature (MAAT); mean, maximum, and minimum monthly temperatures, monthly extreme temperatures, mean wind speed and direction, snowfall accumulation, and precipitation totals for each station. These are the most common methods of compiling weather data. In subsequent years we will analyze trends and employ the techniques derived from the analysis contract.

RESULTS

2005 Monthly Weather Summary

Note: For this section we used information from the Alaska Climate Research Center at the University of Alaska Fairbanks. The maps depicting the departures from normal are in degrees Fahrenheit and precipitation is described in inches. The data are summarized in standard units for this section only.

January

Temperatures: In mid January the temperatures in the Yukon Valley, including Eagle were cooler than normal. But, overall the temperatures in DENA and WRST were above average. The NE region of WRST had temperatures that were +6 degrees warmer than normal, Talkeetna was +6 degrees warmer than normal, and McKinley Park was +4 degrees warmer than normal. Cantwell was just a few degrees below normal for the month.

Snow: All of the snow markers and snow courses south of the Alaska Range in Denali had more snow than normal, and the areas west of Wonder Lake had above normal snowpacks. Lake Minchumina, in the Lower Tanana Valley, was 177 percent of normal and had the 3rd highest snow water content measured since the record began in 1967.This trend continued to the south side of the Brooks Range. McKinley Park had 5 inches more snow than normal for the month and Eagle had 10 inches more than normal. In the Copper River Basin snowfall was slightly more than normal. There

were no data for Gulkana, but at Jatahmund Lake there was 5 inches more than normal and Chistochina had 6 inches more than normal. Dadina Lake and Kenny Lake were near normal to slightly below normal. Yakutat, on the coast, usually has 34 inches of snowfall in January and they only had 10 inches fall.

February
Temperatures: All of the long-term reporting stations in the CAKN area reported warmer than normal temperatures for February. Gulkana, Nabesna, and McKinley Park were over 4 degrees warmer than normal. Talkeetna, Eagle and Yakutat were 1 – 3 degrees warmer.

Snow: The area south and west of the Alaska Range in Denali had record snow packs for three sites: Purkeypile (west of Mt. Foraker along the north slope of the Alaska Range), and Ramsdyke Creek and Dutch Hills in the Tokositna Valley. These snow courses have records dating back to 1980. Lake Minchumina remained above normal for February with snowcover 145% of normal. The snowfall at McKinley Park was 30% of normal, but was above normal at Eagle. The snow courses in WRST were above normal by a few inches at all of the long-term sites including Jatahmund, Chistochina, Tazlina, and Kenny Lake.

March
Temperatures: March was warm. Five of the long-term stations in or around the CAKN had monthly means 8 degrees or more above average. These locations included: Talkeetna, McKinley Park, Eagle, Gulkana and McCarthy. Cantwell and Yakutat had temperatures that were 4 to 8 degrees warmer than normal. Figure 5 shows the March temperature departure from normal for the state. The warmest areas are centered over the CAKN parks. The onset of these warm temperatures in March lead to record breaking spring temperatures (March, April, May) for Gulkana and Eagle.

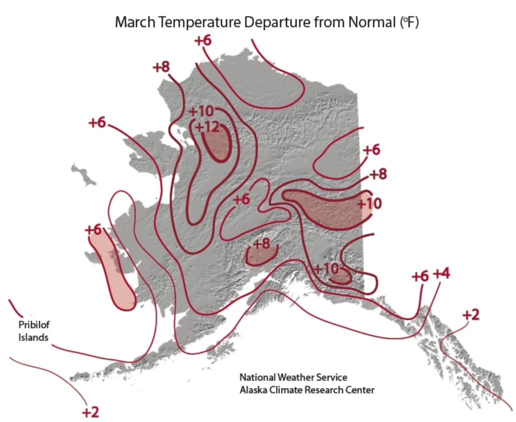


Figure 5 March temperature departure from normal in degrees Fahrenheit. Map courtesy of the Alaska Climate research Center, University of Alaska Fairbanks.

Snow: Record snowpacks continued south of the Alaska Range especially in the Tokositna Valley area and the area in the Kuskokwim drainage including Purkey pile and Lake Minchumina. The interior had near normal snowpacks, and the Copper Basin snow courses were also near normal.

April
Temperatures: Monthly temperatures were 4 to 8 degrees above normal in the Copper Basin area at the following locations: Nabesna, Gulkana, McCarthy, and Yakutat. Gulkana had four record breaking maximum temperatures in April (23 [61°F], 28 [67°F], 29 [69°F] and 30 [67°F]). In the Interior it was warm, monthly means were between one and three degrees warmer than normal. Eagle had two record breaking maximum temperatures for the month (7 [53°F], 23 [62°F]) and McKinley Park had three (April 28, 29 and 30 [all at 65°F]).

Snow: record snowpacks south of the Alaska Range continued, especially in the Tokositna Valley. On May 1st the three sites in this area had record snow water contents. There was still 68 inches of snow on the Valley floor and 112 inches at 3100' at Dutch Hills. In the interior and Copper River basins the warm temperatures melted down the snowpack quickly.

May
Temperatures: The warm trend continued through May. Fairbanks had its warmest May in 101 years. Eagle's mean temperature in May was 52.2 °F also the warmest May on record. Once again every long-term recording station in the CAKN area from the Yukon Valley to the coast of Alaska and everything in between recorded mean monthly temperatures warmer than normal. Greenup across the Interior came about a week earlier than normal.

Precipitation: May was wet in the southern Interior and in the eastern areas of WRST, Nabesna recorded 3.12 inches of rain for the month (the 24-year mean is 1.00 inches for May). Other areas were near normal (Figure 6). Snow off date at McKinley Park for 2005 was May 2, in the past 80 years the average is around the 11th of May.

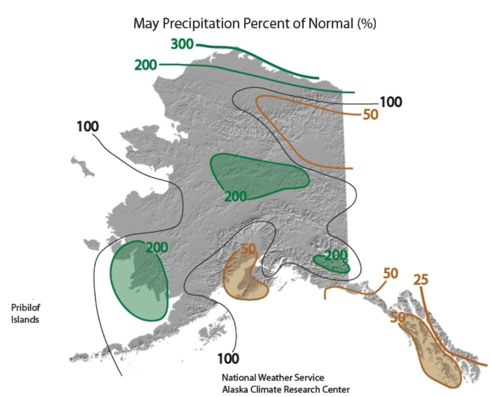


Figure 6 Precipitation percent of normal for state of Alaska May 2005 in inches. Map courtesy of the Alaska Climate Research Center, University of Alaska Fairbanks.

June
Temperatures: At most of the CAKN long-term station the temperatures were one to two degrees warmer than normal.

Precipitation: The eastern Interior had less rainfall than normal for June. Eagle had 0.58 inches of rain (the normal is 1.86). In the southern area at McKinley Park there was 3.15 inches of rain in June compared to an average of 2.20 inches. Isolated summer thunderstorms brought considerable amounts of precipitation in short periods of time. It is unusual to get more than 0.5 inches of rain in a 24-hour period at McKinley Park, but it happened two times in June (0.68 inches on the 1st and 0.53 inches on the 13th).

On the 15th, the Alaska Lightning Detection System recorded 11,163 strikes in 24 hours. This is more than 2,000 over the previous record total of 9,022 on July 15, 2004. Forest fires in the Interior became widespread by the second week of June, and by the end of the month, over 1 million acres in Alaska had burned. This is more acreage than is burned in an average season, but less than what had burned by the end of June in the record season of 2004 (ACRC, 2005). Smoke most likely contributed to moderating temperatures by blocking some of the sun's rays.

July
Temperatures: Temperatures across the network area were normal to slightly cooler by a degree. Yakutat and Talkeetna were the exception; these stations south of most of the major mountain ranges in the state had monthly means 3 degrees warmer than normal. This was most likely due to the widespread smoke that blanketed most of the Interior, reaching down into the upper parts of the Copper River Basin.

Precipitation: Gulkana had a record 3.64 inches of rain fall for the month (average is 1.82 inches). This was most likely due to isolated thunderstorms that dumped considerably amounts of rain in a very short time. Elsewhere around the parks, Eagle was dry (30% of normal), McKinley Park was near normal, and Talkeetna was about 50% of normal.

August
Temperatures: Smoke persisted in most of the Interior areas through August and temperatures were one to three degrees warmer at most of the long-term stations in and around CAKN. McKinley Park and Talkeetna were 3 to4 degrees warmer. Eagle was the exception with monthly temperatures just at normal for the month.

Precipitation: August was unusually dry. Rainfall for the month was 25 to 50% of normal everywhere, except Yakutat. The northeast Gulf Coast was the only wet spot in the CAKN area, and even for Yakutat it was wet at 100% of normal for August with 23.95 inches (average is 12.2 inches).

September

Temperatures: Temperatures were one to three degrees warmer than normal in the CAKN, with the exception of McCarthy which was four degrees warmer than normal - the mean was 47.4°F (26-year average is 43.1°F).

Precipitation: Precipitation amounts at Gulkana were near normal, but were above normal at McKinley Park and Eagle. Talkeetna was 100% of normal with 8.42 inches for the month.

October

Temperatures: Temperatures in Eagle were three degrees warmer than normal, in McKinley Park they were two degrees warmer than normal and Gulkana was slightly warmer. In general temperatures in the CAKN area were once again just above normal. Yakutat temperatures were at normal.

Precipitation: Snow was late in coming this year. Most of the long-term stations had 50% precipitation amounts for the month. McKinley Park had only 3.1 inches for the month, normal is 12.9 inches. Snow surveys don't start until the end of November, so I could find no snowfall data for the Copper River Basin except for the new CAKN stations that record snow depth.

November

Temperatures: November was the only month of 2005 where the mean temperatures at almost all of the long-term station in the CAKN were below normal. It was the coldest November in McKinley Park since 1977 – the mean temperature was 13 degrees colder than normal. Talkeetna was almost 5 degrees colder, Gulkana was 3 degrees colder. Yakutat was the exception, the mean temperature of 40.8°F was normal. Figure7 shows the departure from normal for November.

Precipitation: precipitation was above normal at most sites. By the end of the month Tana Knob in the middle of the Chugach Range had over 50 inches of snow, Gates Glacier had over 30 inches, May Creek and Tebay had over 20 inches and Chisana had just over 10 inches. Coal Creek had 17 inches by the end of November.

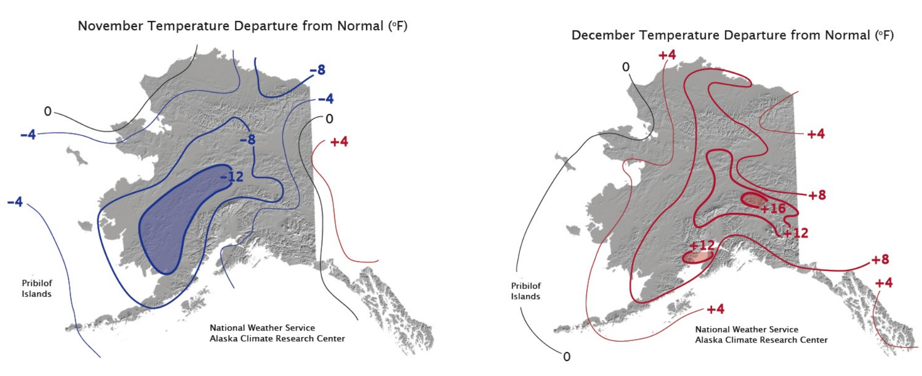


Figure 7 Departures from normal for November and December 2005 in degrees Fahrenheit. Maps courtesy of the Alaska Climate Research Center, University of Alaska Fairbanks.

December
Temperatures: Temperatures were well above normal for December (Figure 7) McKinley Park was 13 degrees warmer than normal, Talkeetna was 12 degrees warmer, Gulkana was 11 degrees warmer, and Eagle was 14 degrees warmer than normal.

Precipitation: Precipitation for the month was less than normal at most stations. At McKinley Park there was a total of 2 inches of snow for December, with almost 0.5 inches of rain. On the south side of the Alaska Range some snow was falling with the Dunkle Hills station reporting 27 inches. Eagle and Gulkana precipitation was 50% of normal. McCarthy was the exception with precipitation totals about normal.

2005 Station Records

Eagle – Warmest May - Mean temp 11.2°C (52.2°F) or +3.8°C (+6.2°) above normal
Talkeetna - Warmest spring (March, April, May) - mean temp 4.4°C (39.9°F)
Gulkana – Warmest spring - mean temp 2.2°C (36°F)
Eagle – Warmest spring - mean temp 0.8°C (33.4°F)
Eagle – Lowest summer precipitation (June, July, August) - total 49.8 mm (1.96 in.)
Yakutat – Wettest Day - August 24, 2005: 174mm (6.85 in.) rain

CAKN Data Summaries

We looked at the long-term stations to see how 2005 compared with the period of record, which generally varies from 50 – 80 years in length. The stations we focused on were Eagle, near YUCH; Gulkana, McCarthy and Yakutat near WRST, and McKinley Park, Cantwell, and Talkeetna in/near DENA. Mean monthly and mean annual air temperatures are summarized for each long-term station for 2005 and compared with the period of record average (Table 1). Monthly and annual precipitation totals are also summarized (Table 2). In general most of the stations around the network had above normal temperatures for almost every month of 2005. March and December were the warmest months compared with average conditions. November was the exception where all of the stations from Yakutat to Eagle had temperatures either at or below normal.

After taking a look at the climate for the region, we looked at the individual long-term stations associated with each park and compared 2005 values with the long-term means. Gulkana, Eagle and McKinley Park have been in operation for more than 40 years so climate normals are computed for these sites. The data from the other stations (with shorter records) were then compared with the long-term sites.

Table 1 Mean monthly and mean annual temperatures for 2005 compared with the mean from the period of record (listed in 1st column) from the long-term climate stations in and around the CAKN. Values are presented in degrees Celsius.

Years of		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	
Record		WINTER		SPRING			SUMMER			FALL			WINTER	*Annual*
56	**Talkeetna**													
	2005	-8.6	-7.4	-0.5	3.5	10.3	15.3	16.7	14.8	9.8	1.4	-10.4	-5.2	*3.3*
	MEAN	-11.7	-8.9	-5.6	1.1	7.6	13.1	14.9	13.1	7.9	-0.1	-7.8	-11.2	*1.1*
22	**Cantwell**													
	2005	-18.1	-13.9	-7.3	-2.5	6.1	11.7	13.2	11.7	5.5	-2.9	-17.0	-12.2	*-2.1*
	MEAN	-16.9	-14.3	-10.4	-3.0	4.8	10.9	12.9	10.2	4.5	-4.9	-13.3	-15.1	*-3.0*
81	**McKinley Park**													
	2005	-15.1	-11.8	-5.8	-1.7	8.8	12.7	13.7	12.6	6.1	-3.2	-20.1	-8.7	*-1.0*
	Mean	-16.7	-14.3	-10.5	-2.8	5.3	11.2	12.7	10.4	5.0	-4.2	-12.3	-16.1	*-2.7*
50	**Eagle**				<u>Warmest Spring on Record</u>									
	2005	-25.3	-19.7	-8.2	-0.7	11.2	15.4	15.3	12.4	7.2	-2.7	-21.3	-13.9	*-2.5*
	MEAN	-24.8	-21.1	-13.6	-2.3	7.4	14.0	15.5	12.2	5.6	-4.7	-15.9	-21.9	*-4.2*
25	**Nabesna**													
	2005	-18.2	-14.3		0.7	8.3	10.9	10.6	11.1	5.3	-3.5	-15.7	-12.8	
	MEAN	-20.8	-16.7	-10.8	-2.2	5.5	10.8	12.2	10.2	3.9	-5.7	-15.7	-18.8	*-4.5*
55	**Gulkana**				<u>Warmest Spring on record</u>									
	2005	-19.5	-13.5	-4.2	2.1	8.7	13.0	13.7	12.9	7.5	-2.4	-15.9	-13.4	*0.2*
	MEAN	-21.0	-15.7	-9.4	-0.6	6.7	12.2	14.1	12.0	6.4	-2.8	-14.1	-19.4	*-2.6*
20	**McCarthy**													
	2005	-18.4	-10.9	-1.9	3.0	9.3	12.8	13.4	12.7	8.6	-1.1	-15.3	-13.3	*-0.1*
	MEAN	-18.2	-12.4	-7.2	1.0	7.1	11.8	13.5	11.3	6.2	-2.2	-13.8	-15.5	*-1.2*
57	**Yakutat**													
	2005	-2.6	-0.7	2.7	5.1	9.2	11.2	13.4	12.8	9.6	4.9	0.3	1.3	*5.6*
	MEAN	-3.9	-1.9	-0.6	2.7	6.5	10.1	12.1	11.9	9.1	4.9	0.2	-2.2	*4.1*

Warmer		Cooler	
(red)	>4	(blue)	>4
(orange)	2 to 4	(cyan)	2 to 4
(yellow)	0.5 to 2	(light cyan)	0.5 to 2

Table 2 Monthly precipitation totals for 2005 compared with the mean from the period of record (listed in 1st column) from the long-term climate stations in and around the CAKN. Values are presented in millimeters.

					Monthly Precipitation Totals (mm)									
Years of		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	
Record		WINTER			SPRING			SUMMER			FALL		WINTER	*Annual*
56	**Talkeetna**													
	2005	63.2	26.9	43.4	87.6	40.1	18.5	37.6	105.2	213.9	20.8	44.7	36.1	*702.1*
	MEAN	35.6	38.6	33.0	35.1	39.4	57.4	86.9	118.9	107.4	69.3	44.7	43.9	*711.2*
22	**Cantwell**													
	2005	56.6	50.0	22.6	19.6	44.5	45.0	60.7	40.9	131.3	7.9	22.6	0.0	*501.7*
	MEAN	26.2	18.8	12.2	10.9	21.1	44.7	73.9	80.3	68.8	28.4	21.1	27.2	*430.3*
81	**McKinley Park**													
	2005	37.8	1.5	11.7	23.4	39.6	80.0	84.6	30.5	65.3	5.1	29.5	13.7	*422.7*
	MEAN	18.7	14.7	11.0	11.1	20.4	55.9	76.1	67.9	40.4	24.8	19.6	21.0	*382.3*
50	**Eagle**													
	2005	21.1	17.3	15.2	0.5	27.4	14.5	20.6	14.7	51.1	13.7	54.4	8.9	*259.3*
	MEAN	13.5	11.2	8.6	7.9	25.4	41.7	56.6	47.2	31.5	24.6	17.3	18.0	*299.7*
25	**Nabesna**													
	2005	9.9	7.1	0.0	0.0	79.2	65.0	224.0	28.7	7.1	161.5	15.7	2.0	*600.5*
	MEAN	7.6	10.4	4.1	6.6	25.4	56.1	79.8	41.1	28.2	20.1	12.4	10.2	*322.8*
55	**Gulkana**				-									
	2005	0.0	4.6	0.0	0.0	18.8	49.8	92.5	36.3	43.2	8.1	55.4	0.5	*309.1*
	MEAN	11.4	12.4	7.6	5.1	16.8	36.8	46.2	39.9	39.4	24.1	18.8	21.1	*279.7*
20	**McCarthy**													
	2005	26.2	29.7	3.0	2.0	41.7	37.8	135.6	99.1	71.6	17.3	119.6	61.7	*645.4*
	MEAN	28.4	27.2	11.4	5.8	24.4	43.7	61.5	65.3	74.9	51.6	34.8	52.1	*507.5*
57	**Yakutat**													
	2005	192.0	452.1	307.3	137.4	119.6	46.7	236.0	608.3	554.0	442.2	475.2	423.7	*4069.3*
	MEAN	287.5	270.5	262.9	229.6	225.8	154.2	204.2	309.9	465.6	532.6	382.3	370.8	*3694.9*

Denali 2005 Climate Summary--

This site, located at park headquarters at DENA, has been in continuous operation for 80 years. Because this station is within the park boundary and has been operated by park staff it is the most complete dataset we have for any site in the three parks.

In 2005, every month except November was warmer than normal based on the 80-year mean (Figure 8). March was +5 degrees C warmer than normal and December was +7 degrees C warmer than normal. Table 3 shows the growing degree days for this area for the period of record using a range of temperatures as a base from 40°F to 65°F. The mean annual air temperature for 2005 was -1.0°C (30.1°F) and the 11th warmest on record. The past ten years are plotted with a linear trend line indicating an overall warming trend (Figure 9).

The total precipitation for 2005 was 422.7 mm compared with 382.3 mm as the normal. Spring and early summer were wetter than normal as well as the snowfall totals for January and November. August by comparison was dry, less than 50% of normal (Figure 10 and 11).

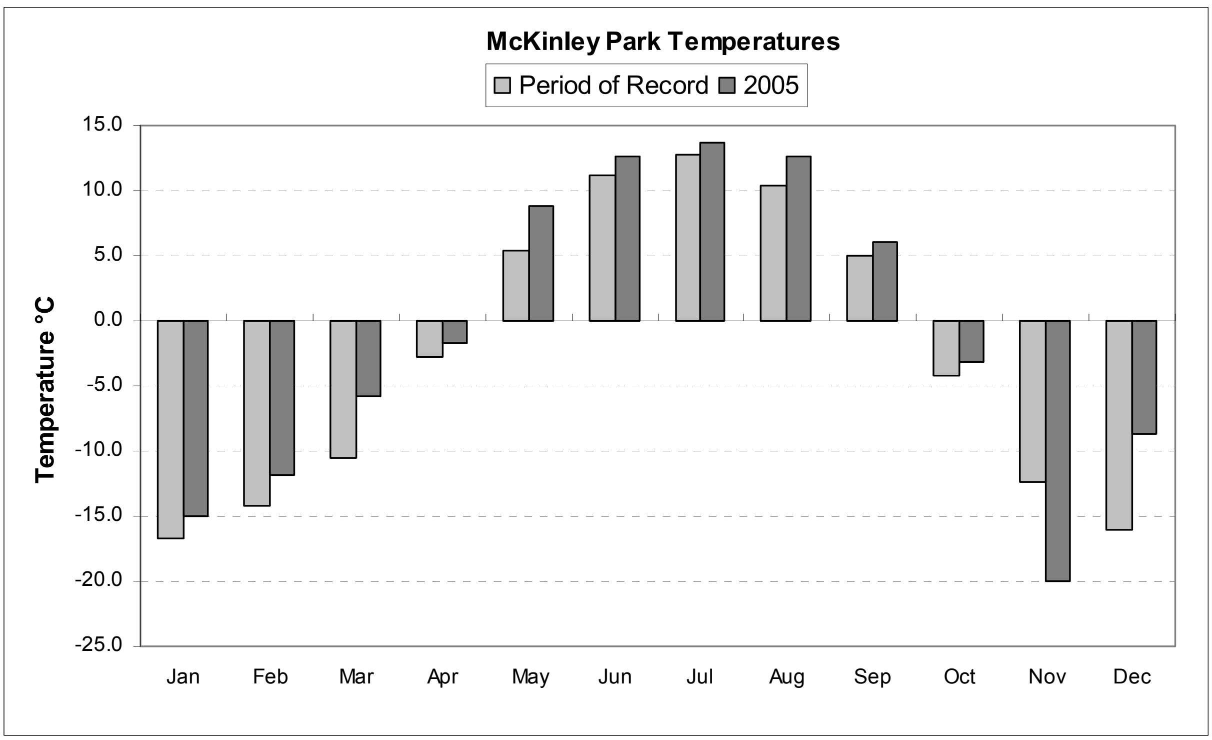


Figure 8 McKinley Park mean monthly temperatures for 2005 compared with the period of record average (1925-2005)

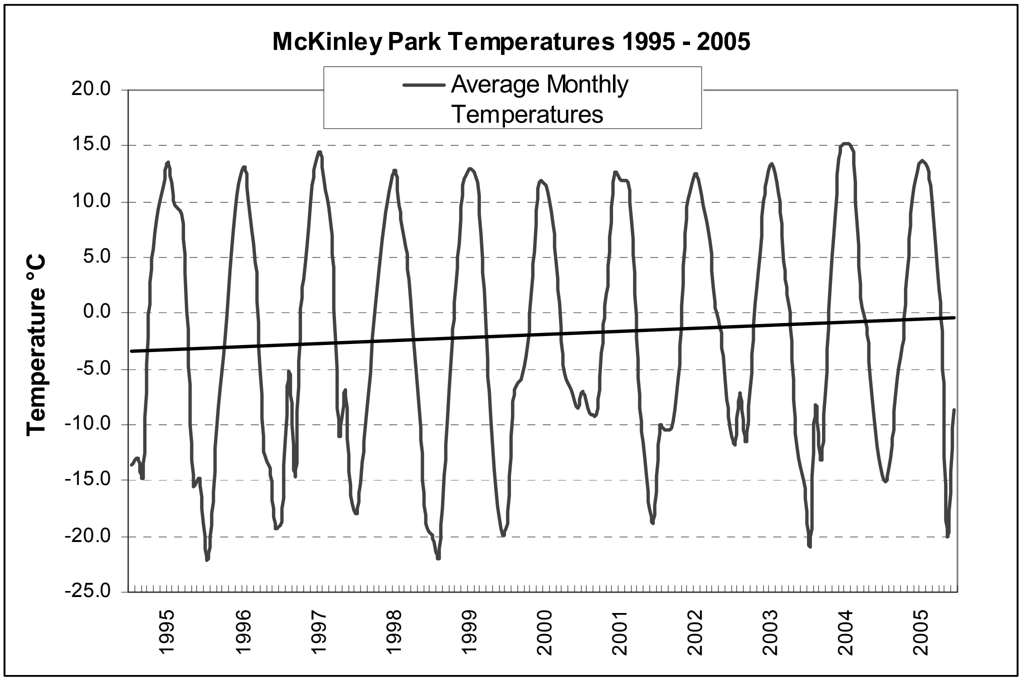


Figure 9 McKinley Park mean monthly temperatures for the past 10 years. A linear trend line indicates an overall warming trend over the past 10 years.

Table 3 McKinley Park growing degree days based on the period of record from 1949 – 2005. M=Monthly data. S= Running Sum of monthly data.

Station:(505778) MCKINLEY PARK													
From Year=1949 To Year=2005													
Growing Degree Days for Selected Base Temperature (F)													
Base	*Jan.*	*Feb.*	*Mar.*	*Apr.*	*May*	*Jun.*	*Jul.*	*Aug.*	*Sep.*	*Oct.*	*Nov.*	*Dec.*	*Annual*
40 M	*0*	*0*	*0*	*5*	*108*	*358*	*460*	*334*	*97*	*8*	*0*	*0*	*1372*
40 S	*0*	*0*	*0*	*5*	*113*	*471*	*931*	*1266*	*1363*	*1371*	*1372*	*1372*	*1372*
45 M	*0*	*0*	*0*	*1*	*38*	*216*	*307*	*192*	*33*	*2*	*0*	*0*	*789*
45 S	*0*	*0*	*0*	*1*	*39*	*255*	*562*	*754*	*787*	*789*	*789*	*789*	*789*
50 M	*0*	*0*	*0*	*0*	*10*	*103*	*165*	*84*	*8*	*1*	*0*	*0*	*371*
50 S	*0*	*0*	*0*	*0*	*10*	*114*	*278*	*363*	*371*	*371*	*371*	*371*	*371*
55 M	*0*	*0*	*0*	*0*	*2*	*36*	*60*	*27*	*2*	*0*	*0*	*0*	*127*
55 S	*0*	*0*	*0*	*0*	*2*	*38*	*98*	*125*	*127*	*127*	*127*	*127*	*127*
60 M	*0*	*0*	*0*	*0*	*0*	*8*	*12*	*6*	*0*	*0*	*0*	*0*	*26*

Growing Degree Day units are computed as the difference between the daily average temperature and the base temperature. (Daily Ave. Temp. - Base Temp.) One unit is accumulated for each degree Fahrenheit the average temperature is above the base temperature. Negative numbers are discarded. Example: If the days high temperature was 95 and the low temperature was 51, the base 60 heating degree day units is ((95 + 51) / 2) - 60 = 13. This is done for each day of the month and summed.

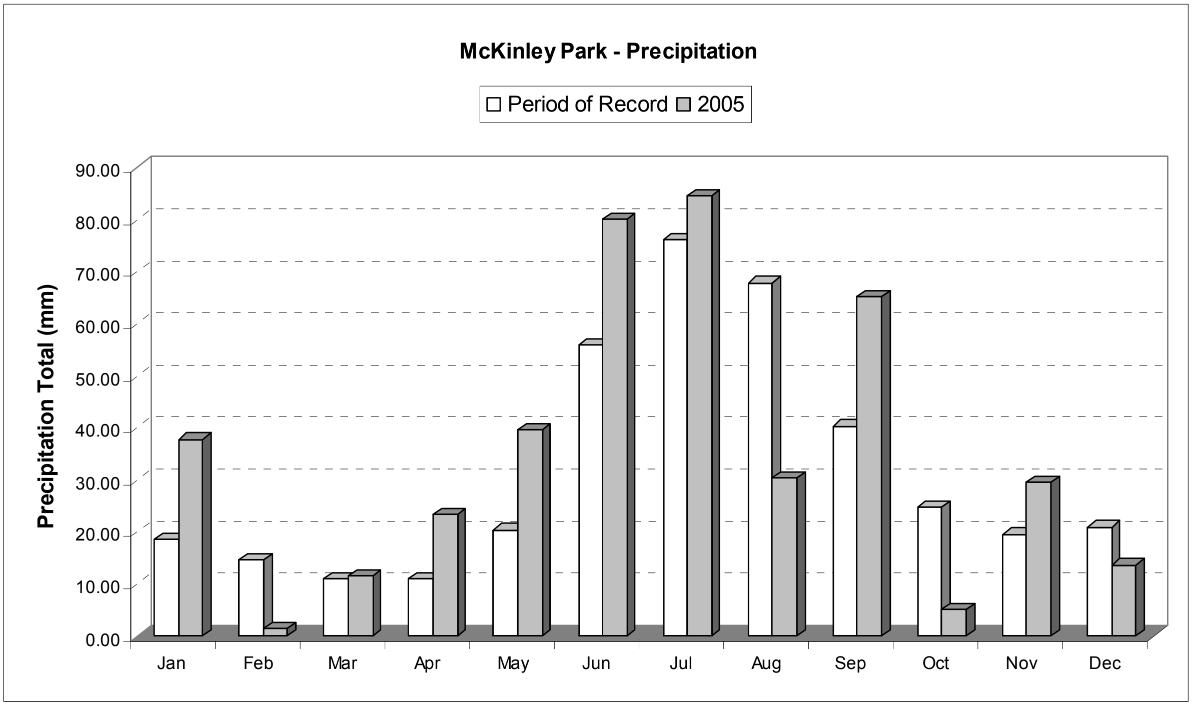


Figure 10 McKinley Park total monthly precipitation totals fro 2005 compared with the period of record averages (1925-2005).

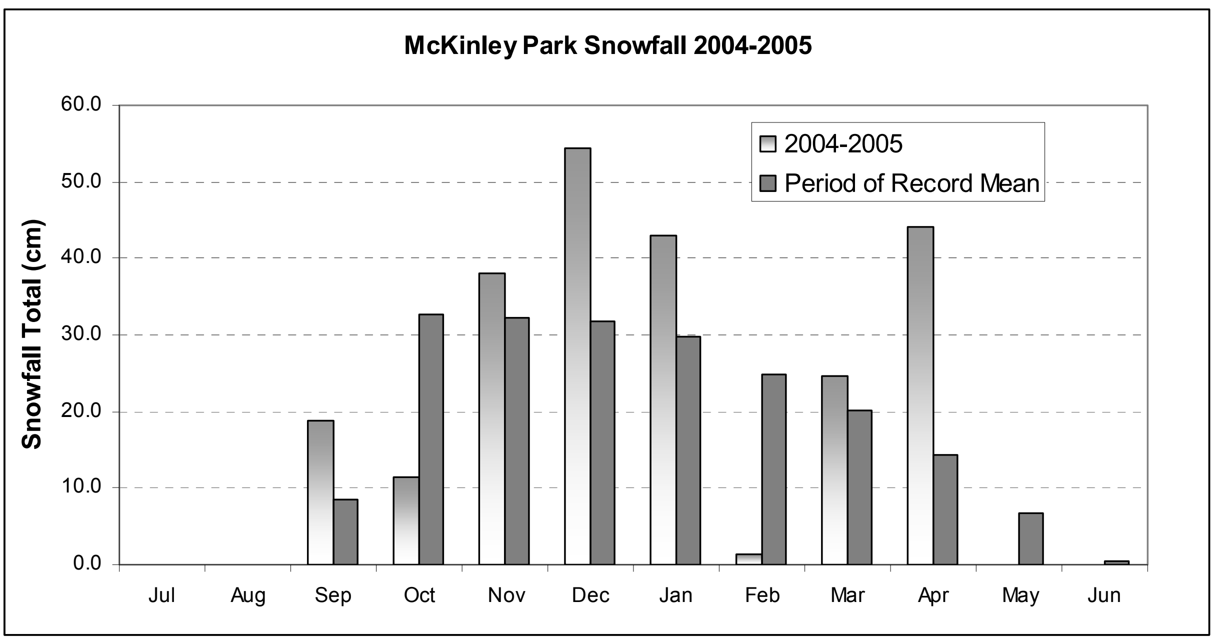


Figure 11 McKinley Park monthly snowfall totals for 2005 compared with the period of record averages (1925-2005).

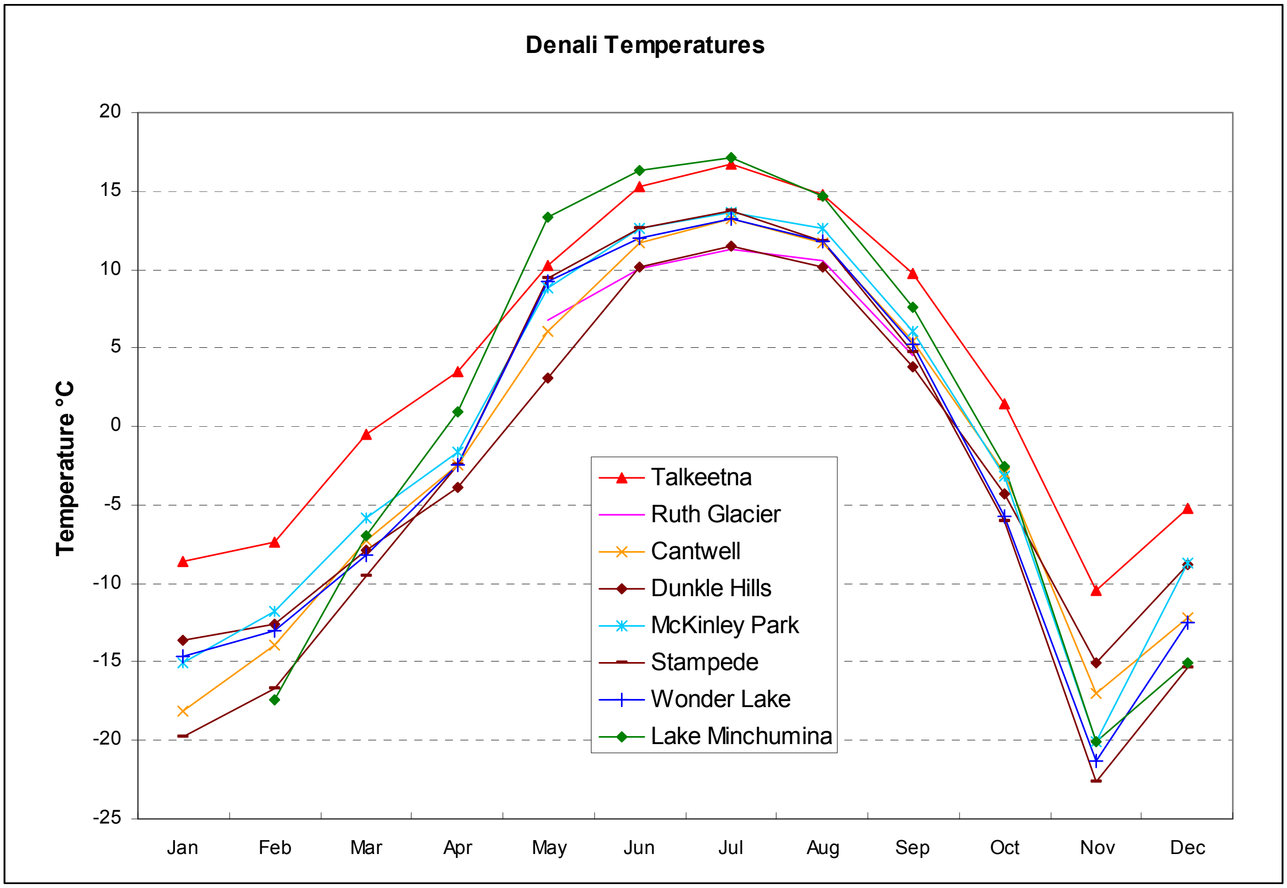


Figure 12 Monthly mean temperature comparisons from climate stations in and around Denali.

We looked at mean monthly temperatures at eight stations starting with Talkeetna outside the SE corner of the park traversing across the Alaska Range and ending with Lake Minchumina in the far NW corner of the park. In 2005, Talkeetna had moderate winter temperatures and warm summer temperatures. The warmest temperatures were recorded at Lake Minchumina in the NW corner of the park approximately 100 km north of the Alaska Range. The coldest temperatures were recorded at Stampede, located in the Kantishna Hills east of the Toklat Basin. The two sites south of the Alaska Range are both at elevation above 1000 meters; the monthly temperatures have the least variation of all of the sites, they are cool in the summer and relatively warm in the winter. Wonder Lake, Cantwell, McKinley Park and Stampede all had similar summer temperatures (Figure 12). In order to make the graph readable, Wigand Creek and McKinley River were not displayed because they tracked almost identically with Stampede and Lake Minchumina, respectively.

The orographic effect of the Alaska Range is responsible for the deep snowpacks we find south of the crest of the range. At the aerial snow markers that have been surveyed for 20 years the average snow depth on March 1st is 153 cm (60 inches). McKinley Park north of the range has an average snow depth on March 1 of 50.8 cm (20 inches). Summer precipitation has been measured at Talkeetna and McKinley Park for over 50 years. Annual precipitation for McKinley Park in 2005 was 422.7 mm (16.2 inches) and the mean for the

period of record is 382.3 mm (15.1 in.). Annual precipitation for Talkeetna for 2005 was 738.1 mm (27.6 inches) the mean is 711.2 mm or 28 inches (Figure 13).

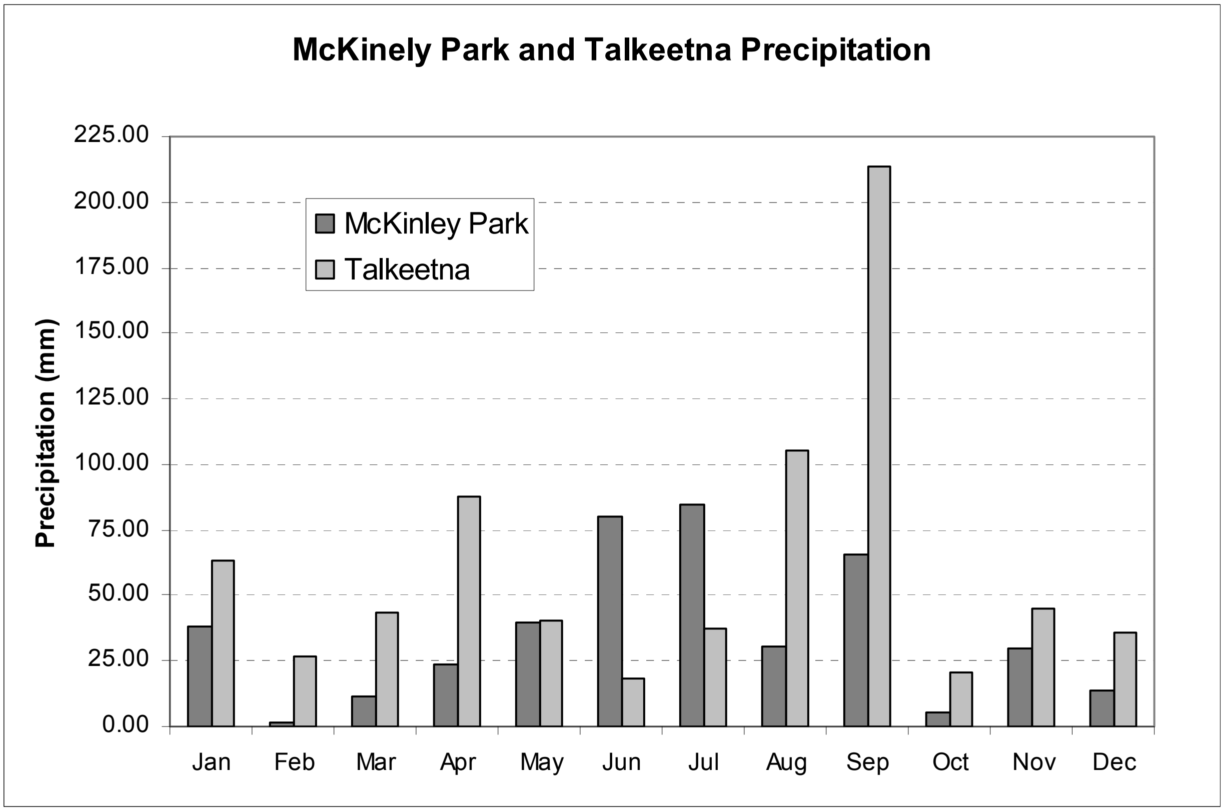


Figure 13 Monthly precipitation totals for 2005 at McKinley Park on the north side of the Alaska Range and Talkeetna on the south side of the Alaska Range.

Wrangell – St. Elias 2005 Climate Summary--

Gulkana: The long-term station is located at the Gulkana Airport and has been in operation from 1949 – present (57 years). This is the longest continuously running station in the WRST area.

The mean annual temperature for the period of record is -2.6°C (27.3°F). In 2005 the mean annual air temperature was 0.2°C (32.3°F). Only July and November were cooler than normal, all other months were above normal temperatures for the period of record (Figure 8). Gulkana's mean annual air temperature hovers right around freezing or 0°C (32°F). Table 4 shows the growing degree days for Gulkana for a base temperature of 40°F through 65°F. The top ten warmest years on record for this site include 2000, 2002, 2003 and 2004.

Mean precipitation based on the 57-year period of record is 281.4 mm (11.06 in.).The 2005 precipitation was 320.8 mm (12.63 in.). May, June, September and November and especially July were above average (Figure 15). July precipitation was over 200% of normal. The top ten driest years on record for Gulkana include 2001, 2003 and 2004.

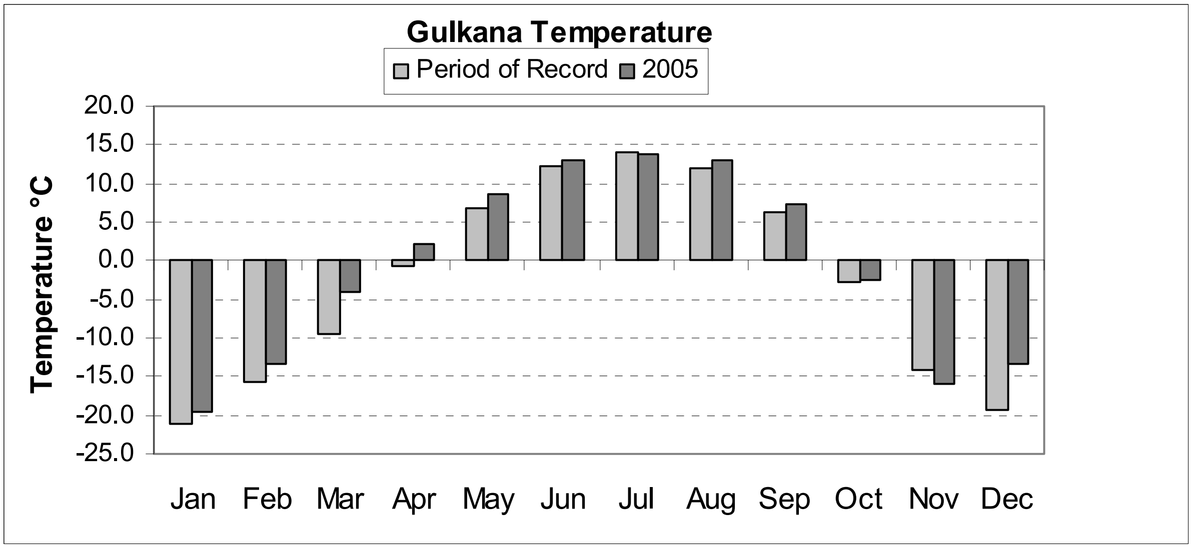


Figure 14 Gulkana mean monthly temperatures for 2005 compared with the period of record (1949-2005).

Table 4 Gulkana growing degree days based on the period of record 1949 – 2005. M=Monthly data. S= Running Sum of monthly data.

Station:(503465) GULKANA FAA/AMOS													
From Year=1949 To Year=2005													
Growing Degree Days for Selected Base Temperature (F)													
Base	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
40 M	0	0	0	9	149	420	539	422	143	11	0	0	1694
40 S	0	0	0	9	158	578	1117	1539	1682	1693	1694	1694	1694
45 M	0	0	0	1	57	272	384	270	55	2	0	0	1042
45 S	0	0	0	1	58	330	714	984	1040	1042	1042	1042	1042
50 M	0	0	0	0	15	142	231	136	13	0	0	0	537
50 S	0	0	0	0	15	157	388	524	536	537	537	537	537
55 M	0	0	0	0	3	54	101	48	1	0	0	0	207
55 S	0	0	0	0	3	57	158	206	207	207	207	207	207
60 M	0	0	0	0	0	13	27	10	0	0	0	0	51

Growing Degree Day units are computed as the difference between the daily average temperature and the base temperature. (Daily Ave. Temp. - Base Temp.) One unit is accumulated for each degree Fahrenheit the average temperature is above the base temperature. Negative numbers are discarded. This is done for each day of the month and summed.

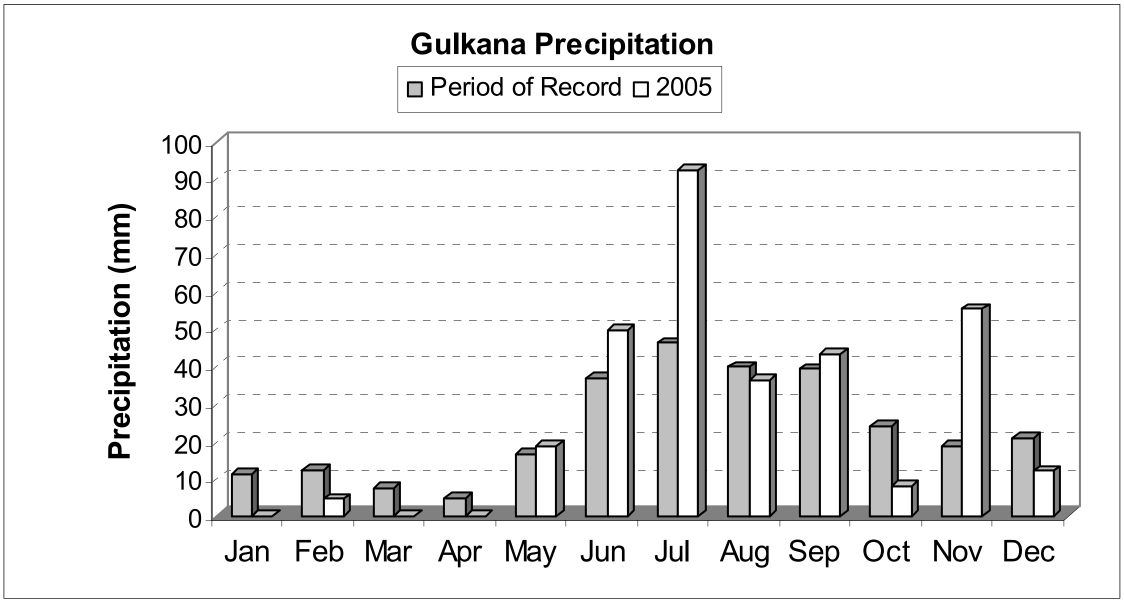


Figure 15 Gulkana monthly precipitation totals for 2005 compared with the period of record totals.

Note: The monthly snowfall totals have not been recorded at this site since 1999.

We looked at seven stations along the north-south transect that runs through WRST from the coast to the foothills of the Alaska Range. Jatahmund, Chisana and May Creek exhibit a typical interior Alaska climate pattern with warm summer temperatures and very cold winter temperatures. Bering Glacier and Yakutat data show less temperature variation and warmer year-round temperatures as would be expected in locations south of the Chugach Range. These locations are moderated by the warm moist systems moving across the Pacific Ocean. Bering Glacier has the flattest curve or the least amount of variation in temperature throughout the year. Figure 16 shows the mean monthly temperatures for all stations along the transect from north to south.

In summer the warmest location along the transect is Jatahmund Lake, the site farthest north and farthest from the coast. The coolest site, and the highest site in elevation, is Chicken Creek. In the winter the coldest location is Chisana. The northern plateau of WRST is unique because it sits in a broad high plateau surrounded by high peaks and glaciers. The “low” elevation sites are much higher in elevation than typical low elevation sites in Alaska. Chisana in the valley bottom sits at 1011 meters. We purposefully paired two of the new CAKN stations as high elevation counterparts to lower elevation sites. Chicken Creek (high - 1603m) is paired with Chisana (low-1011m) and Chititu (High 1402m) is paired with May Creek (low-503m). In winter, because of typical winter inversions where cool air settles into valley bottoms, the high elevation sites are warmer than the low elevations sites. This past year the average difference was 7 degrees. The trend reverses in March when the sun rises high enough above the horizon to warm up the daytime temperatures and temperatures once again decrease with increased elevation. This lasts until October when the inversions settle in once again (Table 5).

Table 5 Mean monthly temperatures at low elevation sites versus high elevation sites at WRST. Red shading indicates warmer temperatures and blue are cooler.

	Northern Area of Park		Central Area of Park	
	Low	High	Low	High
	Chisana	Chicken Creek	May Creek	Chititu
Jan		-12.9	-19.1	-11.0
Feb		-11.7	-11.0	-9.9
Mar		-7.5	-1.8	-6.0
Apr		-2.5	4.0	-1.5
May	9.0	4.7	9.4	4.3
Jun	11.2	7.4	13.3	7.5
Jul	10.9	7.2	13.0	7.3
Aug	11.2	8.6	12.7	9.0
Sep	4.7	3.1	7.2	3.0
Oct	-6.9	-4.9	-2.2	-2.9
Nov	-19.9	-13.1	-15.9	-11.0
Dec	-16.7	-7.0	-13.2	-5.1

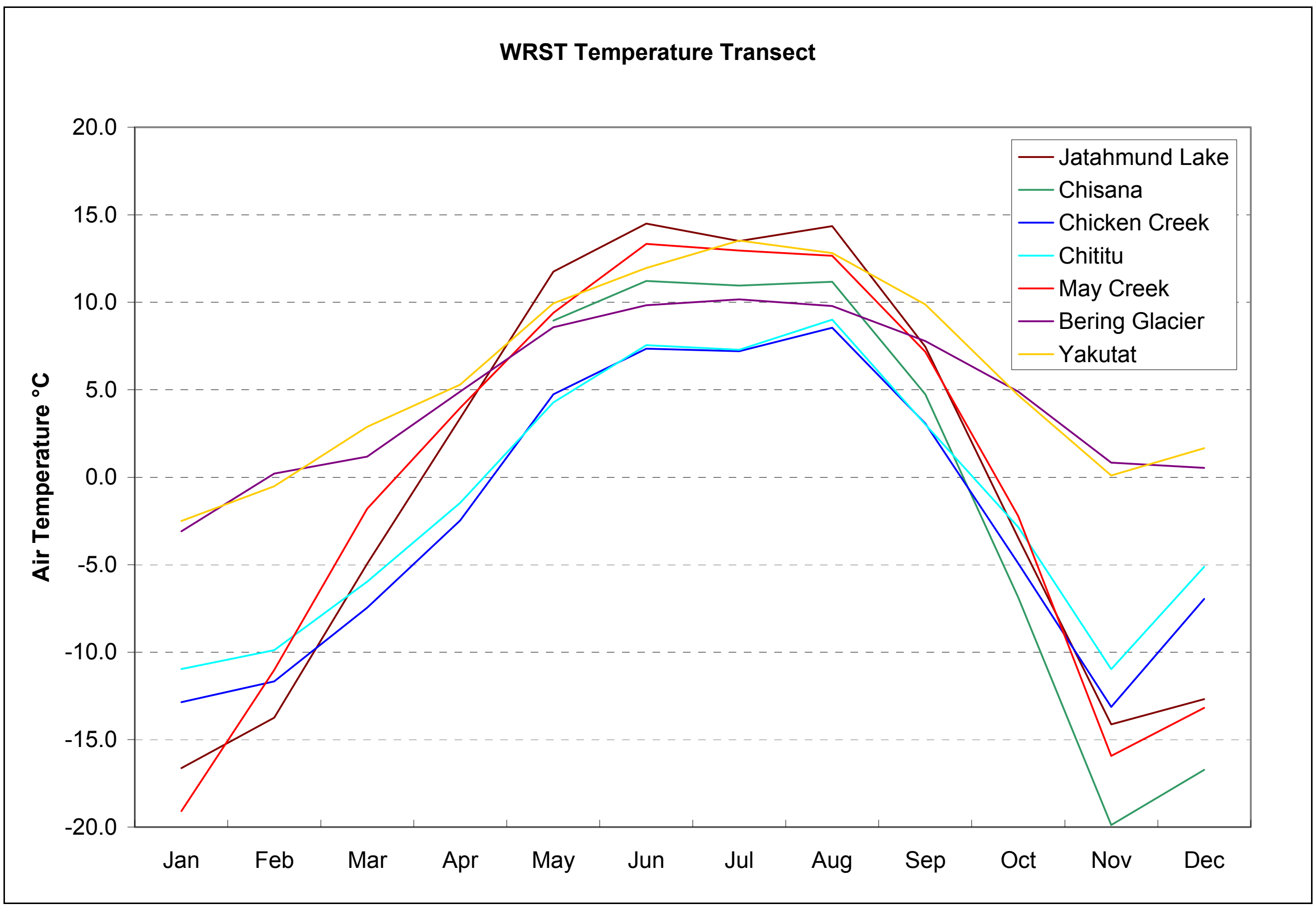


Figure 16 Comparison of mean monthly temperatures along the north-south climate transect of WRST. Jatahmund Lake is the station farthest north and Yakutat is the farthest south.

Precipitation

The southern portion of WRST along the coast are where Pacific storms traveling across open ocean run into the Chugach Range. The region succumbs to storms that spiral around as part of the Aleutian Low. PRISM models estimate that as much as 12.5 meters of annual precipitation might fall in this region. The transition to drier climates is very rapid as you move inland from the coast and across the Bagley Icefield. Along the Chitina River on the north side of the ice fields, the annual precipitation is as low as 300-500 mm. The central mountain peaks (Mt Sanford, Mt Wrangell, etc) receive "only" 2000-3000 mm. On the north side of the Mt. Sanford – Mt. Wrangell complex, values fall even further, to 200-300 mm annually (Redmond et al, 2006). If we compare the 2005 Yakutat precipitation to Gulkana we can see the annual pattern - the coastal region is wettest in the fall and early winter and relatively dry in the late spring early summer, while the interior precipitation peaks during the summer months (Figure 17).

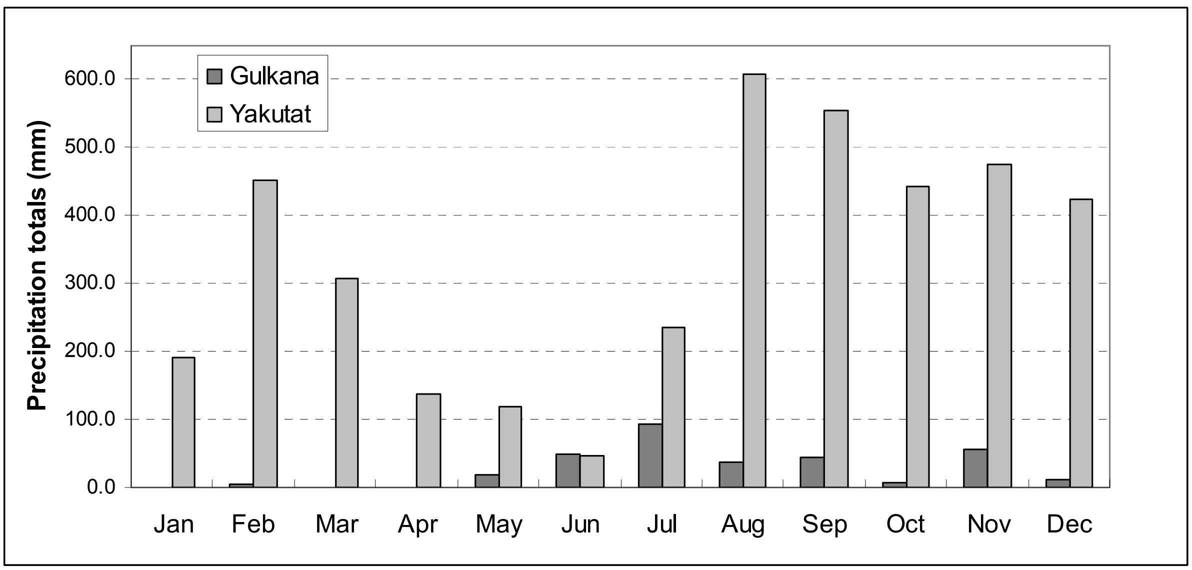


Figure 17 Differences in total monthly precipitation amounts at Gulkana in the drier interior and Yakutat along the Pacific Coast.

Yukon - Charley Rivers 2005 Climate Summary--

Eagle: The Eagle site east of YUCH has the longest continuous record for the area at 57 years.

In 2005, most months were warmer than normal. The mean annual temperature for the period of record is – 4.2°C (24.5°F). In 2005 the mean annual air temperature was -2.5°C (27.5°F). This is the 5th warmest year on record for this site. The spring temperatures were well above normal. July and August were near normal, and the early fall was warmer than normal. The only months that were cooler than average were January and October (Figure 18). Table 6 shows the growing degree days for this area based on the temperature records for the period of record. The top ten warmest years on record for this site include 2001, 2002,

2003 and 2005. Monthly temperatures for the past ten years were plotted with a linear trend line showing an increase in temperatures over the decade (Figure 19).

Mean precipitation based on the 57-year period of record is 299.7 mm (11.80 in.) the 2005 precipitation was 259.3 mm (10.21in.). Early winter snowfall amounts were above normal for 2005. May was slightly wetter than normal, and then the dry summer hit and the fires burned. Precipitation amounts were less than 50% of normal for the entire summer and it went on the record books as the driest summer on record (Figure 20 and 21).

Since there is only one long-term record in this area we can only compare this site to the RAWS and new CAKN stations for a temperature correlation (Figure 22).

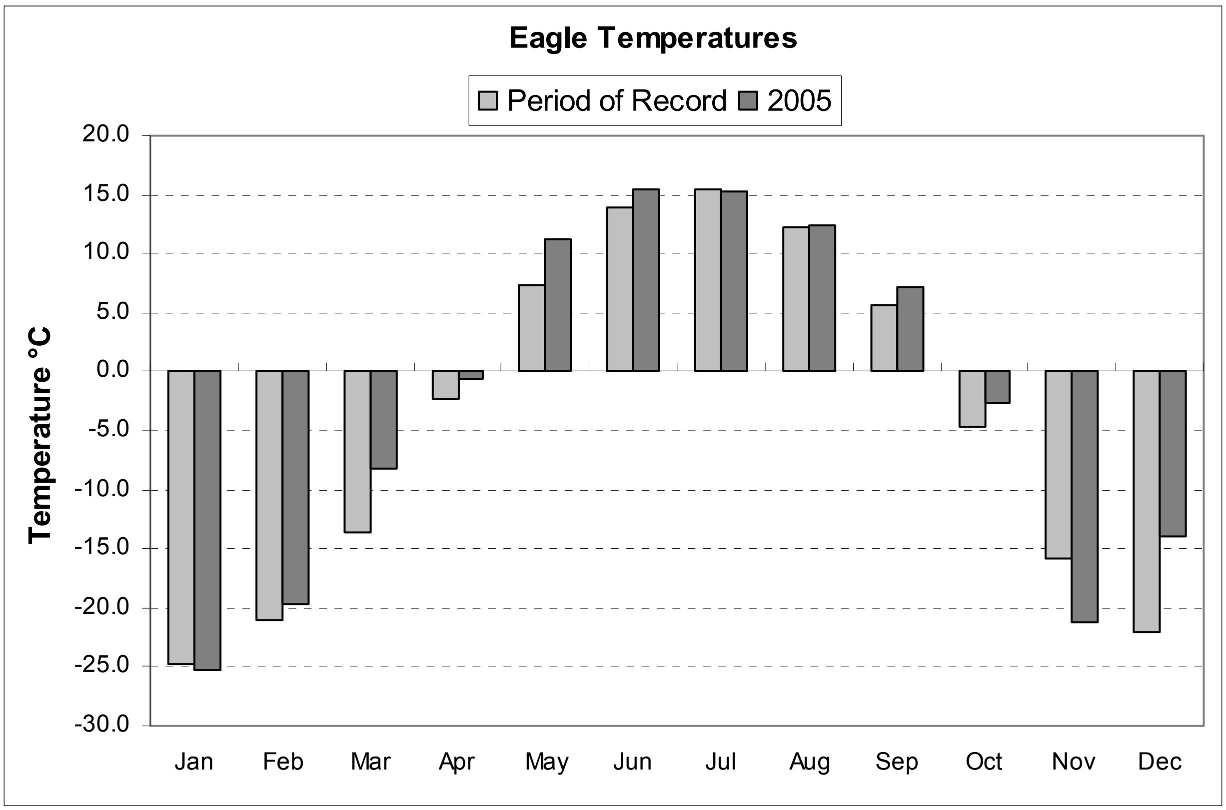


Figure 18 Eagle mean monthly temperatures in 2005 compared with the period of record mean.

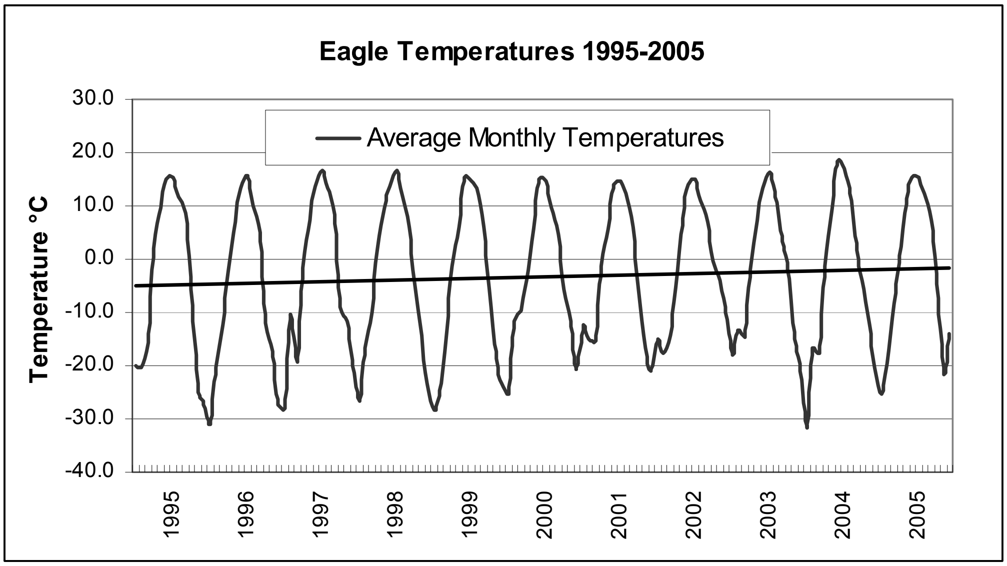


Figure 19 Eagle mean monthly temperatures for the past 10 years. A linear trend line indicates an overall warming trend over the past ten years.

Table 6 Eagle growing degree days based on the period of record 1949 – 2005. M=Monthly data. S= Running Sum of monthly data.

Station :(EAGLE													
From Year=1949 To Year=2005													
Growing Degree Days for Selected Base Temperature (F)													
Base	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
40 M	0	0	0	15	198	515	617	437	126	5	0	0	1913
40 S	0	0	0	15	213	728	1345	1782	1908	1913	1913	1913	1913
45 M	0	0	0	3	97	366	462	289	49	1	0	0	1267
45 S	0	0	0	3	100	466	928	1217	1266	1267	1267	1267	1267
50 M	0	0	0	0	38	224	309	162	12	0	0	0	746
50 S	0	0	0	0	38	262	572	733	746	746	746	746	746
55 M	0	0	0	0	11	108	168	70	2	0	0	0	358
55 S	0	0	0	0	11	119	287	356	358	358	358	358	358
60 M	0	0	0	0	2	36	62	20	0	0	0	0	121

Growing Degree Day units are computed as the difference between the daily average temperature and the base temperature. (Daily Ave. Temp. - Base Temp.) One unit is accumulated for each degree Fahrenheit the average temperature is above the base temperature. Negative numbers are discarded. This is done for each day of the month and summed.

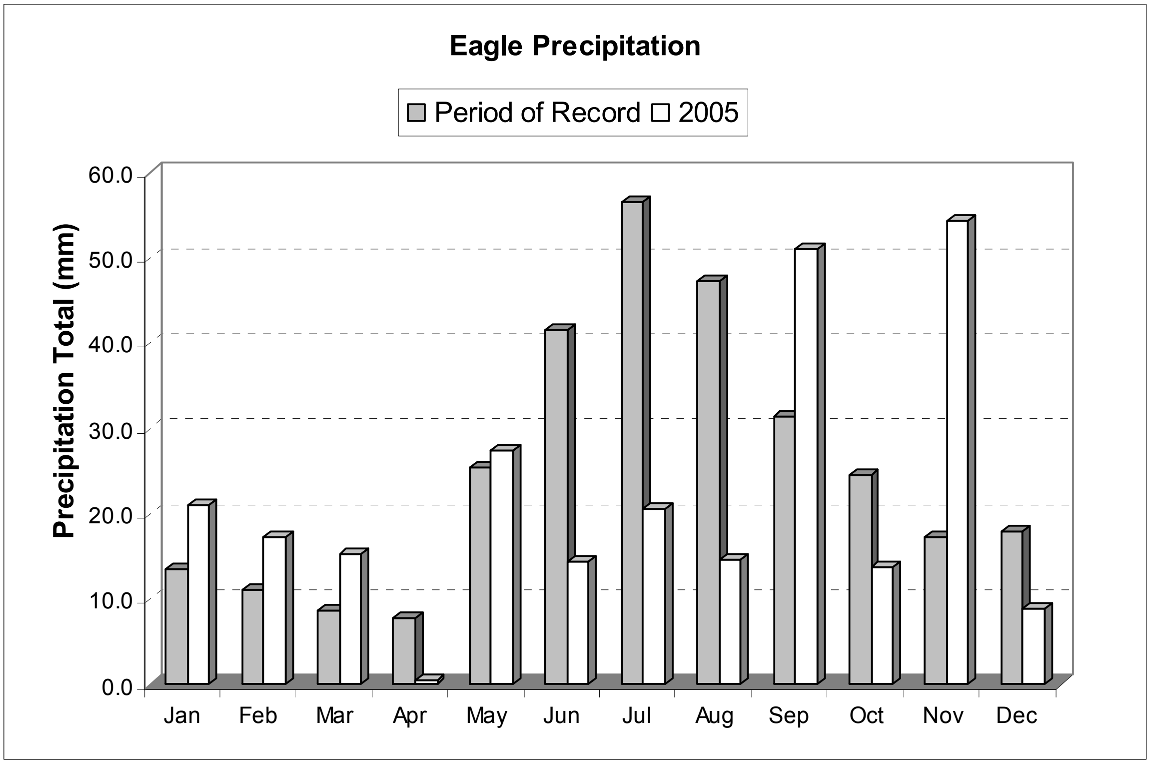


Figure 20 Eagle monthly precipitation totals for 2005 compared with the period of record averages (1949 – 2005).

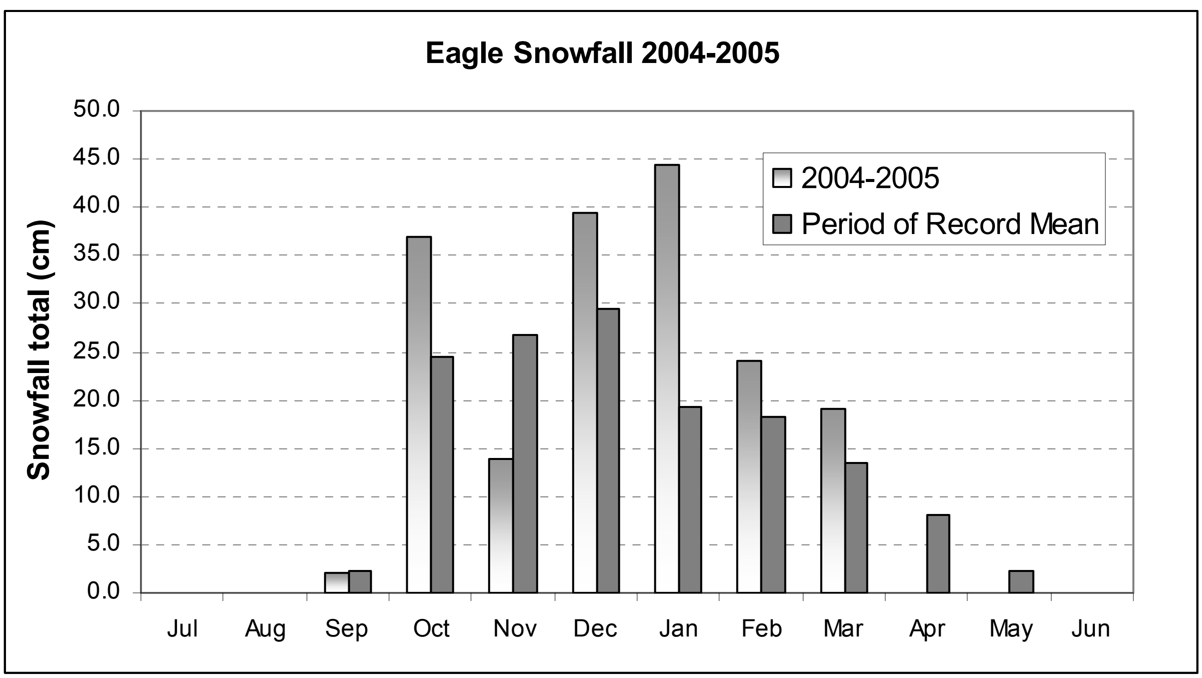


Figure 21 Eagle monthly snowfall totals of 2004-2005 compared with the average monthly totals from the period of record averages (1949 – 2005).

We do not have many stations to look at in YUCH, but the topography is not nearly as diverse as the other CAKN parks. It will be interesting to have a few years worth of data from the Upper Charley River site in the Tanana Uplands to see what the inversion differences are during the winter months. It was installed in August and the monthly averages from its start data are included on the 2005 graph with the other stations, as would be expected the winter temperatures for November and December are 5 degrees Celsius warmer than the valley sites of Coal Creek and Eagle. The 2005 temperature graphs of the four stations in the area show that Ben Creek which sits above the Yukon River drainage at 564 m (1850') is slightly warmer in the summer than Eagle at 247m (or 1000' lower) in elevation (Figure 23).

Because this area is susceptible to fire, the data form the stations can aid fire management by providing more data for fire weather indices. These data can also be used in the future for predictive models.

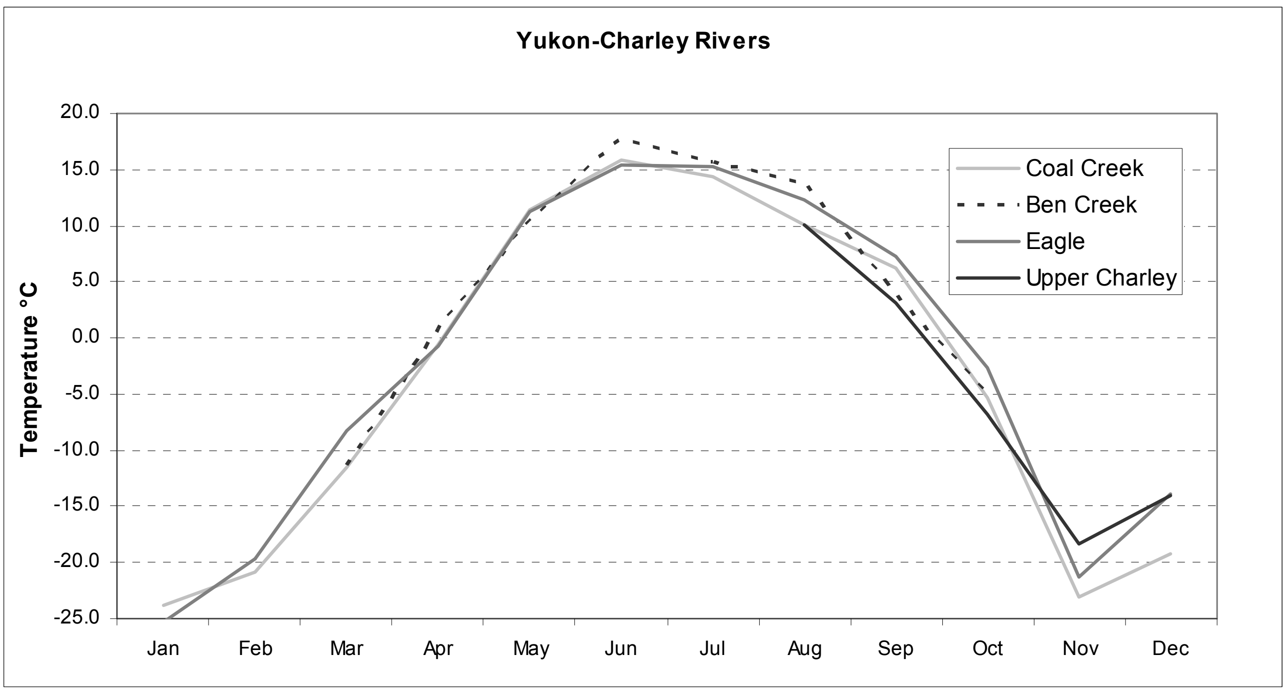


Figure 22 Monthly mean temperature comparisons from climate stations in and around Yukon-Charley Rivers.

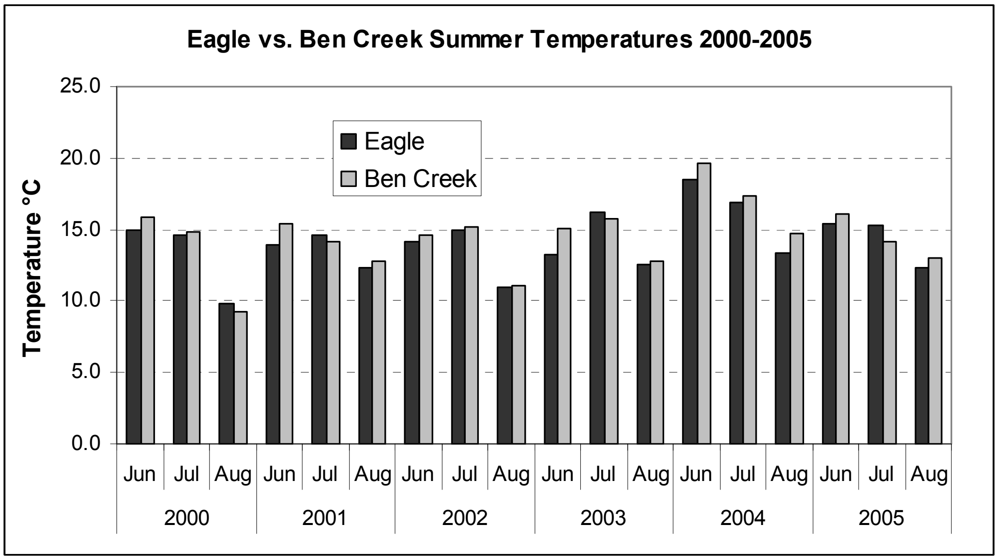


Figure 23 Mean monthly summer temperatures at Eagle compared with the Ben Creek RAWS site in YUCH.

DISCUSSION

There are many vital signs that are sensitive to even small changes in the mean annual temperature; permafrost and glacial extent are two examples. In 2005, Hinzman et al. published an article discussing evidence and implications of recent climate change in northern Alaska and Chapin et al. published an article on the role of land-surface changes as a result of warmer temperatures. Hinzman's article states that, "New extreme and seasonal surface climatic conditions are being experienced, a range of biophysical states and processes influenced by the threshold and phase change of freezing point are being altered, hydrological and biogeochemical cycles are shifting, and more regularly human sub-systems are being affected." The mean annual temperature hovers just below freezing at Gulkana, McCarthy and McKinley Park. We can assume that if the overall warming trend that has been experienced over the past 5-years continues, we will see sudden and rapid changes in the CAKN ecosystem. Chapin's article associates the terrestrial warming to a longer snow free season that changes the summer albedo. The May 1st snow survey and the snow depth sensors on the climate stations will help to quantify the snow on and off dates.

The new CAKN climate stations have been a valuable addition to the state of Alaska for forecasting and climate modeling purposes and are providing information that will help us to better understand climate variation with the parks. Including the new CAKN data streams as part of a larger network system has not only made it easier for CAKN personnel to manage data, but it has made the data available to a wide range of researchers, climate modelers, forecasters, and the general public. Although we may give up some flexibility with how data are managed, the overall affect is positive. Models, such as PRISM, will be refined as these data are incorporated.

Precipitation continues to be the most difficult climate measurement to quantify. Many of the long-term stations that have been reviewed have poor precipitation records. In fact, only those sites where there is a dedicated person or persons that have been around for the last 50 years have decent records. There are only a handful of these in the state. Things that were not obvious during the initial inventory are now being revealed. The NWS coop sites that have been co-located at airports went through a management shift in 1999 that put the observation responsibility in the hands of the FAA. The FAA sites that once had personnel living next to the instrumentation are a thing of the past and in their place are automated instruments (AWOS). Winter precipitation and snowfall measurements are not included in the new AWOS suite of observations. Fortunately, Eagle and McKinley Park have good records. Gulkana's winter observations ended in 1999 (as well as those at Tonsina and Glenallen). While it will be difficult to have influence over these sites, we are moving forward with plans to incorporate year-round precipitation gages through the NRCS SNOTEL program in the three parks. We are confident that this is the most robust, reliable way to get these data. The new site at Kantishna has given us the first six months of continuous precipitation data for a site in Denali other than the McKinley Park manual site.

During the 2005 field season we noticed that the posts that the precipitation tipping buckets are attached to (which are independent of the tripod) were heaving at some locations. The funnels that sit on the top of the housing were also loose or missing. In 2006, the gage will be moved to the top of the tripod on a cross-arm opposite the snow depth sensor and small machine screws will be used to secure the funnel to the housing.

PLANS FOR COMING YEAR

In 2006 we will continue to develop the program by strengthening partnerships with the climate community. We have plans to collaborate on presentations and to participate in educational and informational outreach opportunities. The partnerships that were fostered during the development of the program are critical to its success and an effort will be made to keep these relationships dynamic.

The field work for 2006 will include:

- Maintenance and sensor calibration at all CAKN stations. This will involve 1-2 trips to WRST and 1 trip to YUCH. The Denali field work will take place throughout the summer. The maintenance schedule will remain sensitive to the management policies at each of the parks and strive to be unobtrusive to visitor experiences.
- Potential installations include a station on the south side of the Alaska Range in DENA and a high elevation site in WRST.
- A SNOTEL site will be installed at Tokositna River with Rick McClure of the NRCS and maintenance of the Kantishna SNOTEL will be done in early September.

Another goal of the 2006 field season is to ensure consistency among all stations including design, data flow, and equipment and to continue with the development of web analysis tools and data packaging.

ACKNOWLEDGMENTS

The development of this program has been a challenging and rewarding endeavor, but it could not have been done without the help of many people. At the conclusion of the first annual report for the climate monitoring program I would like to take the opportunity to thank Guy Adema and Maggie MacCluskie for their continued support during the past four years. The first few years were so important and many people contributed to the process, in particular I'd like to send a big thanks to Paul Atkinson who helped so much during the first year of development. Thanks also to Danny Rosenkrans who helped gain perspective on the complexities of climate at WRST; to Tom Liebscher, Nikki Guldager, and Steve Ulvi for providing guidance in YUCH.; Larissa Yocum for being a great field assistant; and to Bruce Giffen, Kelly Redmond and Dave Simeral (WRCC), Rick McClure (NRCS), Rick Thoman(NWS), Gary Hufford (NWS), and Buddy Adams (NIFC) for helping with the big picture.

LITERATURE CITED

Alaska Climate Research Center [Internet]. Fairbanks, AK. Geophysical Institute, Atmospheric Sciences Group, and the University of Alaska Fairbanks. Available from http://climate.gi.alaska.edu/Statewide/departures.html. Updated monthly.

Chapin, F. S., *et al.* 2005. Role of Land-Surface Changes in Arctic Summer Warming Science 310: 657-660.

Larry D. Hinzman *et al*. 2005. Evidence and Implications of Recent Climate Change in Northern Alaska and Other Arctic Regions, Climatic Change, Volume 72, Issue 3, Pages 251 - 298

Sousanes, Pamela J. 2004. Climate Monitoring Protocol for the Central Alaska Network – Denali National Park and Preserve, Yukon-Charley River National Preserve, and Wrangell -St. Elias National Park and Preserve. National Park Service unpublished report.

Sousanes, Pamela J. 2006. Draft. Central Alaska Network Climate Monitoring Metadata Report. National Park Service Unpublished Report. xxpg

Western Regional Climate Center [Internet]. Reno, NV. Division of Atmospheric Sciences - Desert Research Institute. Data available from http://www.wrcc.dri.edu/NPS.html. Updated daily.

APPENDIX A – 2005 FIELD SEASON ACCOMPLISHMENTS

Denali 2005 Fieldwork

Two new climate stations were added to the park. One station was installed in the Toklat road camp area with assistance from Dave Simeral of WRCC. This site is located adjacent to the Toklat River, a major river valley flowing north out of the Alaska Range. This site serves both long-term monitoring needs and park management needs. The second site was installed adjacent to the former National Weather Service (NWS) coop station at Eielson Visitor Center, which had to be relocated during the construction of the new visitor center. The new site is located south of the construction zone approximately 400 ft SW of the old manual station. During 2004, the automated station was set up adjacent to the coop site for comparison.

The existing nine CAKN stations were serviced during an annual maintenance trip. Data were downloaded from the dataloggers at each site. Air temperature sensors were swapped at each site for calibration and all others sensors were either checked or swapped depending on the maintenance cycle. Three sites were accessed via the Western Area Fire Management helicopter during other missions.

A new snow telemetry (Snotel) station was installed at Kantishna in cooperation with the Natural Resources Conservation Service (NRCS). This site includes the standard suite of climate measurements as well as a year-round precipitation gage capable of measuring both snow and rainfall. The existing snow course was brushed and maintained during this installation. Monthly snow surveys will continue giving us the opportunity to check on the station and ground truth the snow measurements. The Purkeypile and Rock Creek Ridge snow courses were also brushed this year.

Figure 2 shows the distribution of climate stations in DENA.

WRST 2005 Fieldwork

Three new stations were installed in the park in 2005. In June two stations were transported out to May Creek Camp via contract aircraft out of Gulkana. Staging equipment prior to the field season made logistics easier for helicopter load calculations and the amount of time needed to accomplish a mission. The installation and maintenance was accomplished in July with the Eastern Area Fire Management contract helicopter. We met the helicopter in Gulkana and moved people and gear out to May Creek Camp, basing out of there for the next three days.

We installed the first station on July 5, 2005 at Gates Glacier on a gently sloping ridge between the Kennecott and Gates glaciers. The aspect of the slope shields the site from extreme down glacier winds and offers a high elevation site situated in the Wrangell Mountain Range. This site is representative of the glacial region of the park and is located on the north-south transect identified in the site evaluation process. The Tana Knob site was also installed along the transect within the Chugach Range, an area lacking in climate data. This site is also a high elevation site located above 1000 m. An additional site was installed at Tebay Lakes, also within the Chugach Range but at a lower elevation in an area of

importance identified in the site evaluation. The addition of these three sites will help complete the climate picture for the park by addressing high elevation and spatial data gaps.

The two sites installed in 2004 were serviced during the 2005 season. However, due to programming issues while in the field these two sites were not changed over to the new program and are still running the CAKN_2005 program (which means the data are transmitted in metric units). This will be remedied in 2006 when all of the stations will be programmed identically.

A reconnaissance of potential new sites in the White River area east of Chisana was conducted on July 7, 2005 by Pam Sousanes, Danny Rosenkrans, and Larisssa Yocum. This area is considered valuable for climate purposes, but was not evaluated in 2003 due to time and weather constraints. We landed at two sites in the White River area and surveyed other potential sites by air. We also looked at high elevation sites between the Nizina and Chisana Glaciers in the Wrangell Mountains along the north-south transect.

One new aerial marker was added to WRST at Notch Airstrip in the upper Chitina Valley and snow courses were added to the Tebay and Long Glacier aerial marker sites. See Figure 3 for a map of the climate stations in Wrangell- St. Elias.

YUCH 2005 Fieldwork

One new site was installed on August 4, 2005 in the Upper Charley River, south of the Three Fingers airstrip on a broad open plain above the river valley. This high elevation site (1125 m [3700’]) will capture the climate of the Yukon - Tanana upland area.

For this installation we based out of Coal Creek Camp and used the Eastern Area Fire Management helicopter to access the site. Transportation to Coal Creek Camp was via contract air charter out of Fairbanks. On the day of the installation, two trips were required to ferry the field crew, field gear, and equipment to the site. Once on site the installation took approximately six hours.

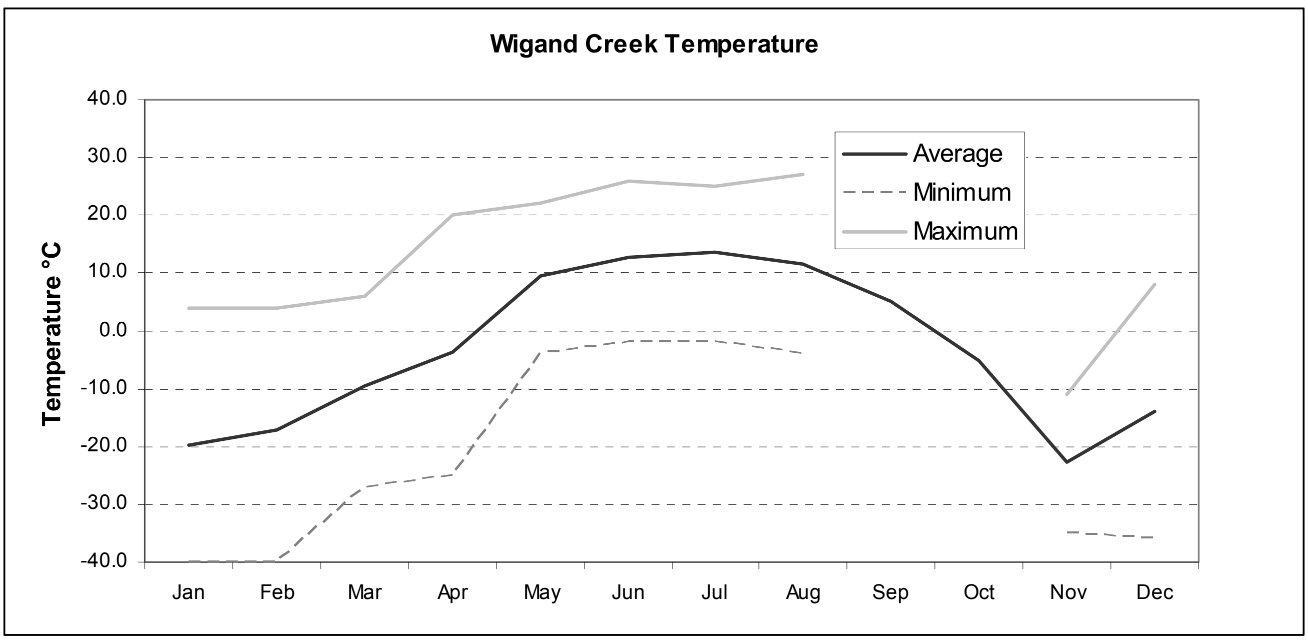
The aerial snow markers in the park were painted and plumbed on August 5, 2005. We retained the use of the fire management helicopter to accomplish this mission. These markers were originally installed in 2002 and had moved about a bit in the permafrost laden ground. Considering the locations of these markers they fared pretty well. All of them were repainted and stabilized, and guy wires were tightened and replaced as necessary.

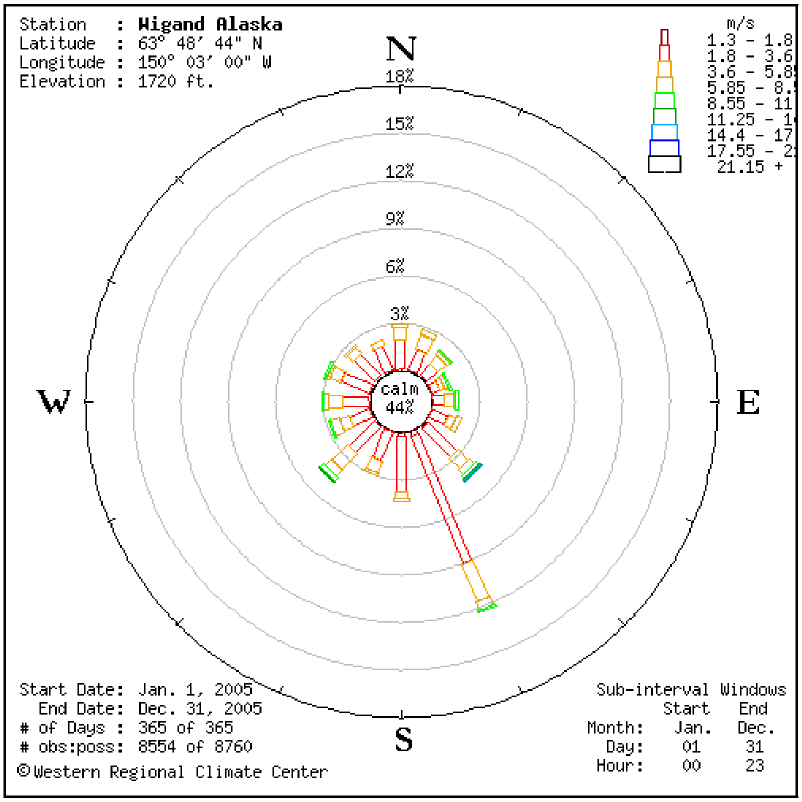
See Figure 4 for a map of climate stations in Yukon-Charley Rivers.

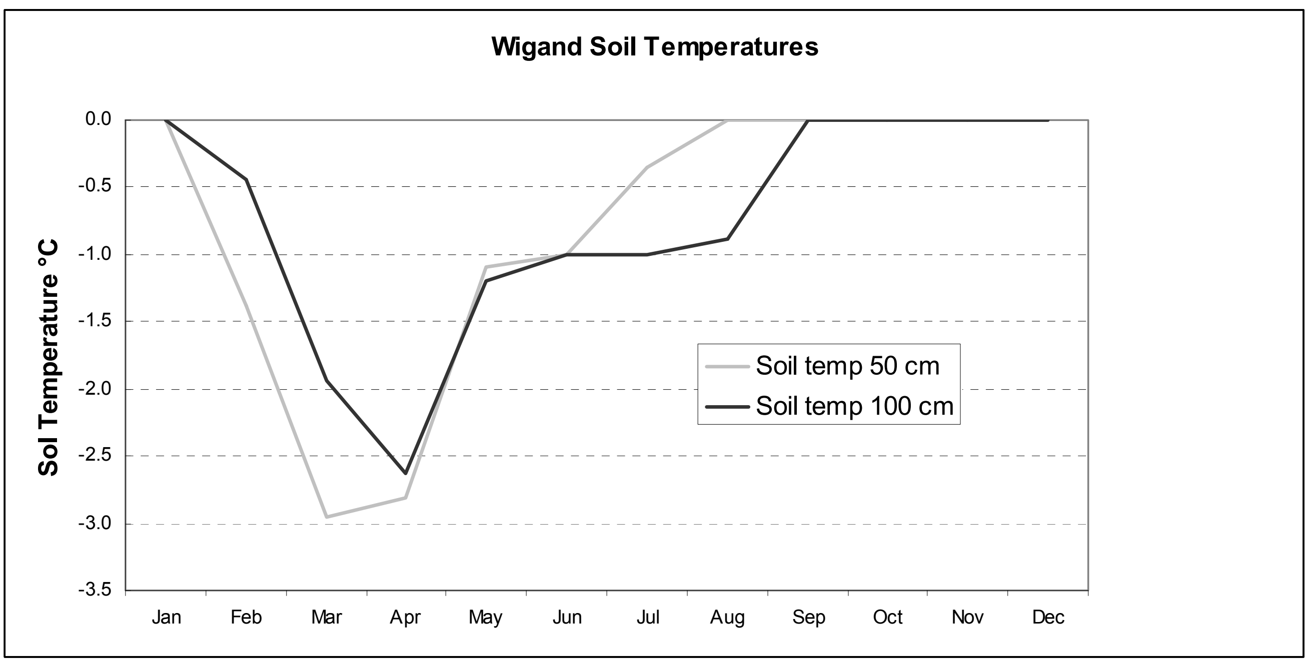
Appendix B - Denali National Park and Preserve Station Data

Wigand Creek – Elevation 533m (1750')

	Air Temp °C	Air Temp °C	Air Temp °C	Relative Humidity %	Wind Speed m/s	Wind Direction °	Wind Gust m/s	Surface Temp °C	Soil Temp 50 cm	Soil Temp 90cm
	Average	Minimum	Maximum	Average	Average	Average	Max	Average	Average	Average
Jan	-19.8	-40.0	4.0	78.4	2.0	185.4	3.0	-3.3	0.0	0.0
Feb	-17.2	-40.0	4.0	78.1	1.8	171.2	2.8	-4.1	-1.4	-0.4
Mar	-9.6	-27.0	6.0	73.3	2.7	174.3	4.0	-4.1	-2.9	-1.9
Apr	-3.6	-25.0	20.0	67.9	2.2	173.0	3.2	-1.4	-2.8	-2.6
May	9.5	-4.0	22.0	60.0	2.9	171.0	4.4	10.6	-1.1	-1.2
Jun	12.9	-2.0	26.0	66.8	2.7	186.9	4.1	14.3	-1.0	-1.0
Jul	13.7	-2.0	25.0	67.6	3.0	174.5	4.4	14.7	-0.3	-1.0
Aug	11.7	-4.0	27.0	74.0	2.7	184.1	4.0	12.4	0.0	-0.9
Sep	5.0			81.9	4.7	198.3	7.1	4.9	***	***
Oct	-5.3			86.8	2.8	198.3	4.8	-0.7	***	***
Nov	-22.7	-35.0	-11.0	81.4	2.8	179.2	4.2	***	***	***
Dec	-14.0	-36.0	8.0	83.2	1.4	150.9	2.3	***	***	***

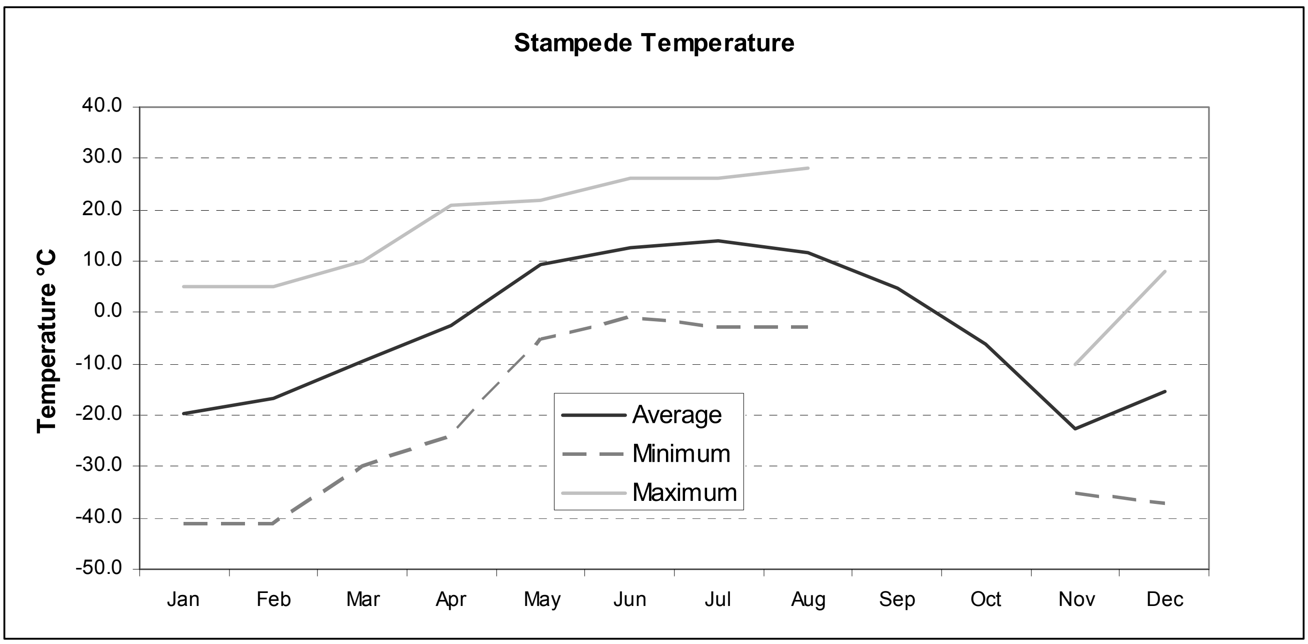


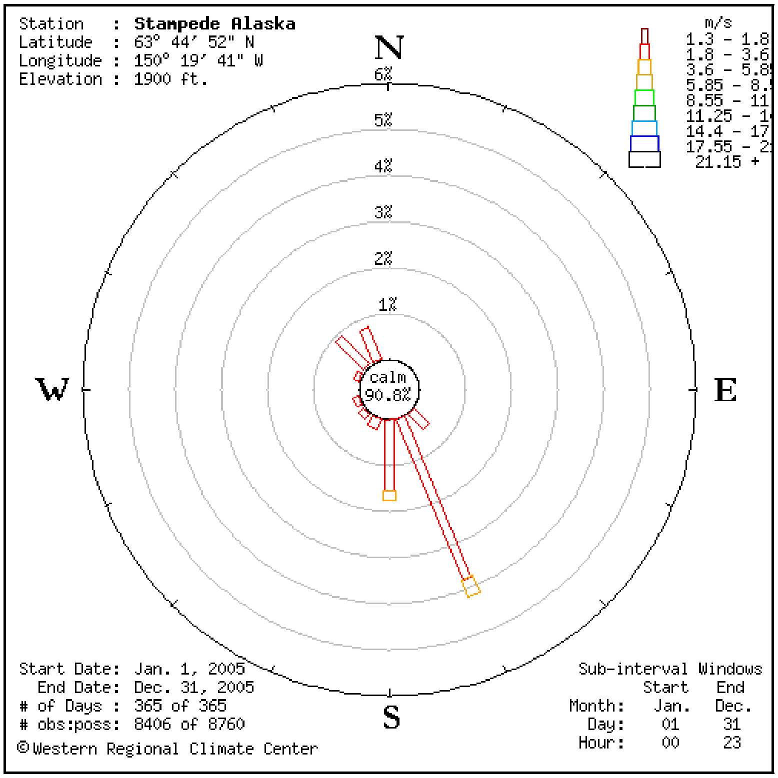

Station : Wigand Alaska
Latitude : 63° 48' 44" N
Longitude : 150° 03' 00" W
Elevation : 1720 ft.
N
S
E
W
18%
15%
12%
9%
6%
3%
calm
44%
m/s
1.3 - 1.8
1.8 - 3.6
21.15 +
Start Date: Jan. 1, 2005
End Date: Dec. 31, 2005
# of Days : 365 of 365
obs:poss: 8554 of 8760
©Western Regional Climate Center
Sub-interval Windows
Start End
Month: Jan. Dec.
Day: 01 31
Hour: 00 23


Wigand Soil Temperatures
Sol Temperature °C
0.0
-0.5
-1.0
-1.5
-2.0
-2.5
-3.0
-3.5
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Soil temp 50 cm
Soil temp 100 cm

Stampede – elevation 549m (1800')

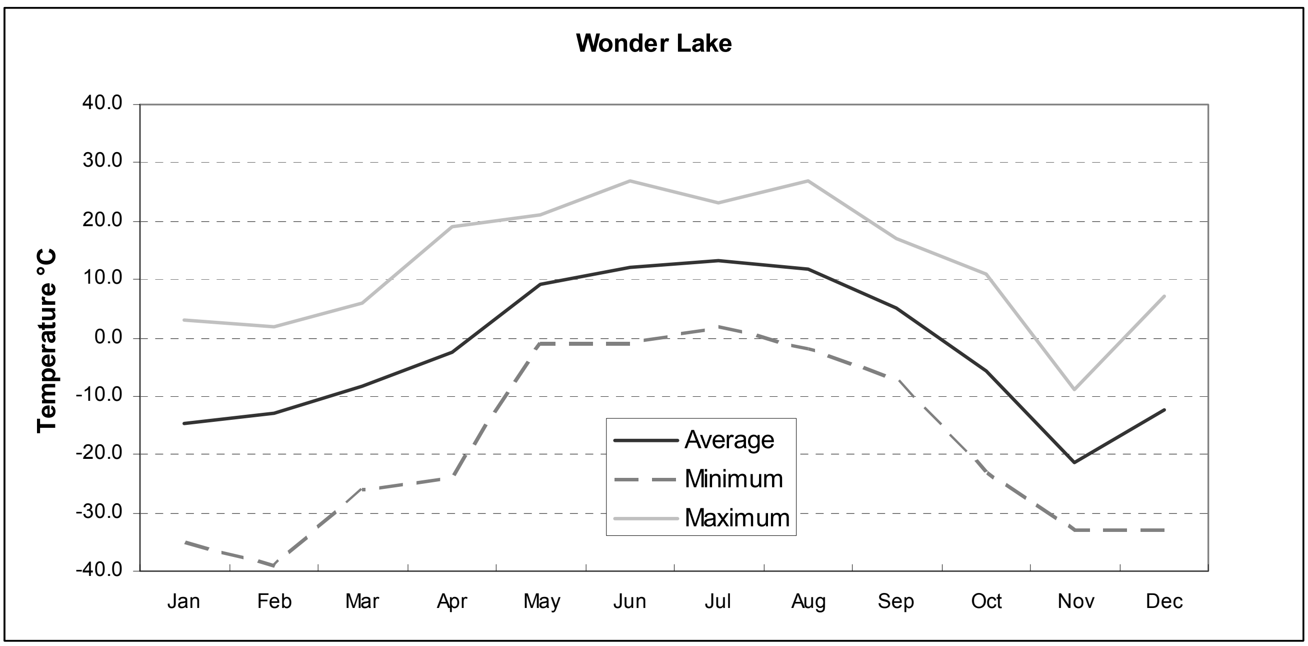
	Air Temp °C	Air Temp °C	Air Temp °C	Relative Humidity %	Wind Speed m/s	Wind Direction °	Wind Gust m/s	Surface Temp °C	Snow Depth 5mm
	Average	Minimum	Maximum	Average	Average	Average	Max	Average	Average
Jan	-19.8	-41.0	5.0	77.4	0.3	139.5	1.1	-4.3	***
Feb	-16.7	-41.0	5.0	74.7	0.6	152.2	1.3	-5.9	***
Mar	-9.5	-30.0	10.0	69.3	1.0	203.0	2.0	-5.5	***
Apr	-2.5	-24.0	21.0	63.7	1.0	210.2	1.9	-2.1	***
May	9.4	-5.0	22.0	62.4	1.1	189.2	2.2	11.0	***
Jun	12.7	-1.0	26.0	71.4	0.9	206.2	1.9	13.8	***
Jul	13.8	-3.0	26.0	71.3	0.9	211.4	2.0	15.5	***
Aug	11.8	-3.0	28.0	77.5	0.8	201.6	1.8	13.0	***
Sep	4.7	***	***	82.5	1.1	195.6	2.9	5.0	0.0
Oct	-6.0	***	***	85.9	0.7	204.0	2.1	-2.9	23.0
Nov	-22.6	-35.0	-10.0	76.2	0.5	213.6	1.5	-8.6	163.0
Dec	-15.4	-37.0	8.0	80.5	0.3	161.4	0.9	***	173.0

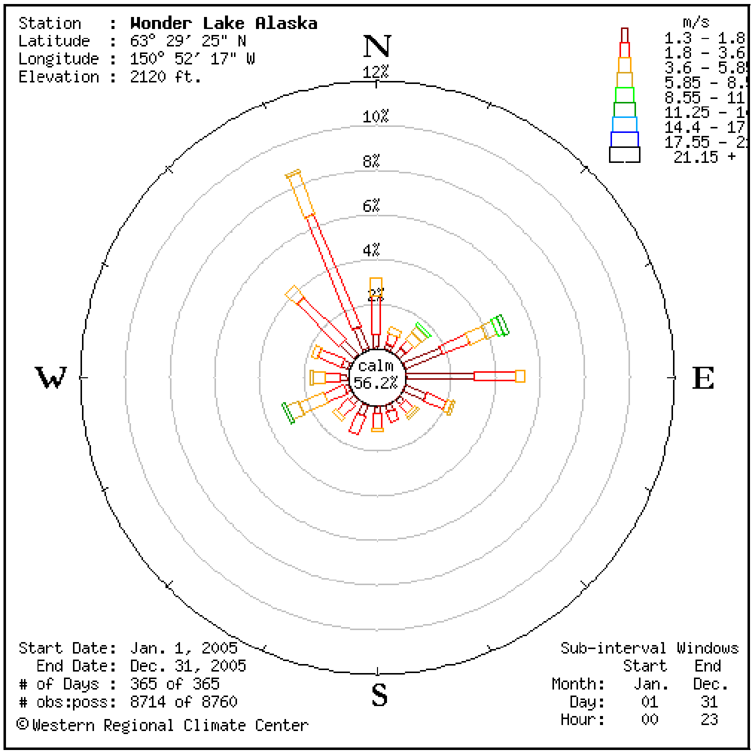


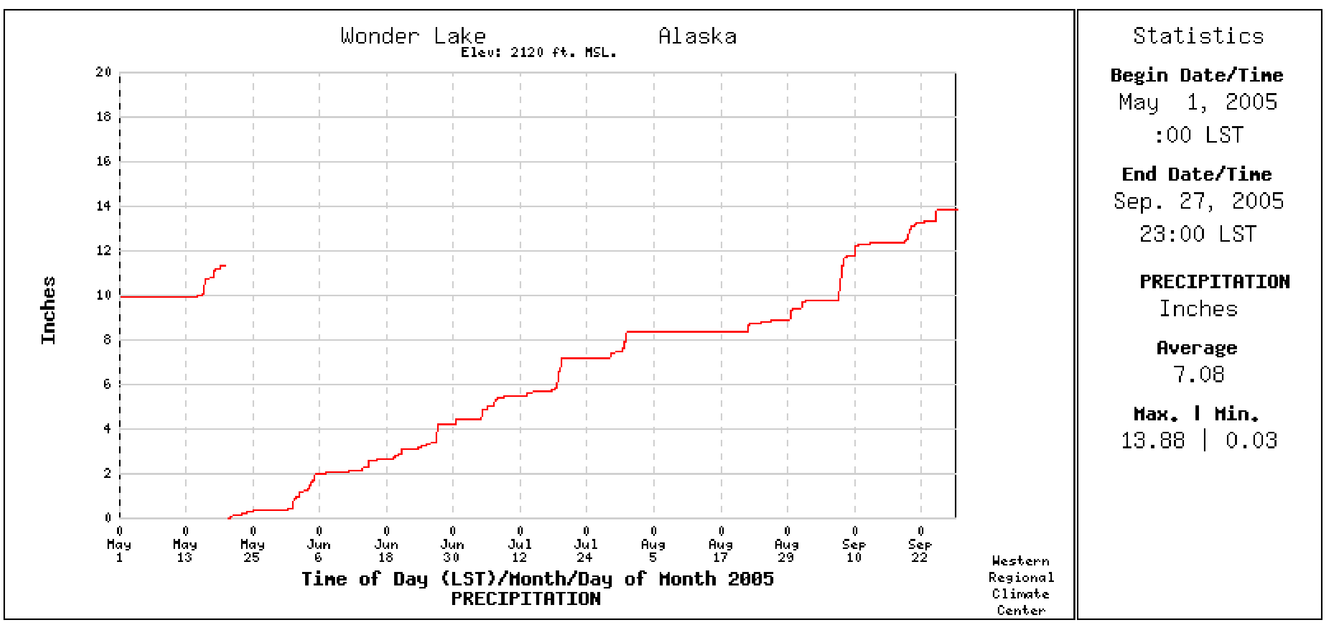

Station : Stampede Alaska
Latitude : 63° 44′ 52" N
Longitude : 150° 19′ 41" W
Elevation : 1900 ft.
N
E
S
W
6%
5%
4%
3%
2%
1%
calm
90.8%
m/s
1.3 - 1.8
1.8 - 3.6
3.6 - 5.8
5.85 - 8.
8.55 - 11
11.25 - 1
14.4 - 17
17.55 - 2
21.15 +
Start Date: Jan. 1, 2005
End Date: Dec. 31, 2005
# of Days : 365 of 365
obs:poss: 8406 of 8760
© Western Regional Climate Center
Sub-interval Windows
Start End
Month: Jan. Dec.
Day: 01 31
Hour: 00 23

Wonder Lake RAWS –Elevation 646m (2119')

	Air Temp °C	Air Temp °C	Air Temp °C	Relative Humidity %	Wind Speed m/s	Wind Direction °	Wind Gust m/s	Surface Temp °C	Precip mm
	Average	Minimum	Maximum	Average	Average	Average	Max	Average	Total
Jan	-14.6	-35.0	3.0	66.5	1.4	157.9	4.2	-16.2	
Feb	-13.0	-39.0	2.0	58.5	0.9	134.7	3.4	-14.3	
Mar	-8.2	-26.0	6.0	60.5	1.9	156.5	4.8	-8.3	
Apr	-2.4	-24.0	19.0	58.0	1.1	175.9	3.3	-1.2	
May	9.2	-1.0	21.0	57.1	1.5	183.3	5.5	10.3	43.2
Jun	12.0	-1.0	27.0	67.0	1.5	176.9	8.1	13.0	84.3
Jul	13.2	2.0	23.0	67.6	1.8	175.8	9.1	14.2	98.8
Aug	11.8	-2.0	27.0	72.6	1.4	192.2	7.2	12.7	35.8
Sep	5.2	-7.0	17.0	79.6	1.9	205.3	8.8	5.5	104.7
Oct	-5.7	-23.0	11.0	78.4	1.4	191.2	6.7	-5.5	
Nov	-21.3	-33.0	-9.0	65.4	0.7	169.5	5.0	-21.6	
Dec	-12.5	-33.0	7.0	70.9	0.9	138.2	6.0	-13.4	

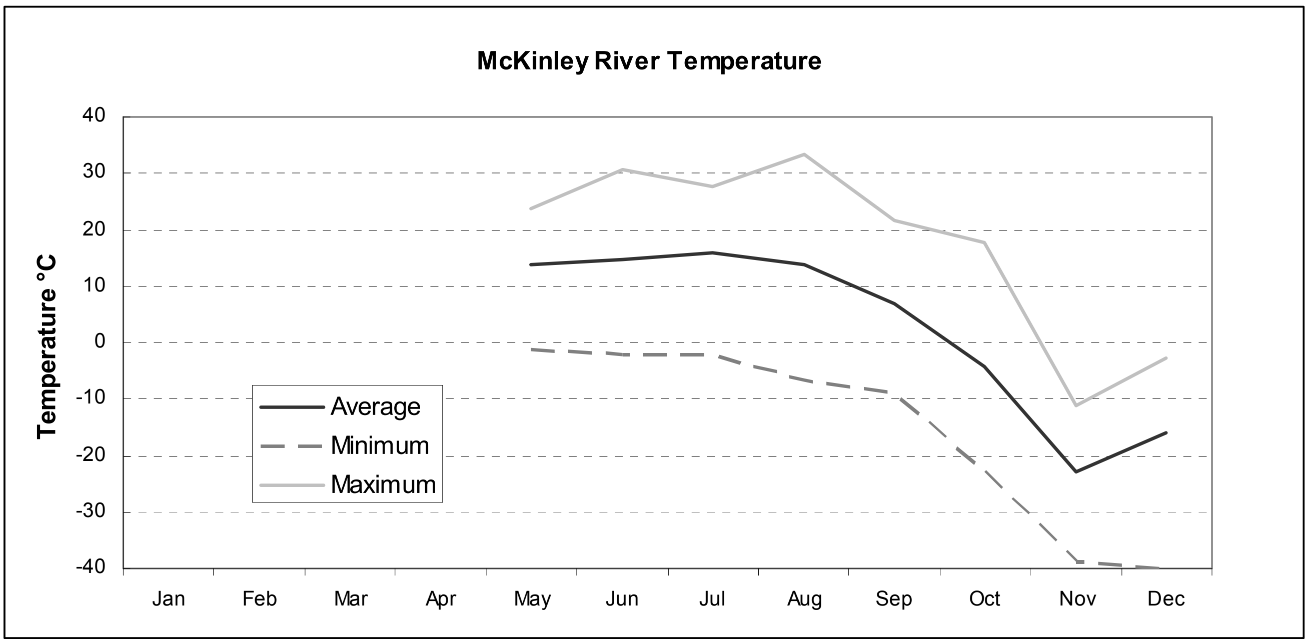


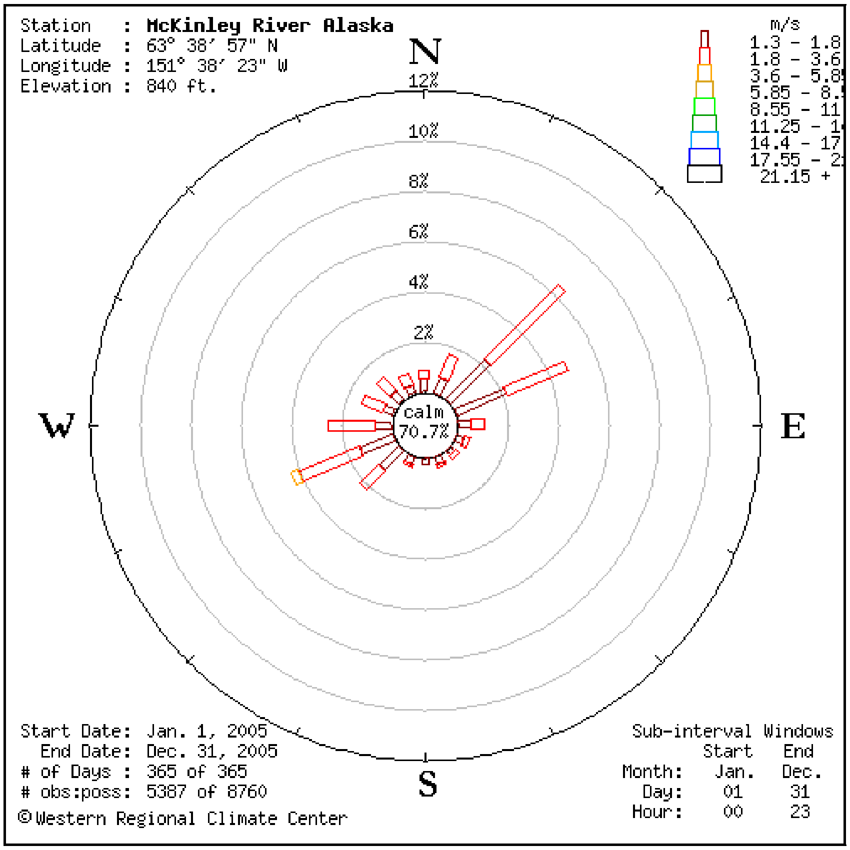

Station : Wonder Lake Alaska
Latitude : 63° 29' 25" N
Longitude : 150° 52' 17" W
Elevation : 2120 ft.
N
S
E
W
12%
10%
8%
6%
4%
2%
calm
56.2%
m/s
1.3 - 1.8
1.8 - 3.6
3.6 - 5.85
5.85 - 8.55
8.55 - 11.25
11.25 - 14.4
14.4 - 17.55
17.55 - 21.15
21.15 +
Start Date: Jan. 1, 2005
End Date: Dec. 31, 2005
# of Days : 365 of 365
obs:poss: 8714 of 8760
©Western Regional Climate Center
Sub-interval Windows
Start End
Month: Jan. Dec.
Day: 01 31
Hour: 00 23

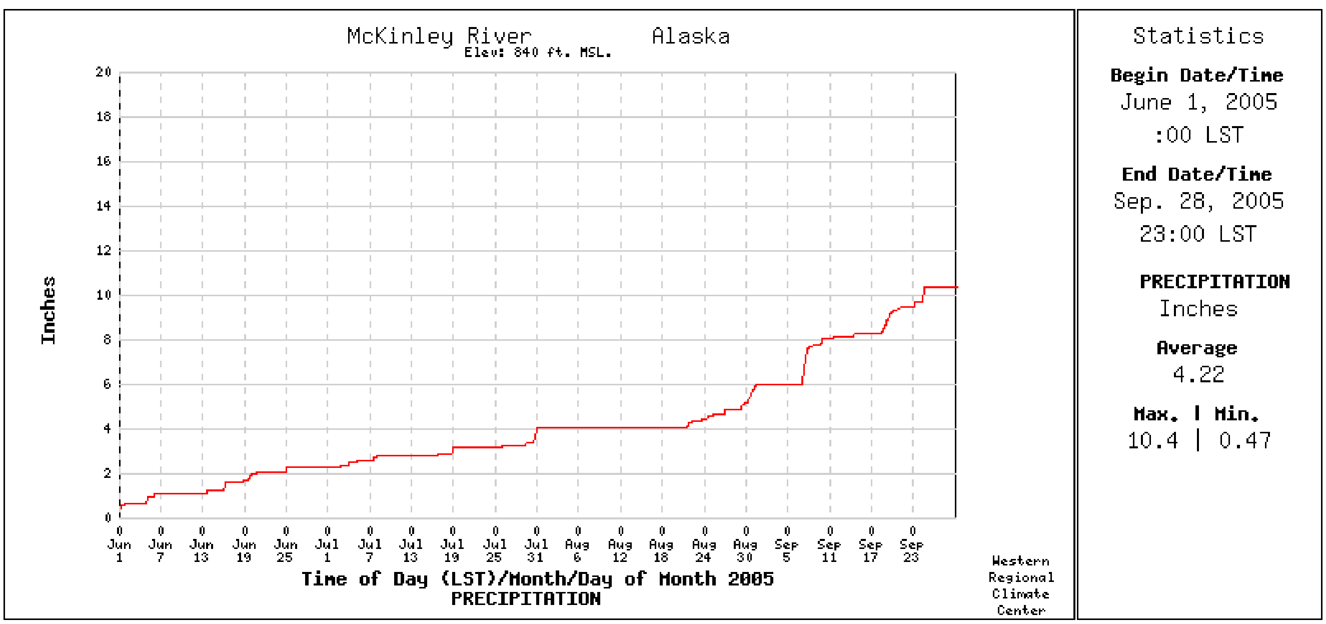

Wonder Lake Alaska
Elev: 2120 ft. MSL.
Inches
Time of Day (LST)/Month/Day of Month 2005
PRECIPITATION
Western Regional Climate Center
Statistics
Begin Date/Time
May 1, 2005
:00 LST
End Date/Time
Sep. 27, 2005
23:00 LST
PRECIPITATION
Inches
Average
7.08
Max. | Min.
13.88 | 0.03

McKinley River RAWS – Elevation 256m (840')

	Air Temp °C	Air Temp °C	Air Temp °C	Relative Humidity %	Wind Speed m/s	Wind Direction °	Wind Gust m/s	Snow Depth mm	Precip mm
	Average	Minimum	Maximum	Average	Average	Average	Max	Average	Total
Jan									
Feb									
Mar									
Apr									
May	14.0	-1.1	23.9	51.1	1.2	169.8	3.3	9.3	
Jun	14.9	-2.2	30.6	62.2	1.0	177.8	2.9	0	45.5
Jul	15.9	-2.2	27.8	61.6	1.2	168.4	3.4	0	45.0
Aug	13.8	-6.7	33.3	64.2	0.9	166.7	2.5	0	48.3
Sep	7.0	-8.9	21.7	76.8	0.9	149.0	2.6	9.3	111.8
Oct	-4.2	-22.8	17.8	78.9	0.6	116.5	1.9	59.6	
Nov	-22.7	-38.9	-11.1	69.2	0.5	103.9	1.8	201.1	
Dec	-16.0	-40.0	-2.8	75.7	0.1	129.3	0.6	311.7	

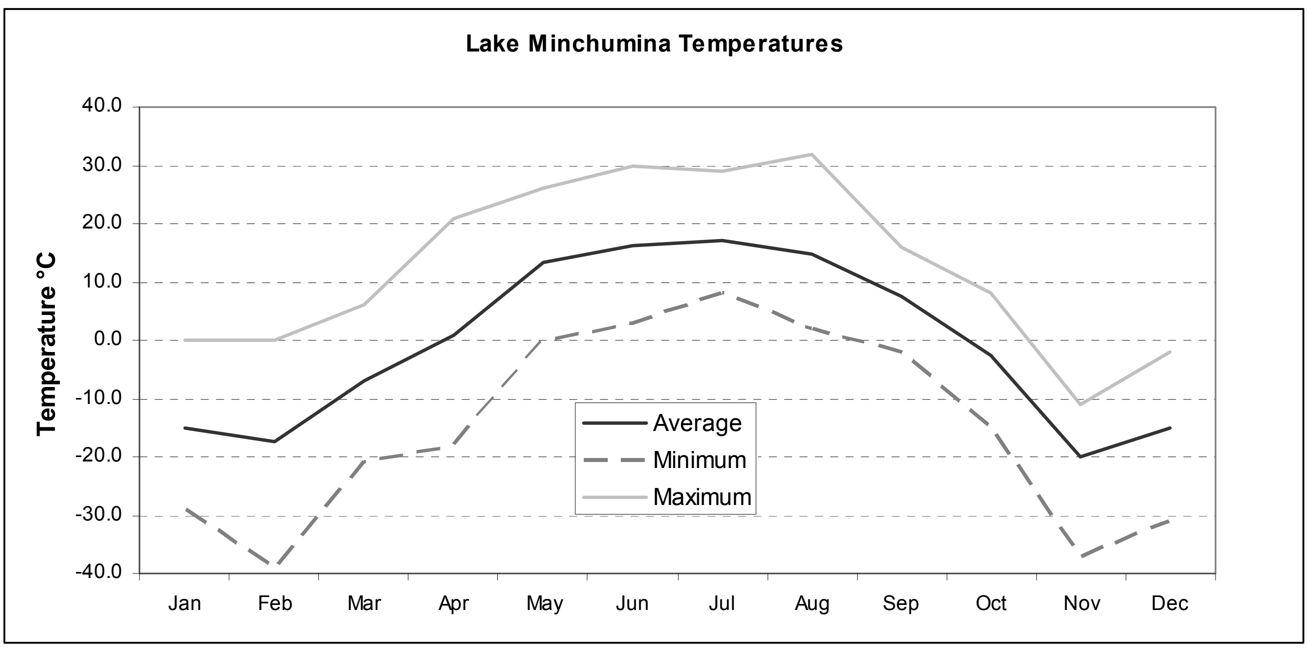


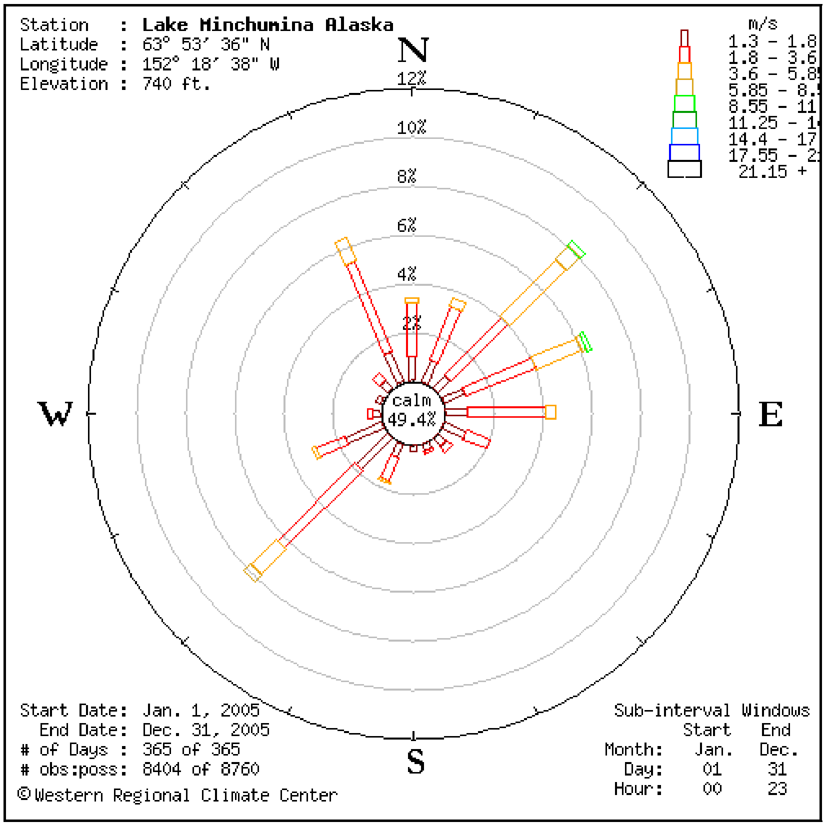

Station : McKinley River Alaska
Latitude : 63° 38′ 57" N
Longitude : 151° 38′ 23" W
Elevation : 840 ft.
N
E
S
W
12%
10%
8%
6%
4%
2%
calm
70.7%
m/s
1.3 - 1.8
1.8 - 3.6
21.15 +
Start Date: Jan. 1, 2005
End Date: Dec. 31, 2005
# of Days : 365 of 365
obs:poss: 5387 of 8760
©Western Regional Climate Center
Sub-interval Windows
Start End
Month: Jan. Dec.
Day: 01 31
Hour: 00 23

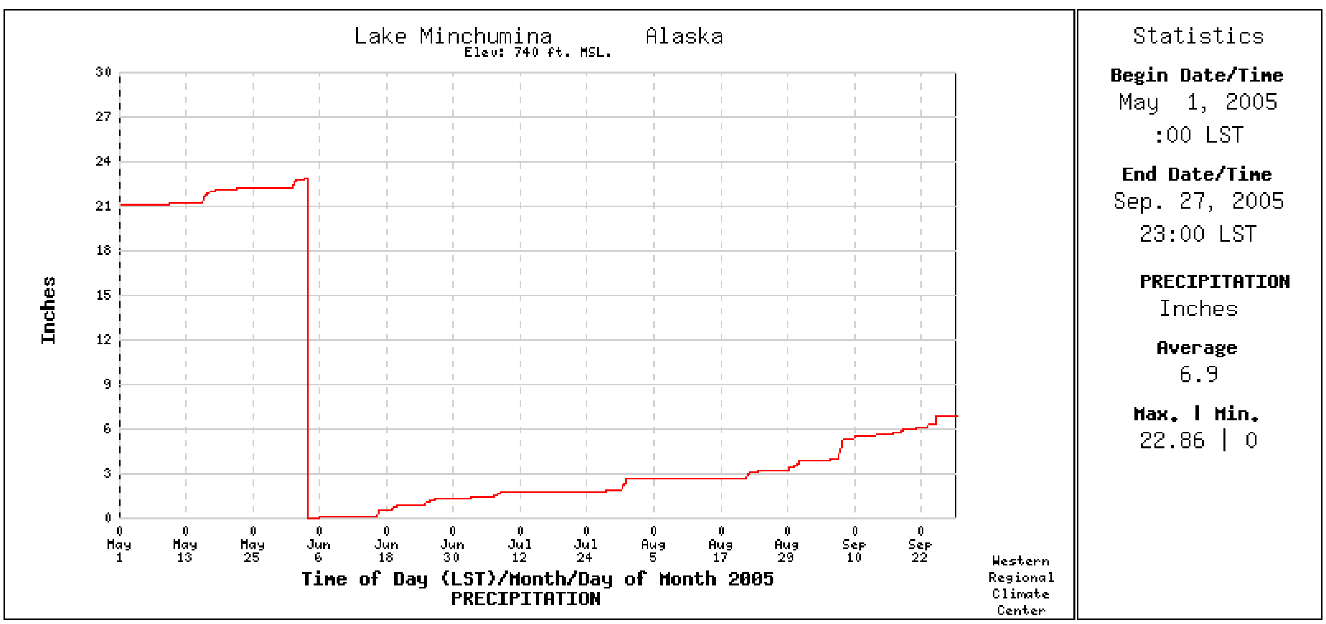

McKinley River Alaska
Elev: 840 ft. MSL.
Inches
Time of Day (LST)/Month/Day of Month 2005
PRECIPITATION
Western Regional Climate Center
Statistics
Begin Date/Time
June 1, 2005
:00 LST
End Date/Time
Sep. 28, 2005
23:00 LST
PRECIPITATION
Inches
Average
4.22
Max. | Min.
10.4 | 0.47

Lake Minchumina RAWS – Elevation 226m (740')

	Air Temp °C	Air Temp °C	Air Temp °C	Relative Humidity %	Wind Speed m/s	Wind Direction °	Wind Gust m/s	Surface Temp °C	Precip mm
	Average	Minimum	Maximum	Average	Average	Average	Max	Average	Total
Jan	-15.0	-29.0	0.0	73.3	1.9	149.1	4.4		
Feb	-17.4	-39.0	0.0	76.2	0.5	171.4	1.8		
Mar	-7.0	-21.0	6.0	66.2	2.0	141.4	4.4		
Apr	0.9	-18.0	21.0	53.0	1.8	180.3	3.9		
May	13.3	0.0	26.0	52.6	1.4	182.3	3.5		30.0
Jun	16.3	3.0	30.0	63.5	1.4	195.5	3.6	17.4	39.1
Jul	17.2	8.0	29.0	62.6	1.8	184.2	4.2	17.4	34.8
Aug	14.7	2.0	32.0	69.1	1.2	195.6	3.1	14.4	31.2
Sep	7.6	-2.0	16.0	84.4	1.5	189.2	3.7	7.4	76.2
Oct	-2.6	-15.0	8.0	83.8	1.7	167.7	3.8	-2.9	
Nov	-20.1	-37.0	-11.0	79.0	1.5	135.5	3.3	-20.6	
Dec	-15.1	-31.0	-2.0	88.5	0.6	171.3	1.8	-15.2	

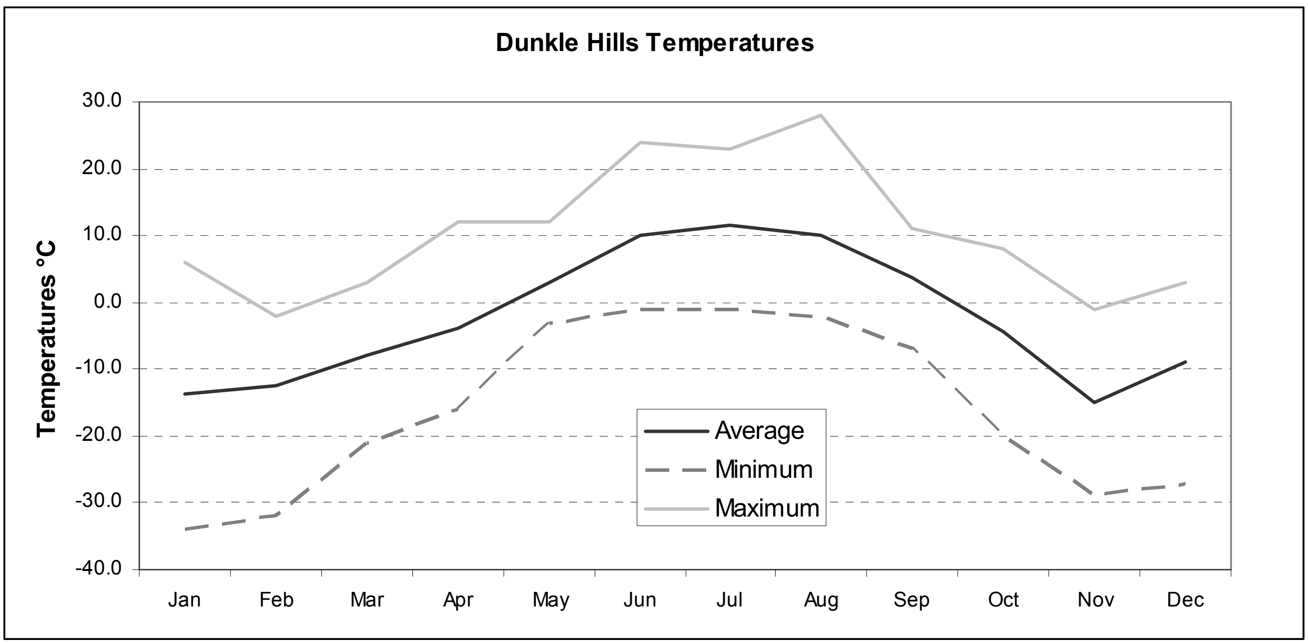


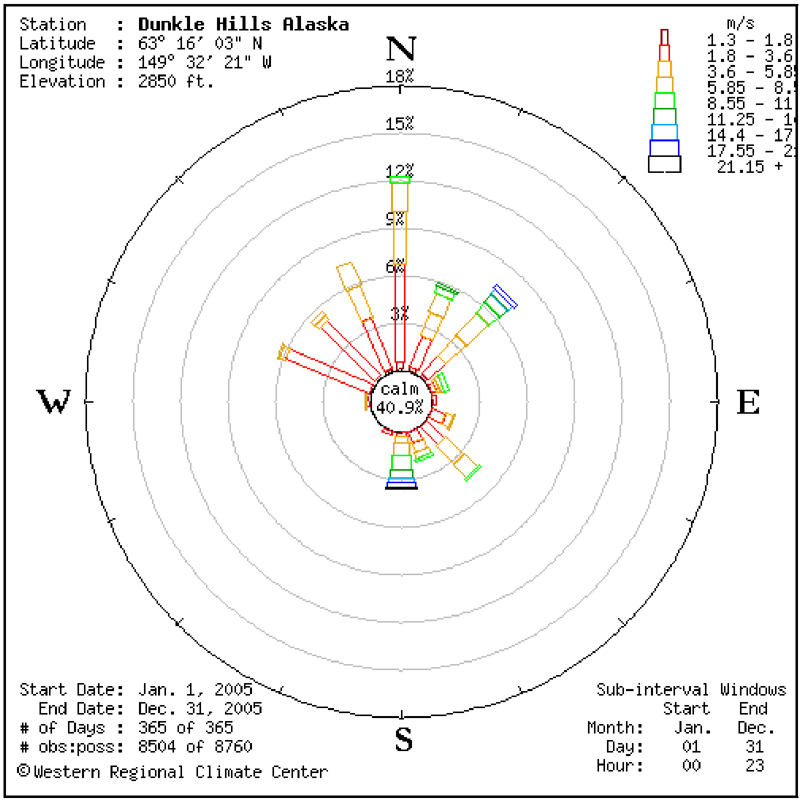

Station : Lake Minchumina Alaska
Latitude : 63° 53' 36" N
Longitude : 152° 18' 38" W
Elevation : 740 ft.
N
E
S
W
12%
10%
8%
6%
4%
2%
calm
49.4%
m/s
1.3 - 1.8
1.8 - 3.6
3.6 - 5.8
5.85 - 8.5
8.55 - 11
11.25 - 1
14.4 - 17
17.55 - 2
21.15 +
Start Date: Jan. 1, 2005
End Date: Dec. 31, 2005
# of Days : 365 of 365
obs:poss: 8404 of 8760
©Western Regional Climate Center
Sub-interval Windows
Start End
Month: Jan. Dec.
Day: 01 31
Hour: 00 23

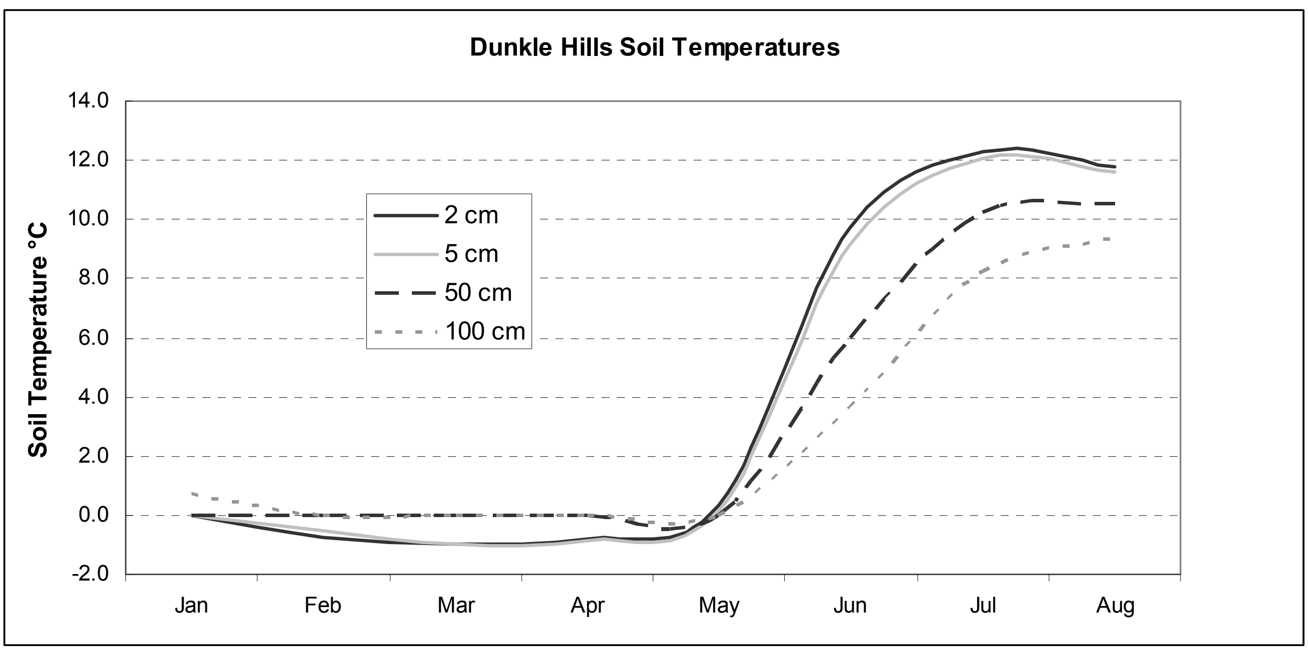

Lake Minchumina Alaska
Elev: 740 ft. MSL.
Inches
30
27
24
21
18
15
12
9
6
3
0
0 May 1
0 May 13
0 May 25
0 Jun 6
0 Jun 18
0 Jun 30
0 Jul 12
0 Jul 24
0 Aug 5
0 Aug 17
0 Aug 29
0 Sep 10
0 Sep 22
Time of Day (LST)/Month/Day of Month 2005
PRECIPITATION
Western Regional Climate Center
Statistics
Begin Date/Time
May 1, 2005
:00 LST
End Date/Time
Sep. 27, 2005
23:00 LST
PRECIPITATION
Inches
Average
6.9
Max. | Min.
22.86 | 0

Dunkle Hills – Elevation 808m (2651')

	Air Temp °C	Air Temp °C	Air Temp °C	Relative Humidity %	Wind Speed m/s	Wind Direction °	Wind Gust m/s	Surface Temp °C	Snow Depth mm
	Average	Minimum	Maximum	Average	Average	Average	Max	Average	Maximum
Jan	-13.6	-34.0	6.0	72.9	3.6	242.2	5.3	0.0	2000.0
Feb	-12.6	-32.0	-2.0	80.0	3.3	220.7	4.7	-0.8	2000.0
Mar	-7.9	-21.0	3.0	78.7	3.1	223.1	4.5	-1.0	2000.0
Apr	-3.9	-16.0	12.0	77.1	3.0	229.8	4.2	-0.8	2000.0
May	3.1	-3.0	12.0	81.6	2.5	253.2	3.7	0.3	1000.0
Jun	10.2	-1.0	24.0	70.5	1.1	212.7	1.8	9.7	0.0
Jul	11.5	-1.0	23.0	76.0	0.1	215.0	0.5	12.3	0.0
Aug	10.1	-2.0	28.0	79.6	0.6	204.1	1.1	11.3	0.0
Sep	3.8	-7.0	11.0	86.7	4.9	164.3	7.7	5.4	***
Oct	-4.3	-20.0	8.0	79.4	4.7	138.7	7.5	-0.2	***
Nov	-15.0	-29.0	-1.0	76.1	7.9	130.1	11.4	-2.3	701.0
Dec	-8.9	-27.0	3.0	81.6	2.7	139.8	4.2	-2.2	831.0

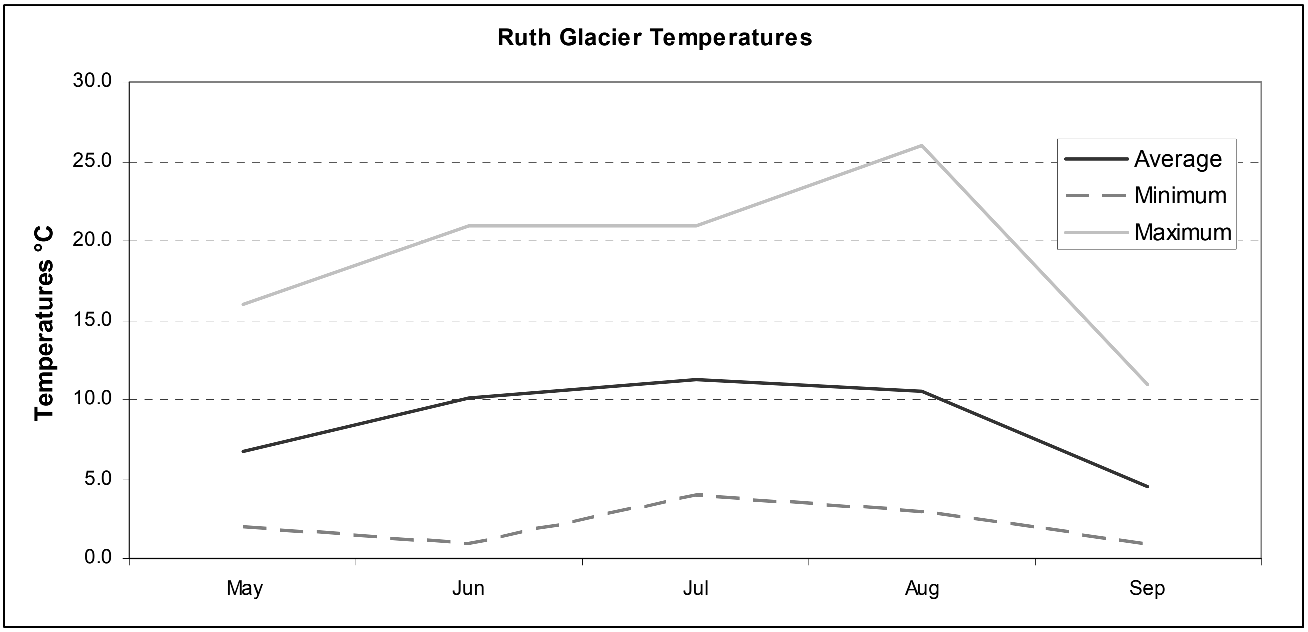


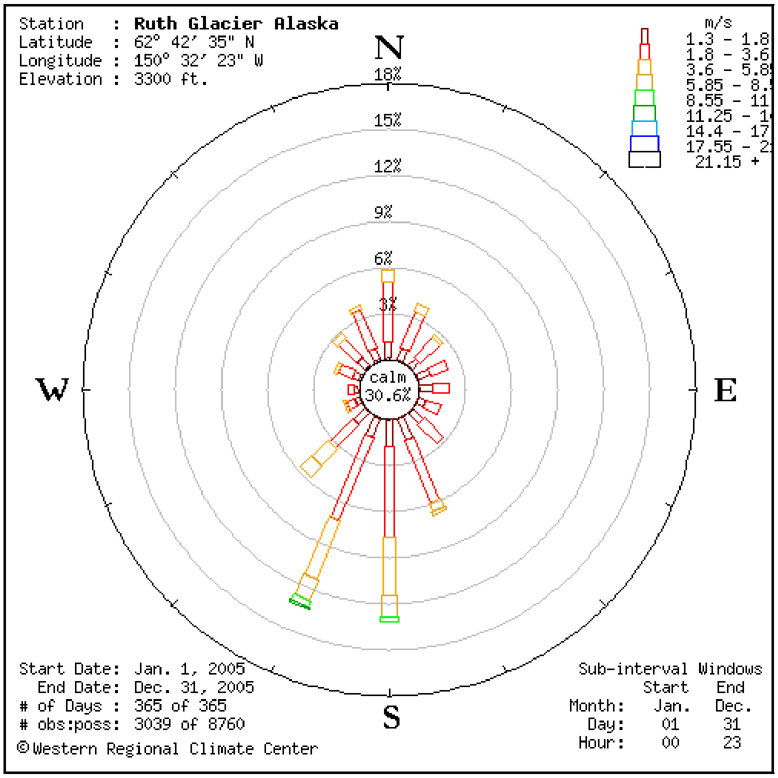

Station : Dunkle Hills Alaska
Latitude : 63° 16' 03" N
Longitude : 149° 32' 21" W
Elevation : 2850 ft.
N
E
S
W
calm 40.9%
18%
15%
12%
9%
6%
3%
m/s
1.3 - 1.8
1.8 - 3.6
3.6 - 5.85
5.85 - 8.
8.55 - 11
11.25 - 1
14.4 - 17
17.55 - 2
21.15 +
Start Date: Jan. 1, 2005
End Date: Dec. 31, 2005
# of Days : 365 of 365
obs:poss: 8504 of 8760
©Western Regional Climate Center
Sub-interval Windows
Start End
Month: Jan. Dec.
Day: 01 31
Hour: 00 23

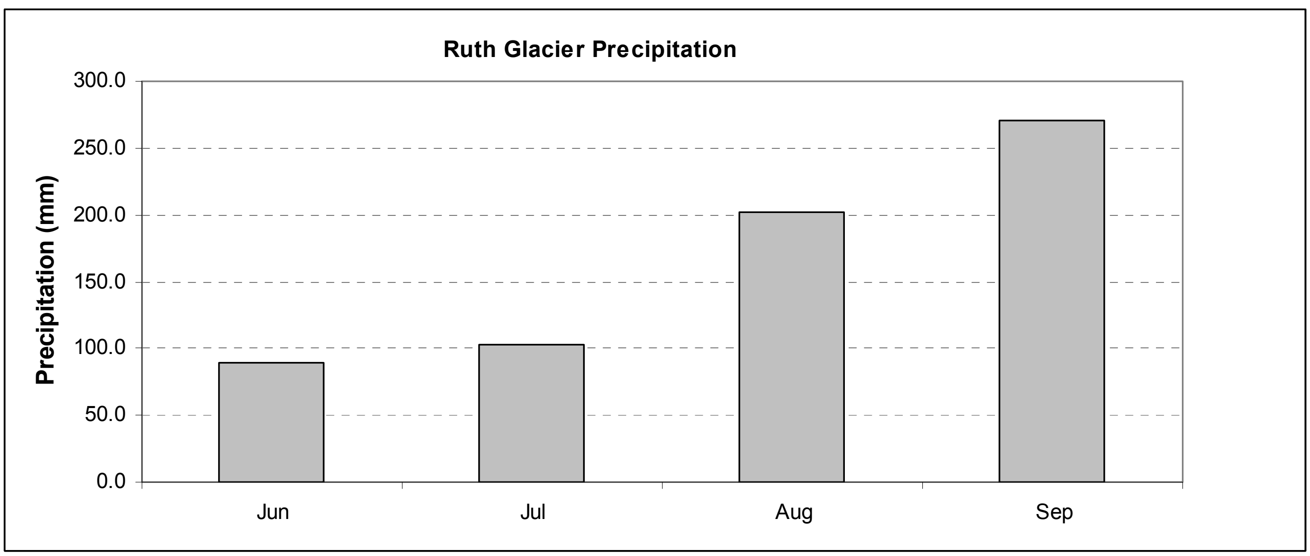

Dunkle Hills Soil Temperatures
Soil Temperature °C
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
-2.0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
2 cm
5 cm
50 cm
100 cm

Ruth Glacier RAWS – Elevation 1006m (3301')

	Air Temp °C	Air Temp °C	Air Temp °C	Relative Humidity %	Wind Speed m/s	Wind Direction °	Wind Gust m/s	Surface Temp °C	Precip mm
	Average	Minimum	Maximum	Average	Average	Average	Max	Average	Total
May	6.7	2.0	16.0	57.0	1.4	218.3	8.9	6.2	
Jun	10.1	1.0	21.0	60.5	2.1	186.0	9.7	10.5	89.2
Jul	11.2	4.0	21.0	71.1	2.4	165.2	10.7	11.8	103.4
Aug	10.6	3.0	26.0	74.8	1.8	177.1	8.2	10.7	202.4
Sep	4.6	1.0	11.0	83.6	2.3	198.0	4.6	4.5	270.5

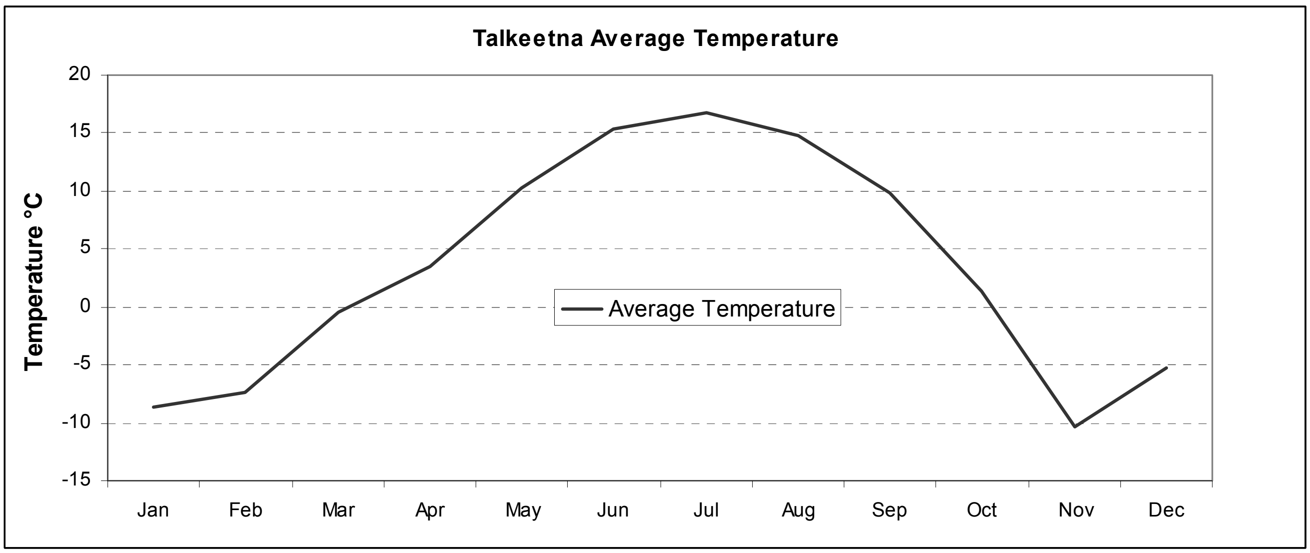


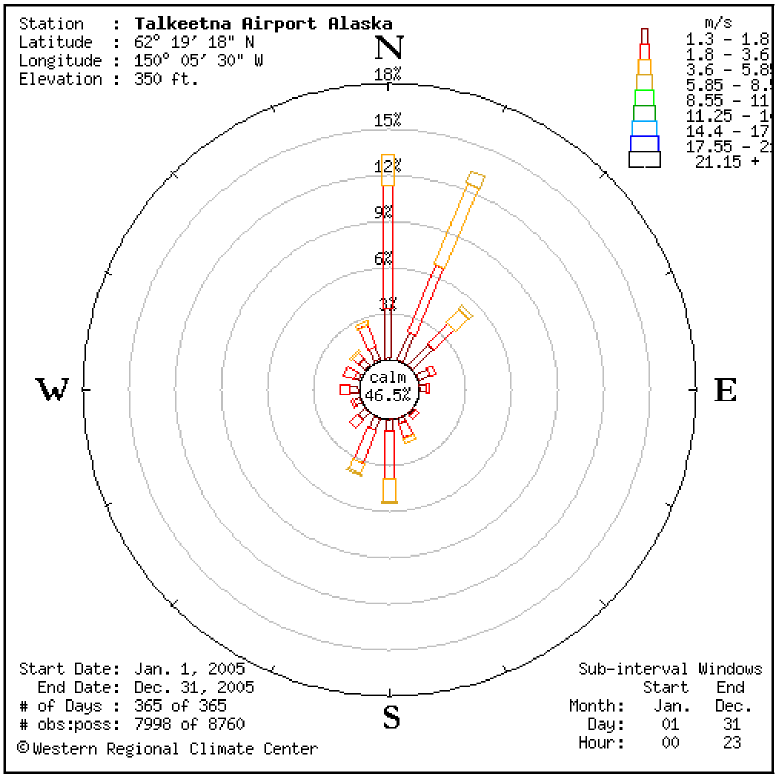

Station : Ruth Glacier Alaska
Latitude : 62° 42′ 35" N
Longitude : 150° 32′ 23" W
Elevation : 3300 ft.
N
E
S
W
18%
15%
12%
9%
6%
3%
calm
30.6%
m/s
1.3 - 1.8
1.8 - 3.6
3.6 - 5.8
5.85 - 8.
8.55 - 11
11.25 - 1
14.4 - 17
17.55 - 2
21.15 +
Start Date: Jan. 1, 2005
End Date: Dec. 31, 2005
# of Days : 365 of 365
obs:poss: 3039 of 8760
©Western Regional Climate Center
Sub-interval Windows
Start End
Month: Jan. Dec.
Day: 01 31
Hour: 00 23

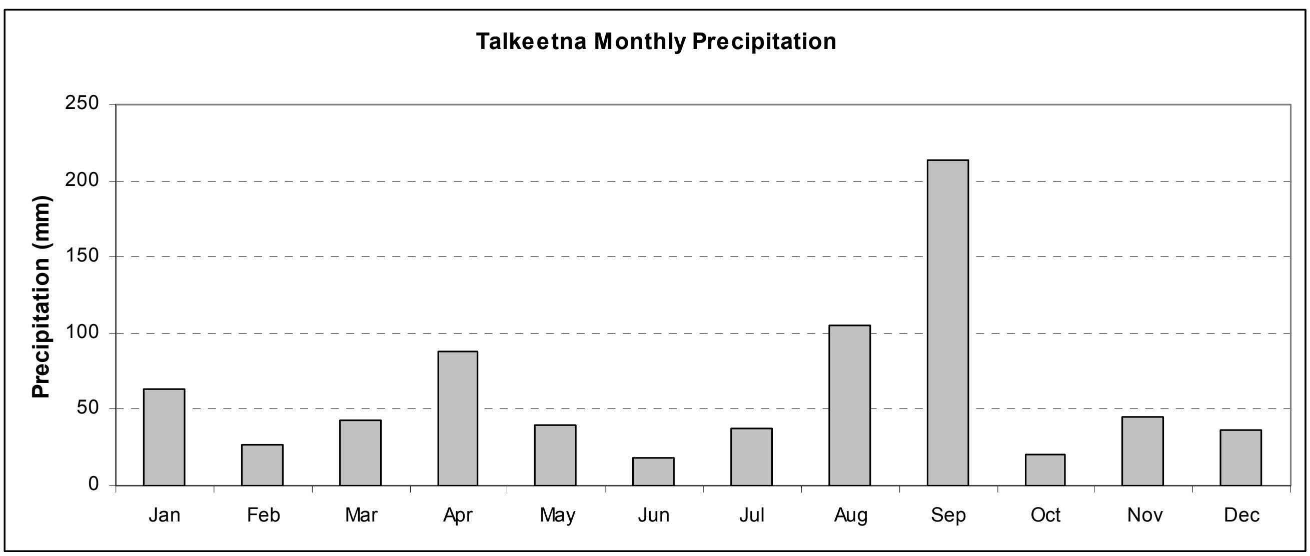

Ruth Glacier Precipitation
Precipitation (mm)
300.0
250.0
200.0
150.0
100.0
50.0
0.0
Jun
Jul
Aug
Sep

Talkeetna Airport – Elevation 107m (350')

	Air Temp °C	Relative Humidity %	Wind Speed m/s	Precipitation Totals
	Average	Average	Average	mm
Jan	-8.6	58.2	2.9	63.25
Feb	-7.4	65.2	2.2	26.92
Mar	-0.5	61.1	1.9	43.43
Apr	3.5	58.5	1.4	87.63
May	10.3	63.9	1.3	40.13
Jun	15.3	64.4	1.5	18.54
Jul	16.7	69.9	1.4	37.59
Aug	14.8	76.1	1.1	105.16
Sep	9.8	81.2	1.1	213.87
Oct	1.4	72.1	1.1	20.83
Nov	-10.4	67.2	1.7	44.7
Dec	-5.2	73.0	2.0	36.07



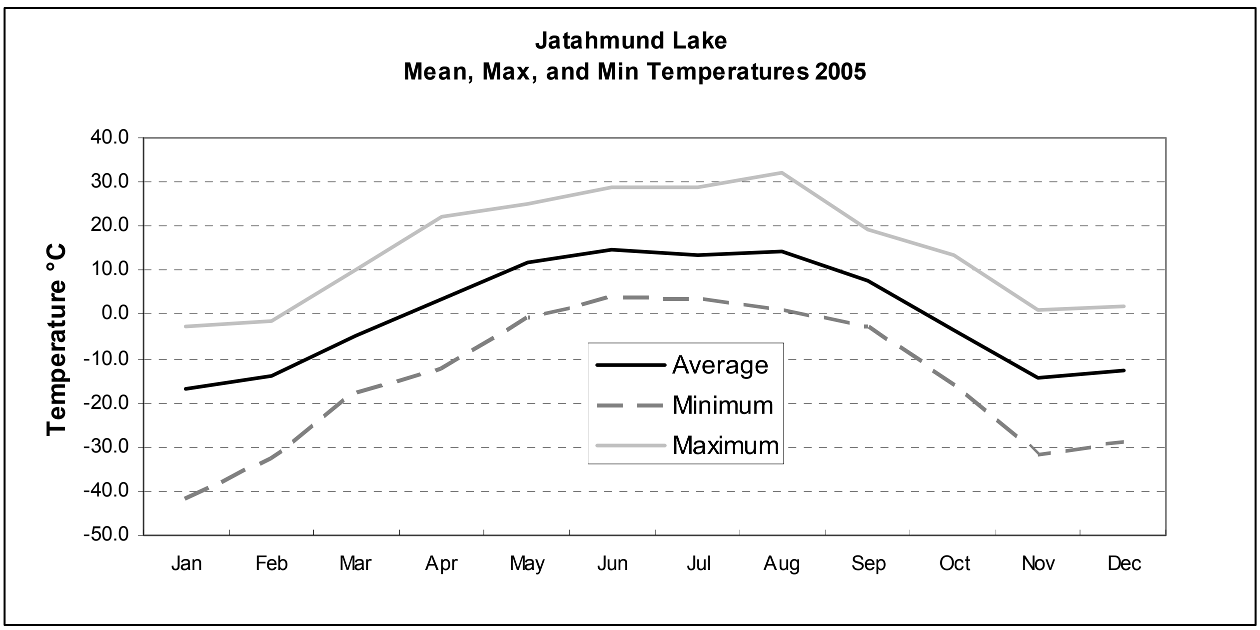

Station : Talkeetna Airport Alaska
Latitude : 62° 19' 18" N
Longitude : 150° 05' 30" W
Elevation : 350 ft.
N
S
E
W
18%
15%
12%
9%
6%
3%
calm
46.5%
m/s
1.3 - 1.8
1.8 - 3.6
21.15 +
Start Date: Jan. 1, 2005
End Date: Dec. 31, 2005
# of Days : 365 of 365
obs:poss: 7998 of 8760
© Western Regional Climate Center
Sub-interval Windows
Start End
Month: Jan. Dec.
Day: 01 31
Hour: 00 23

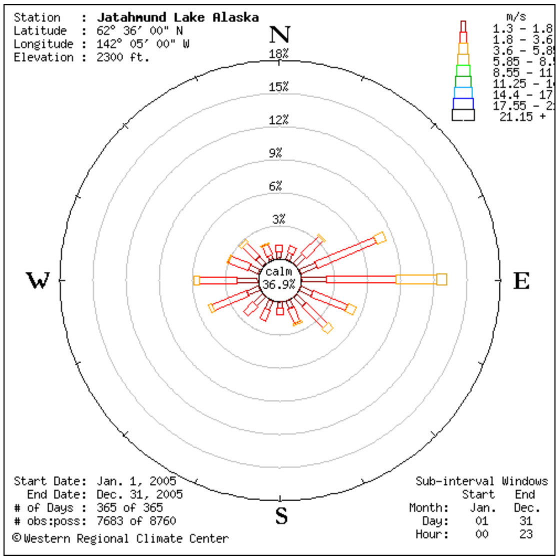

Talkeetna Monthly Precipitation
Precipitation (mm)
250
200
150
100
50
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

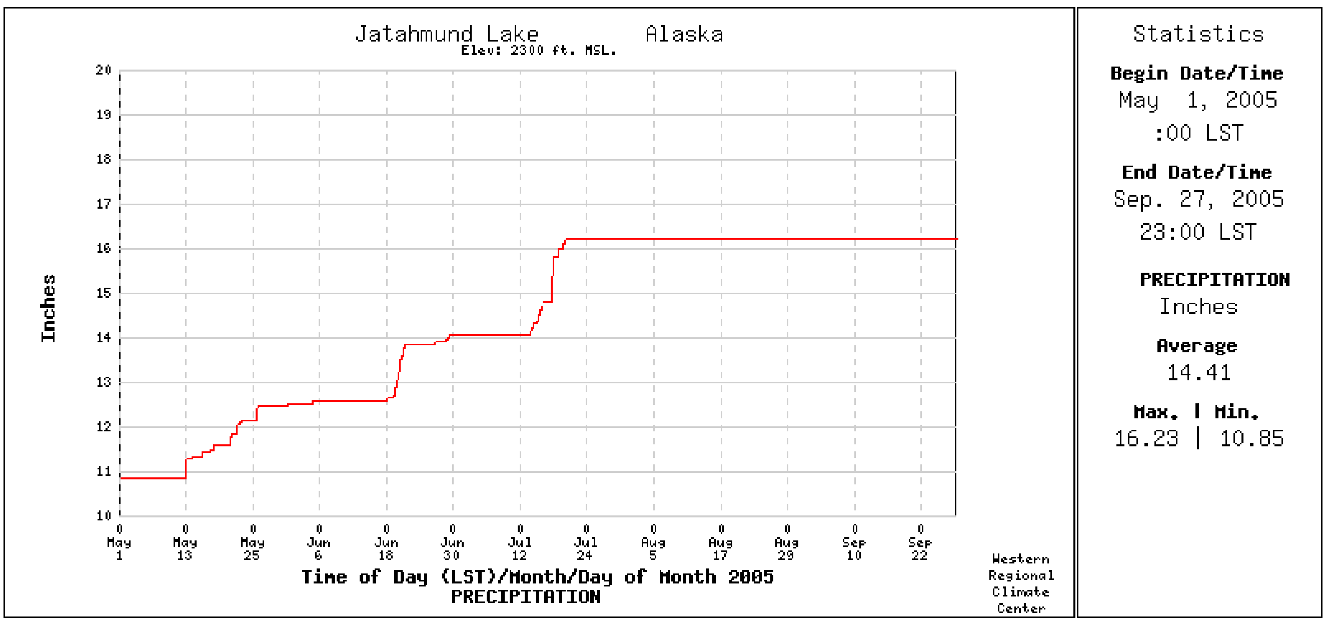
Appendix C– Wrangell - St. Elias National Park and Preserve Station Data

Jatahmund Lake RAWS - Elevation: 701 m (2300')

	Air Temp °C	Air Temp °C	Air Temp °C	Relative Humidity %	Wind Speed m/s	Wind Direction °	Wind Gust m/s	Surface Temp °C	Precip mm
	Average	Minimum	Maximum	Average	Average	Average	Max	Average	Total
Jan	-16.6	-41.7	-2.8	72.8	1.2	171.8	1.9	-11.3	
Feb	-13.8	-32.8	-1.7	74.6	1.0	163.6	2.4	-10.8	
Mar	-4.9	-17.8	10.0	59.5	1.3	193.5	3.5	-5.0	
Apr	3.4	-12.2	22.2	43.9	1.8	188.7	3.5	1.8	
May	11.8	-0.6	25.0	47.0	2.5	159.4	4.8	13.0	36.83
Jun	14.5	3.9	28.9	54.1	2.5	140.2	4.9	15.5	39.88
Jul	13.5	3.3	28.9	66.5	2.6	116.6	4.8	13.7	47.24
Aug	14.3	1.1	32.2	59.7	1.8	155.0	3.5	13.9	0.00
Sep	7.5	-2.8	19.4	69.2	1.5	167.6	3.1	6.8	0.00
Oct	-3.5	-16.1	13.3	78.8	1.1	162.0	2.3	-4.1	
Nov	-14.1	-31.7	1.1	71.8	1.1	182.3	2.3	-13.4	
Dec	-12.7	-28.9	1.7	77.4	0.3	139.1	0.9	-12.0	



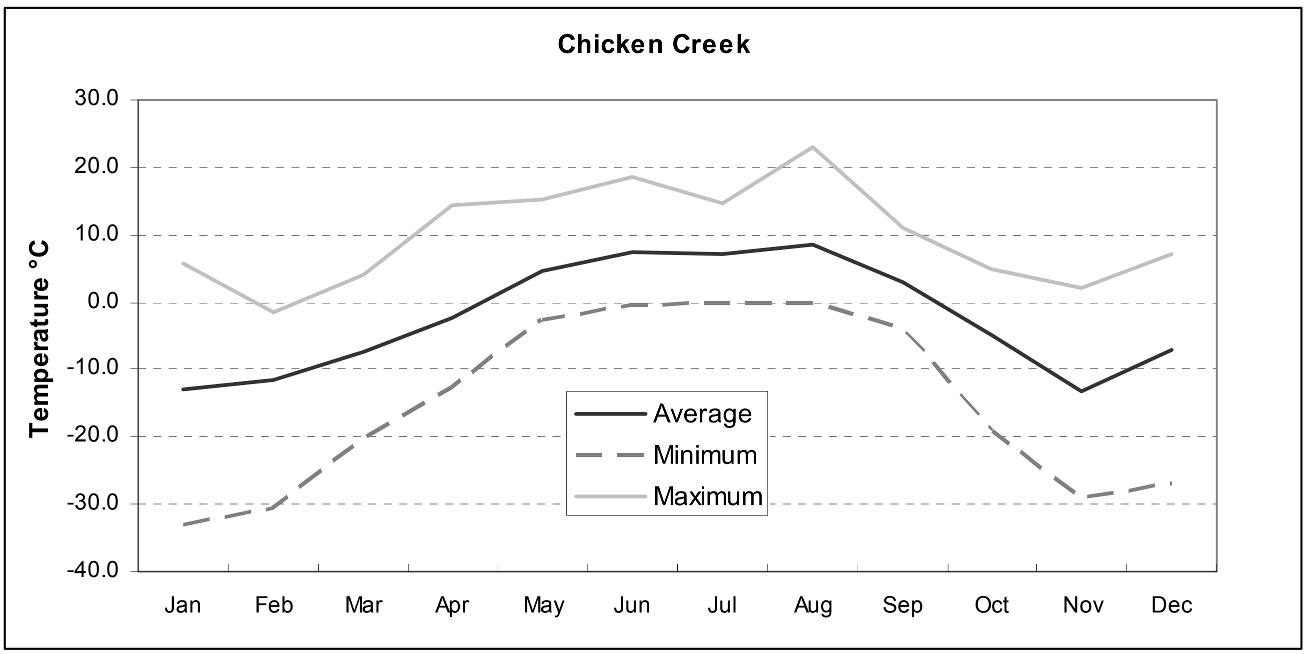


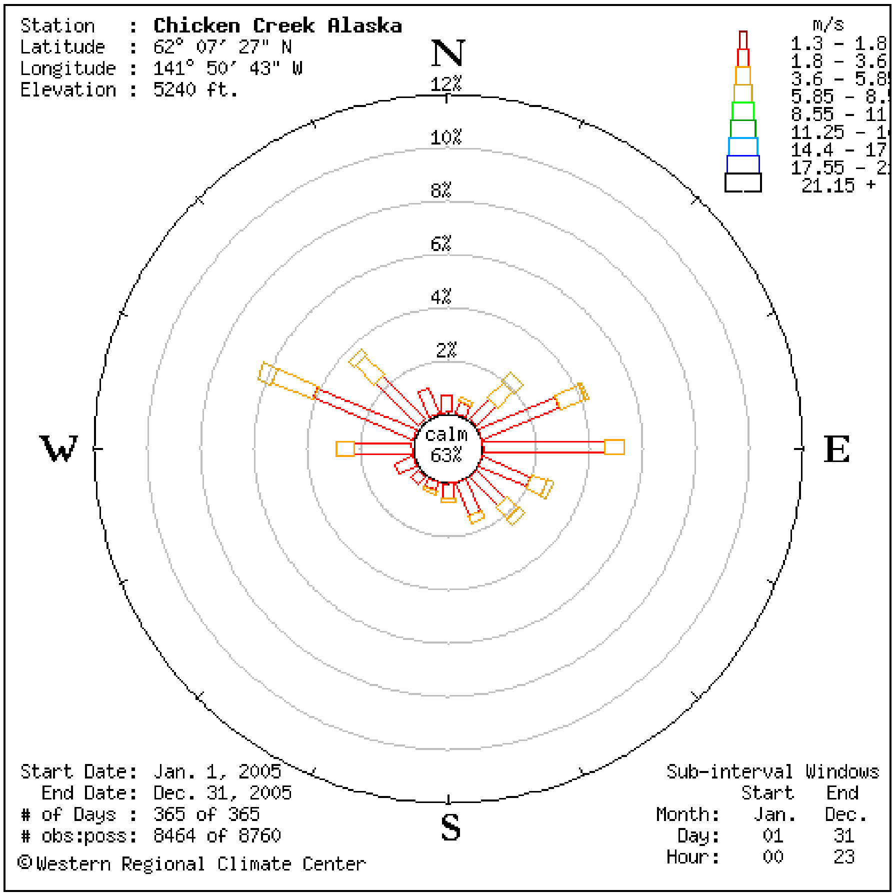


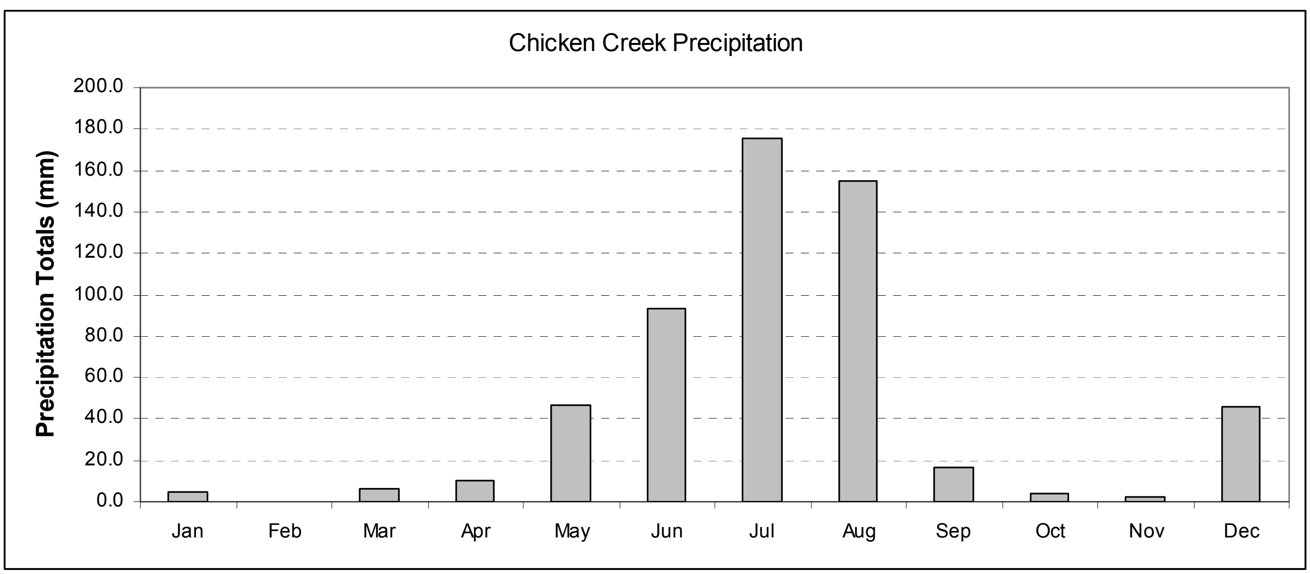
*Flat line after July 20 indicates missing data.

Chicken Creek – Elevation 1603m (5260')

	Air Temp °C	Air Temp °C	Air Temp °C	Relative Humidity %	Wind Speed m/s	Wind Direction °	Wind Gust m/s	Surface Temp °C	Soil Temp 50 cm	Soil Temp 100cm
	Average	Minimum	Maximum	Average	Average	Average	Max	Average	Average	Average
Jan	-12.9	-33.1	5.8	67.7	1.9	135.3	3.4	-9.0	-4.4	-1.8
Feb	-11.7	-30.4	-1.5	63.6	1.8	129.4	3.2	-9.2	-6.0	-3.5
Mar	-7.5	-20.2	4.0	59.6	2.1	128.6	3.7	-7.5	-5.6	-3.9
Apr	-2.5	-12.6	14.5	57.1	2.0	142.8	3.5	-4.5	-4.9	-3.9
May	4.7	-2.7	15.2	60.7	2.5	190.1	4.3	6.0	-0.7	-1.0
Jun	7.4	-0.3	18.6	68.4	2.6	193.5	4.5	10.1	1.3	-0.4
Jul	7.2	0.0	14.7	74.4	2.2	201.0	3.8	9.7	2.2	-0.1
Aug	8.6	0.0	23.0	68.1	1.6	177.7	3.1	9.6	3.8	0.0
Sep	3.1	-4.0	11.0	68.2	1.6	165.4	3.2	2.1	1.7	0.0
Oct	-4.9	-19.0	5.0	71.8	0.9	156.3	2.1	-3.9	0.0	0.0
Nov	-13.1	-29.0	2.0	71.0	1.1	149.0	2.4	-7.5	-2.7	0.0
Dec	-7.0	-27.0	7.0	64.4	1.2	111.9	2.5	-6.6	-3.5	-1.4

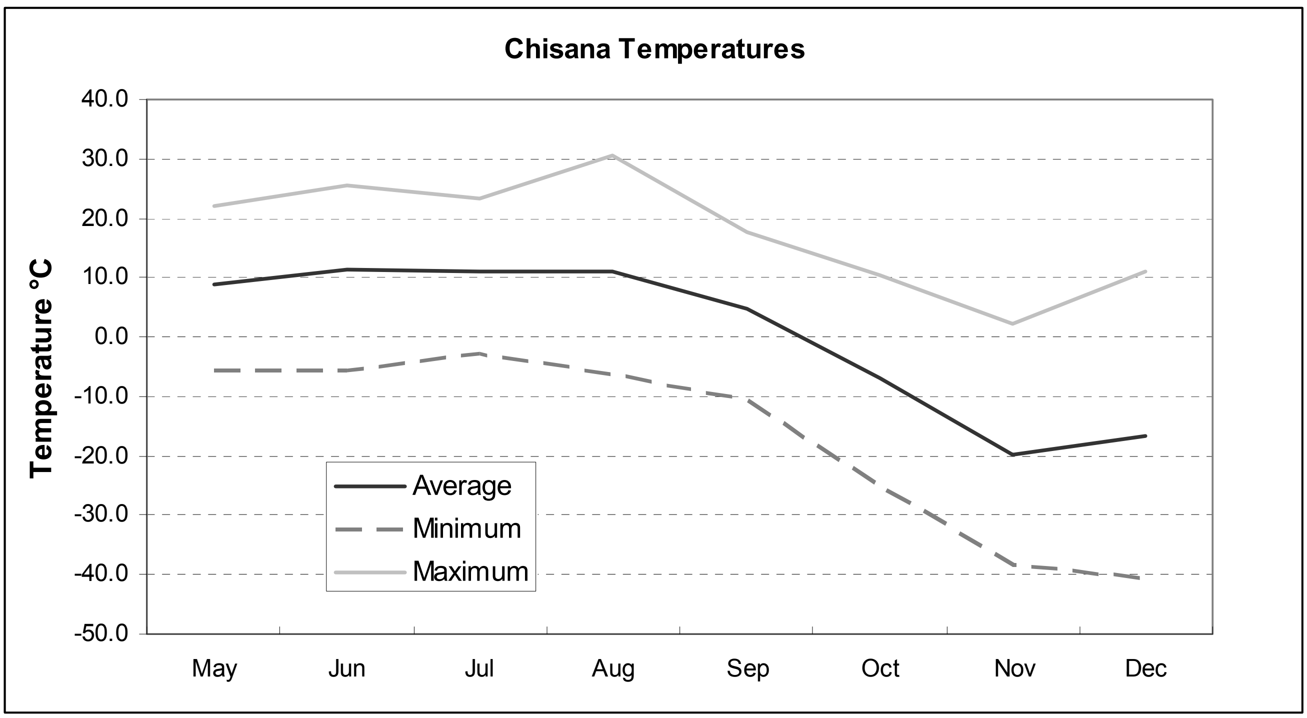


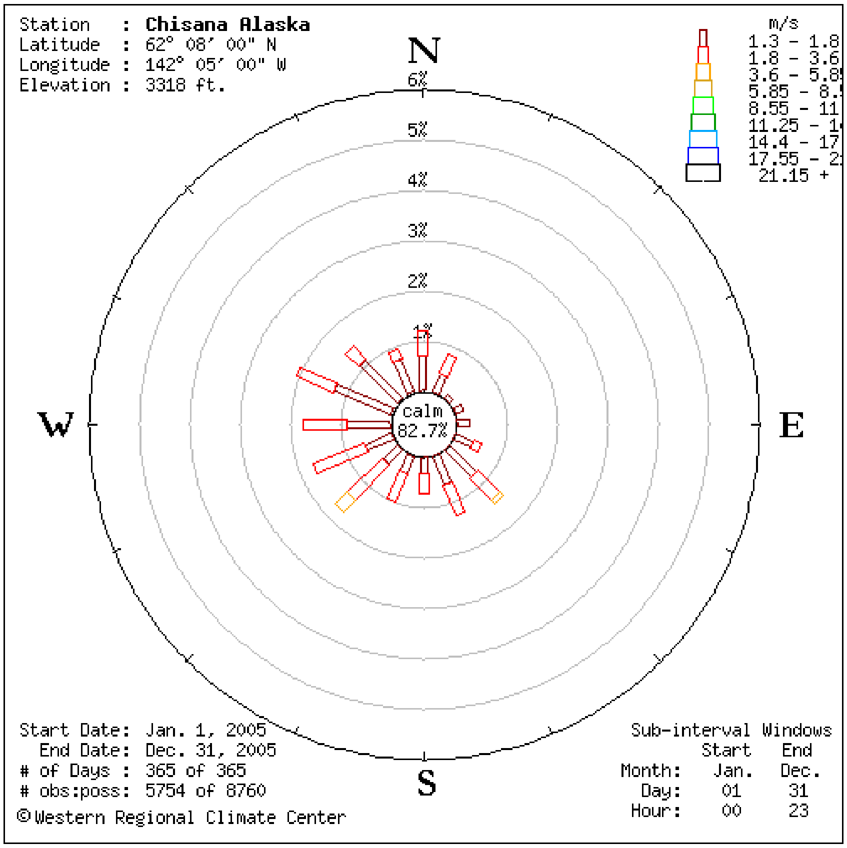

Station : Chicken Creek Alaska
Latitude : 62° 07′ 27" N
Longitude : 141° 50′ 43" W
Elevation : 5240 ft.
N
E
S
W
12%
10%
8%
6%
4%
2%
calm
63%
m/s
1.3 - 1.8
1.8 - 3.6
3.6 - 5.8
5.85 - 8.
8.55 - 11
11.25 - 1
14.4 - 17
17.55 - 2
21.15 +
Start Date: Jan. 1, 2005
End Date: Dec. 31, 2005
# of Days : 365 of 365
obs:poss: 8464 of 8760
©Western Regional Climate Center
Sub-interval Windows
Start End
Month: Jan. Dec.
Day: 01 31
Hour: 00 23

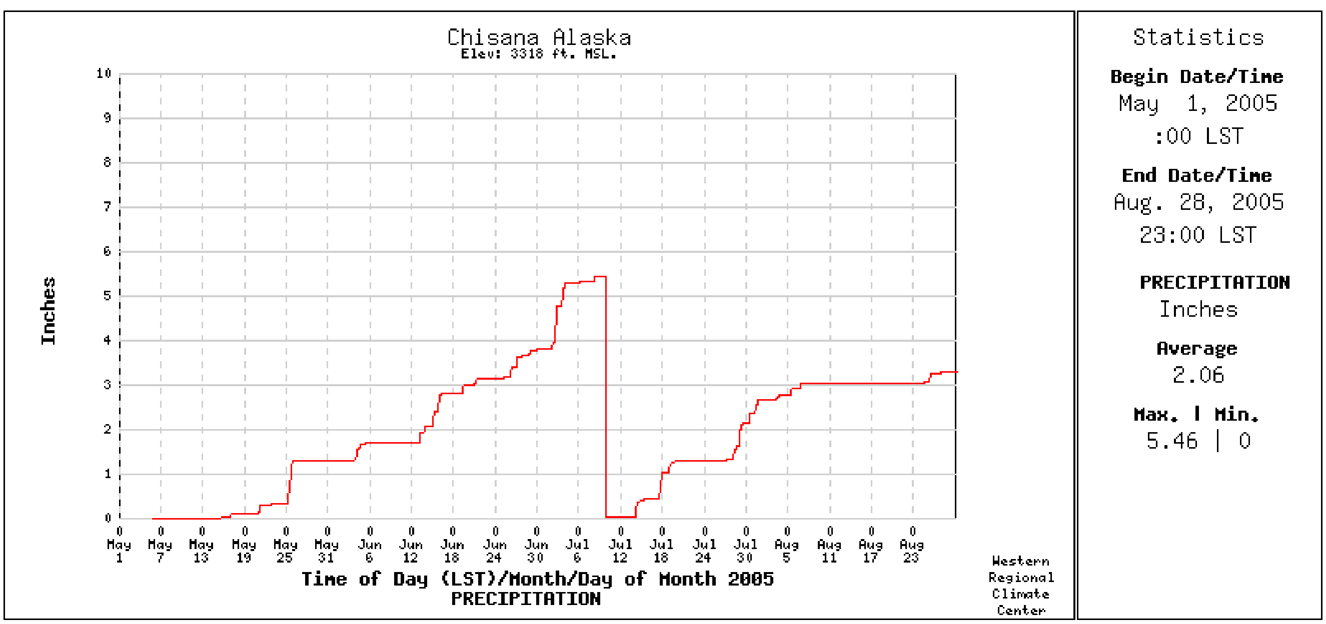

Chicken Creek Precipitation
Precipitation Totals (mm)
200.0
180.0
160.0
140.0
120.0
100.0
80.0
60.0
40.0
20.0
0.0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

Chisana RAWS – Elevation 1012m (3320')

	Air Temp °C	Air Temp °C	Air Temp °C	Relative Humidity %	Wind Speed m/s	Wind Direction °	Wind Gust m/s	Surface Temp °C	Precip mm
	Average	Minimum	Maximum	Average	Average	Average	Max	Average	Total
Jan	***	***	***	***	***	***	***	***	
Feb	***	***	***	***	***	***	***	***	
Mar	***	***	***	***	***	***	***	***	
Apr	***	***	***	***	***	***	***	***	
May	9.0	-5.6	22.2	51.7	0.9	182.5	2.8	9.8	29.7
Jun	11.2	-5.6	25.6	59.3	0.8	181.1	2.6	11.9	64.3
Jul	10.9	-2.8	23.3	70.4	0.7	187.3	2.3	11.2	108.0
Aug	11.2	-6.1	30.6	67.8	0.6	179.4	2.1	11.2	30.2
Sep	4.7	-10.6	17.8	69.9	0.7	166.8	2.3	4.4	9.1
Oct	-6.9	-25.0	10.6	76.6	0.3	155.8	1.3	-7.6	
Nov	-19.9	-38.3	2.2	70.7	0.3	161.7	1.3	-19.7	
Dec	-16.7	-40.6	11.1	77.9	0.2	136.3	1.0	-17.4	



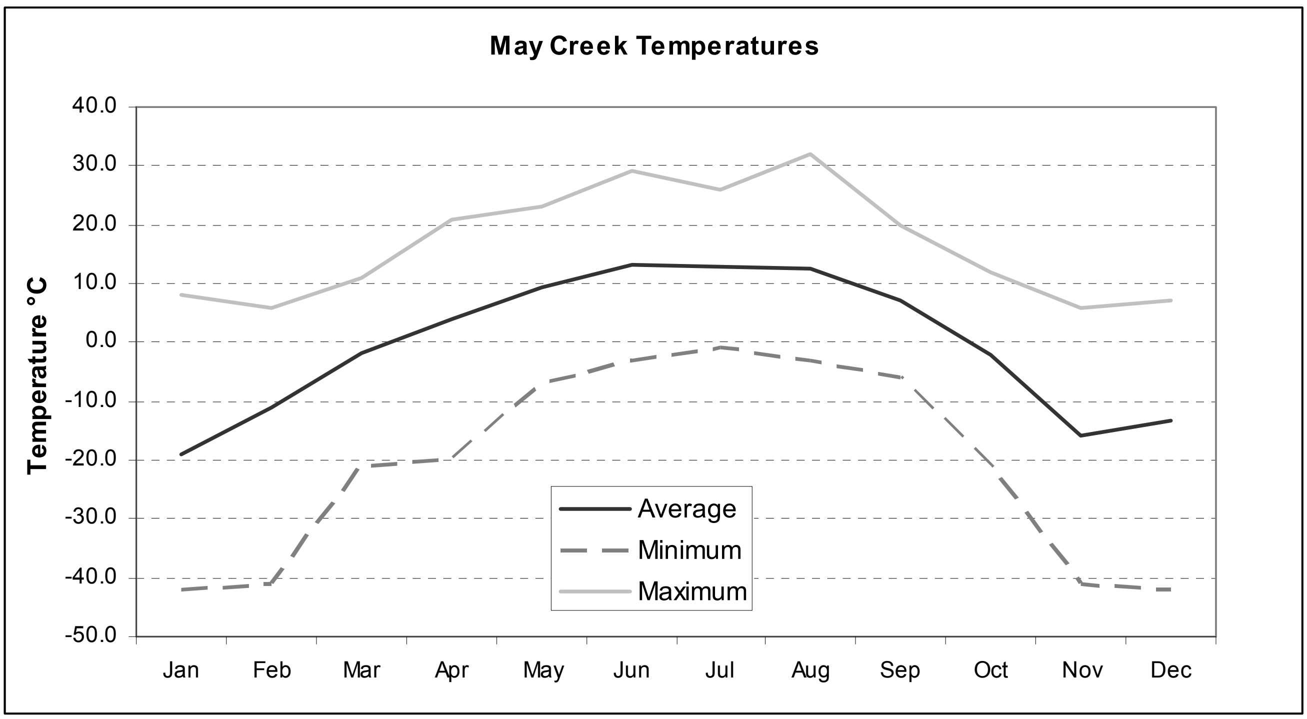


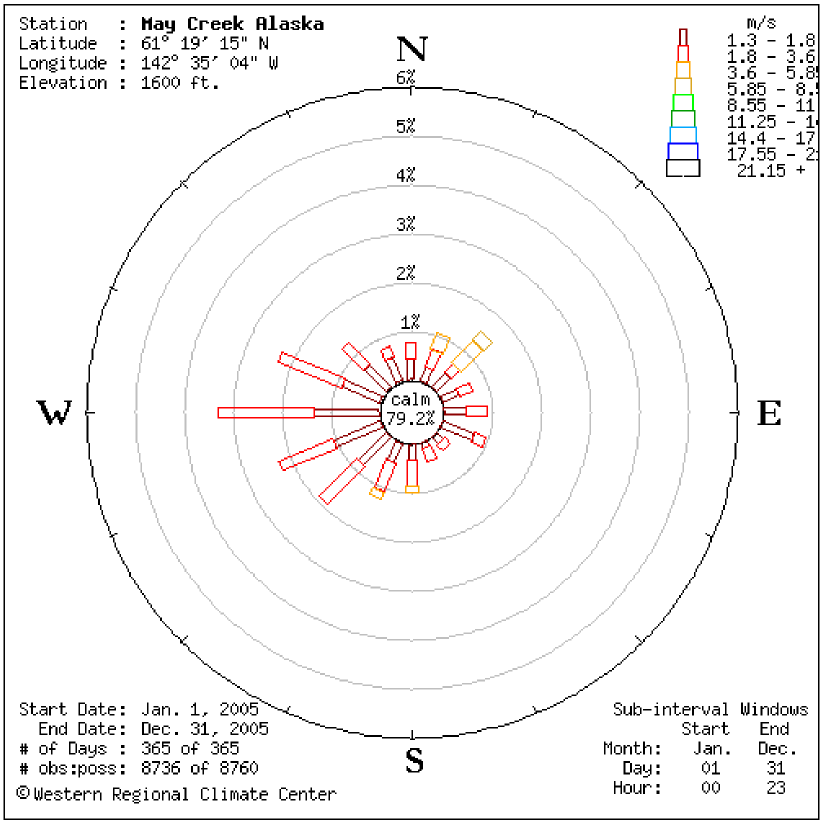


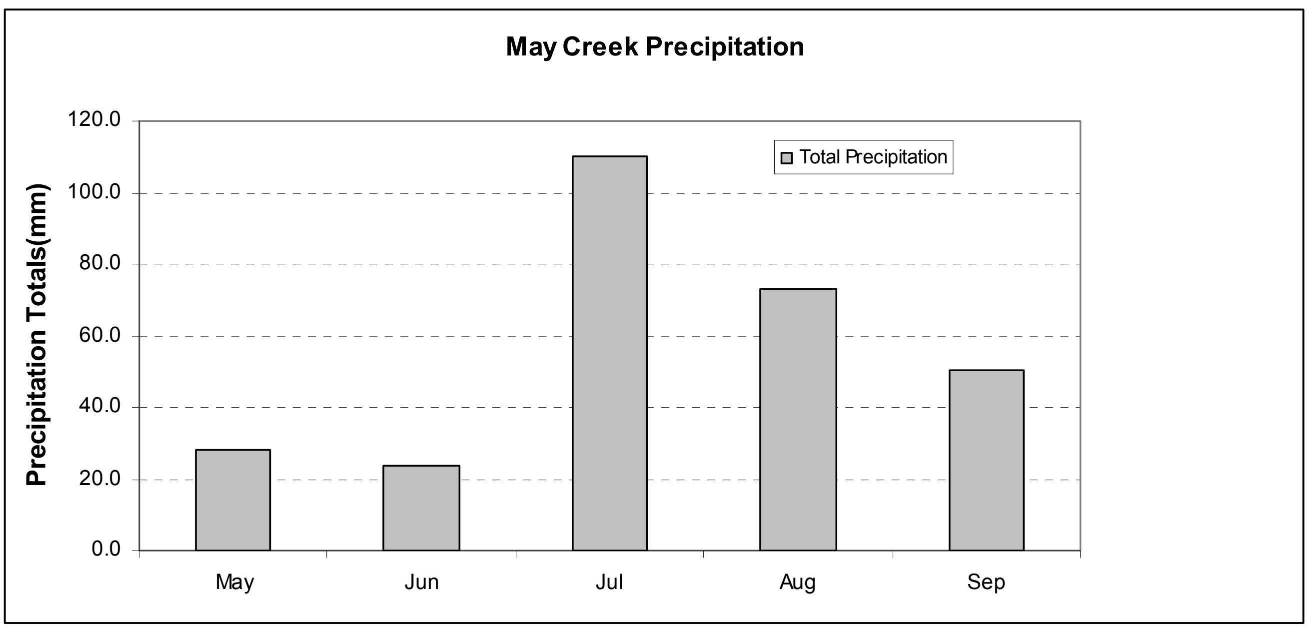
Note: The accumulating tipping bucket value was rest to 0 on July 10, 2005.

May Creek RAWS – Elevation 503m (1650')

	Air Temp °C	Air Temp °C	Air Temp °C	Relative Humidity %	Wind Speed m/s	Wind Direction °	Wind Gust m/s	Surface Temp °C	Precip mm
	Average	Minimum	Maximum	Average	Average	Average	Max	Average	Total
Jan	-19.1	-42.0	8.0	74.3	0.2	163.9	9.0	-19.7	
Feb	-11.0	-41.0	6.0	74.3	0.3	163.2	10.0	-12.6	
Mar	-1.8	-21.0	11.0	56.6	1.1	167.2	16.0	-3.5	
Apr	4.0	-20.0	21.0	47.3	1.2	167.6	12.0	3.5	
May	9.4	-7.0	23.0	54.8	0.8	194.7	8.0	10.1	28.2
Jun	13.3	-3.0	29.0	55.4	0.9	197.0	13.0	14.4	23.6
Jul	13.0	-1.0	26.0	69.1	0.5	173.7	7.0	13.7	110.0
Aug	12.7	-3.0	32.0	68.6	0.4	167.4	10.0	13.4	72.9
Sep	7.2	-6.0	20.0	76.0	0.4	172.3	11.0	7.7	50.6
Oct	-2.2	-21.0	12.0	75.3	0.3	169.0	9.0	-2.3	
Nov	-15.9	-41.0	6.0	75.2	0.3	165.1	11.0	-14.1	
Dec	-13.2	-42.0	7.0	79.1	0.2	138.1	11.0	-9.2	



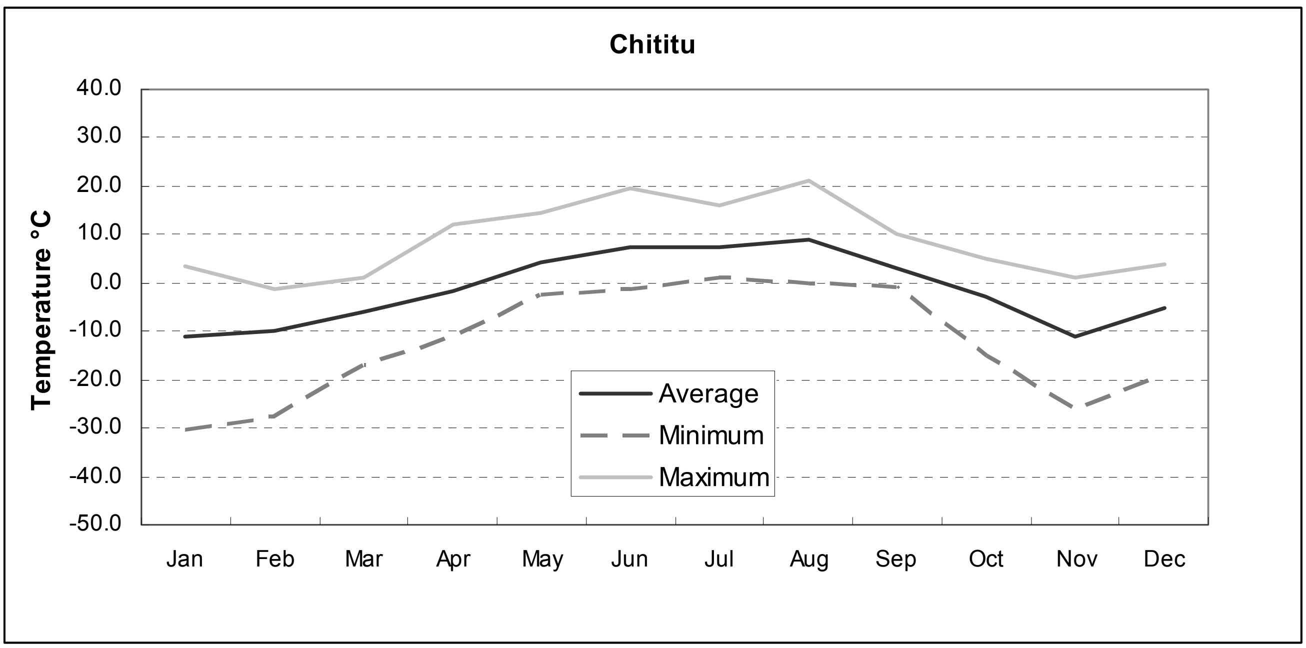

Station : May Creek Alaska
Latitude : 61° 19′ 15" N
Longitude : 142° 35′ 04" W
Elevation : 1600 ft.
N
E
S
W
6%
5%
4%
3%
2%
1%
calm
79.2%
m/s
1.3 - 1.8
1.8 - 3.6
3.6 - 5.8
5.85 - 8.
8.55 - 11
11.25 - 1
14.4 - 17
17.55 - 2
21.15 +
Start Date: Jan. 1, 2005
End Date: Dec. 31, 2005
# of Days : 365 of 365
obs:poss: 8736 of 8760
© Western Regional Climate Center
Sub-interval Windows
Start End
Month: Jan. Dec.
Day: 01 31
Hour: 00 23

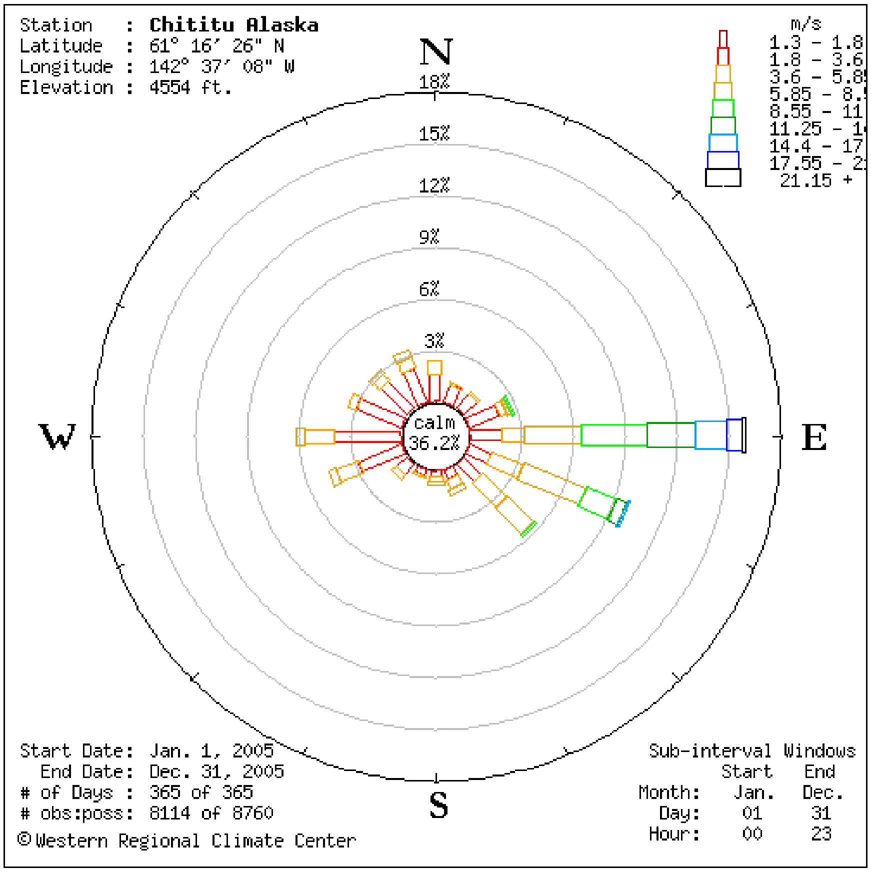

May Creek Precipitation
Total Precipitation
Precipitation Totals(mm)
120.0
100.0
80.0
60.0
40.0
20.0
0.0
May
Jun
Jul
Aug
Sep

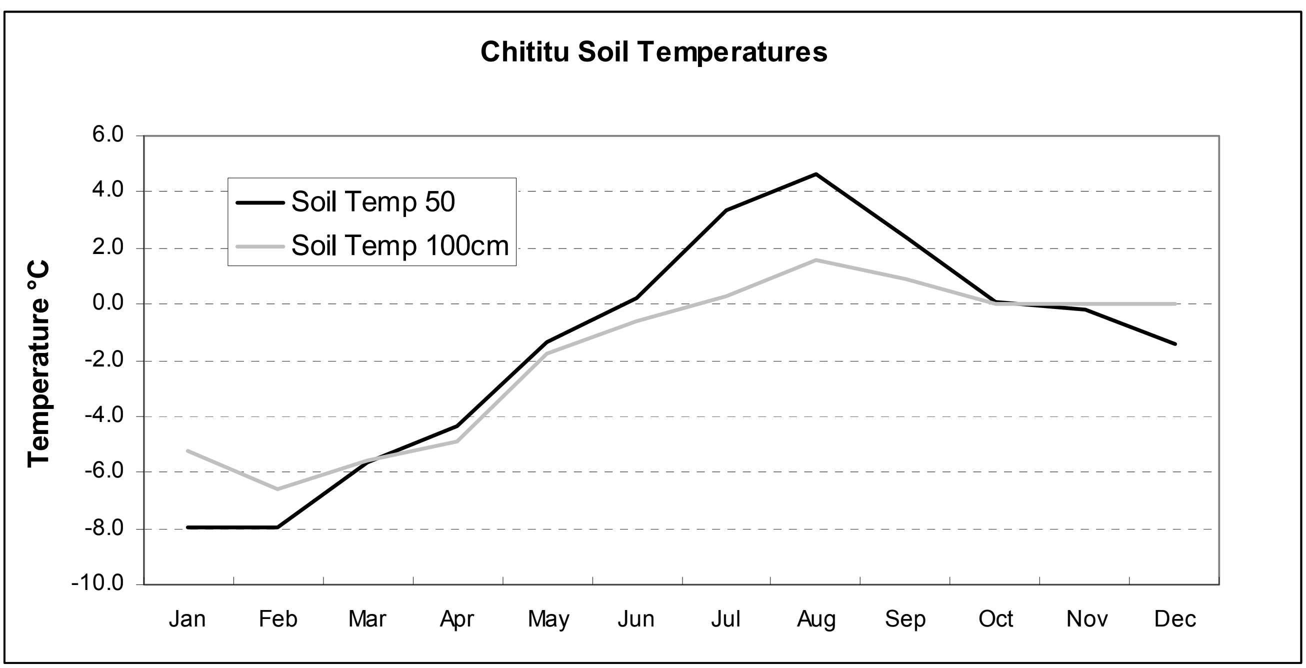
Chititu – Elevation 1385m (4544')

	Air Temp °C	Air Temp °C	Air Temp °C	Relative Humidity %	Wind Speed m/s	Wind Direction °	Wind Gust m/s	Surface Temp °C	Soil Temp 50 cm	Soil Temp 100cm
	Average	Minimum	Maximum	Average	Average	Average	Max	Average	Average	Average
Jan	-11.0	-30.5	3.6	71.2	4.3	169.9	6.1	-11.2	-8.0	-5.3
Feb	-9.9	-27.7	-1.4	73.4	6.1	130.2	8.2	-9.0	-7.9	-6.6
Mar	-6.0	-17.0	1.1	67.8	6.3	153.1	8.6	-6.4	-5.6	-5.6
Apr	-1.5	-11.2	12.0	58.4	4.3	205.3	6.2	-1.6	-4.4	-4.9
May	4.3	-2.3	14.6	65.6	2.8	180.4	4.5	5.8	-1.3	-1.8
Jun	7.5	-1.1	19.6	70.9	3.3	232.9	5.1	10.7	0.2	-0.6
Jul	7.3	1.0	16.1	82.4	2.4	201.2	7.4	9.7	3.3	0.3
Aug	9.0	0.0	21.0	73.5	2.4	178.1	3.9	10.2	4.6	1.6
Sep	3.0	-1.0	10.0	82.3	4.3	154.6	6.3	3.0	2.4	0.9
Oct	-2.9	-15.0	5.0	72.5	3.5	137.5	5.5	-1.6	0.1	0.0
Nov	-11.0	-26.0	1.0	77.3	4.0	168.0	5.9	-3.1	-0.2	0.0
Dec	-5.1	-19.0	4.0	66.7	6.0	124.8	8.5	-3.3	-1.4	0.0

Note: Working out the issues with Chititu snow depth and precipitation

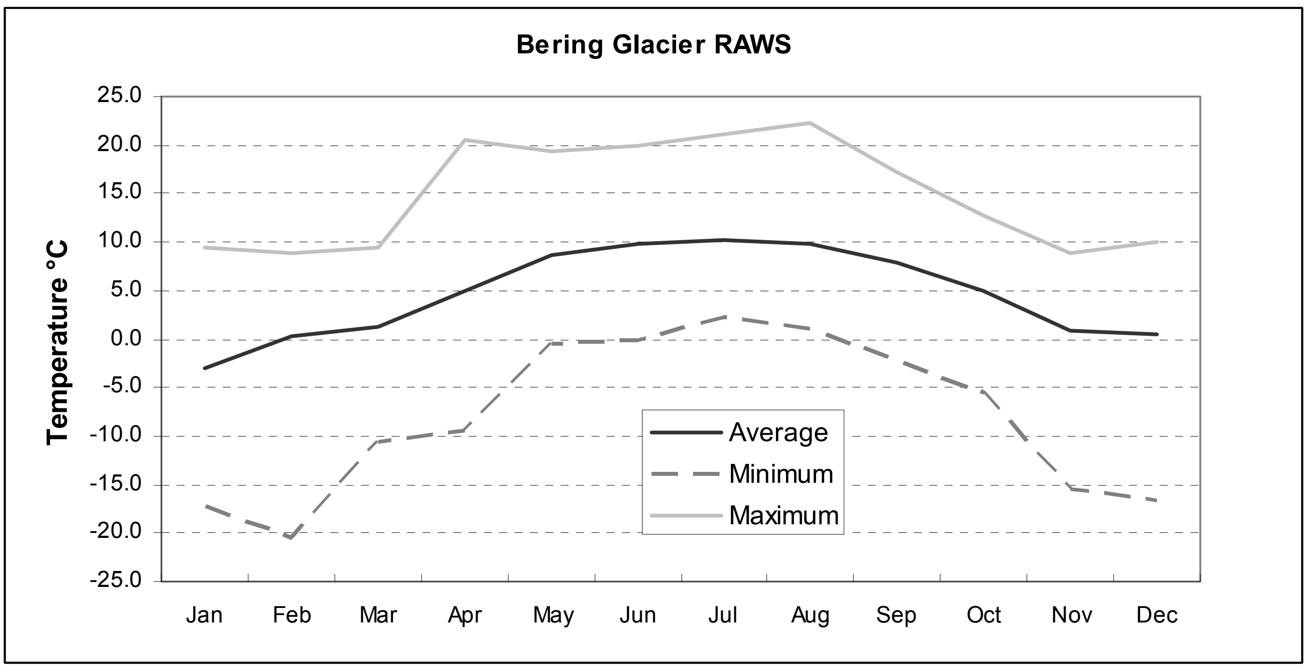


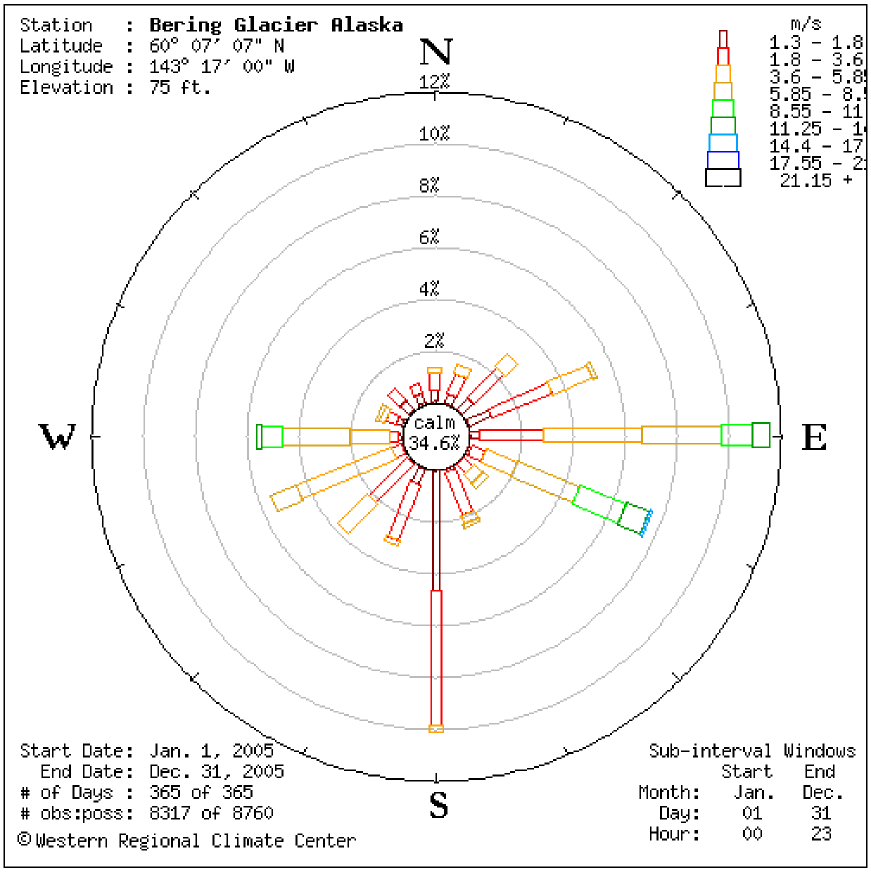

Station : Chititu Alaska
Latitude : 61° 16' 26" N
Longitude : 142° 37' 08" W
Elevation : 4554 ft.
N
E
S
W
18%
15%
12%
9%
6%
3%
calm
36.2%
m/s
1.3 - 1.8
1.8 - 3.6
21.15 +
Start Date: Jan. 1, 2005
End Date: Dec. 31, 2005
# of Days : 365 of 365
obs:poss: 8114 of 8760
© Western Regional Climate Center
Sub-interval Windows
Start End
Month: Jan. Dec.
Day: 01 31
Hour: 00 23

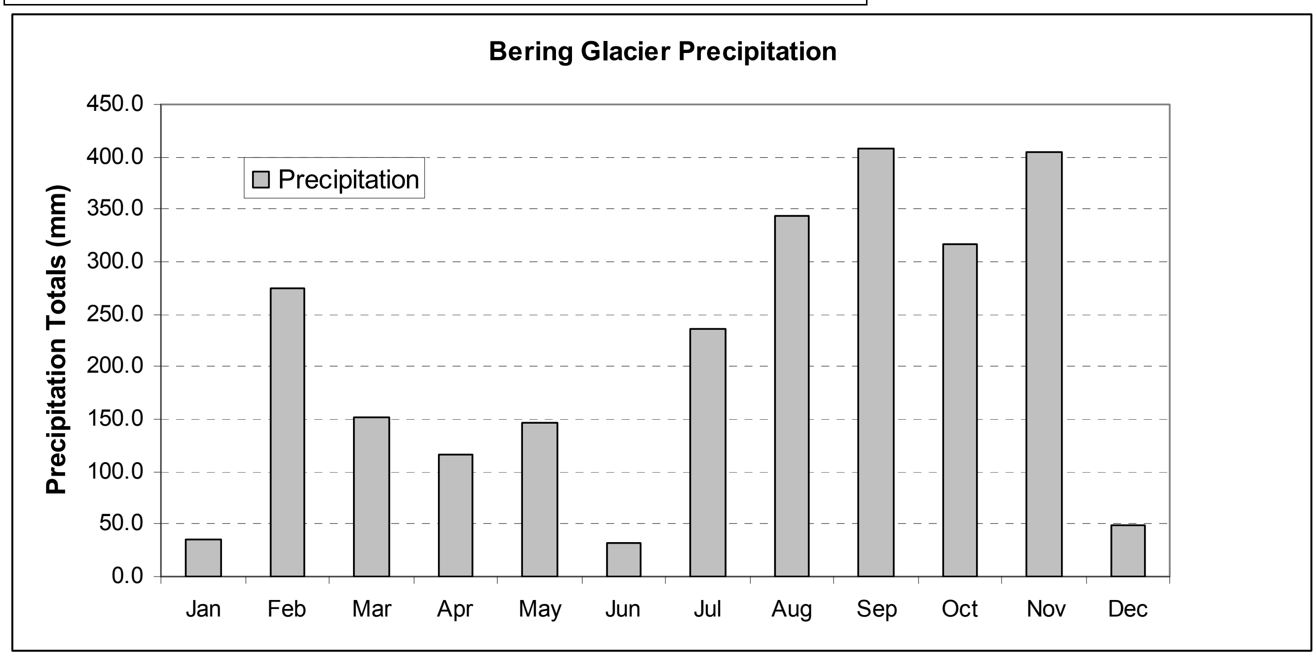

Chititu Soil Temperatures
Soil Temp 50
Soil Temp 100cm
Temperature °C
6.0
4.0
2.0
0.0
-2.0
-4.0
-6.0
-8.0
-10.0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

Bering Glacier RAWS – Elevation 23m (75')

	Air Temp °C	Air Temp °C	Air Temp °C	Relative Humidity %	Wind Speed m/s	Wind Direction °	Wind Gust m/s	Surface Temp °C	Precip mm
	Average	Minimum	Maximum	Average	Average	Average	Max	Average	Total
Jan	-3.1	-17.2	9.4	77.1	2.3	112.2	4.5	11.6	36.1
Feb	0.2	-20.6	8.9	87.5	4.0	118.5	7.5	5.0	274.6
Mar	1.2	-10.6	9.4	83.3	3.5	148.6	6.6	15.8	151.4
Apr	4.9	-9.4	20.6	78.0	3.6	172.4	6.7	28.4	116.6
May	8.6	-0.6	19.4	82.4	2.3	209.9	4.3	15.4	146.6
Jun	9.8	0.0	20.0	80.4	1.9	218.9	3.7	0.8	31.8
Jul	10.2	2.2	21.1	84.8	1.9	222.4	3.9	-2.9	235.7
Aug	9.8	1.1	22.2	85.3	1.7	227.4	3.7	3.0	344.4
Sep	7.8	-2.2	17.2	90.8	2.9	179.2	5.8	3.1	408.7
Oct	4.9	-5.6	12.8	90.9	3.4	132.1	6.7	-1.2	316.5
Nov	0.8	-15.6	8.9	90.7	3.4	116.1	6.6	-3.2	404.1
Dec	0.5	-16.7	10.0	89.4	3.6	105.3	6.5	-7.8	49.3

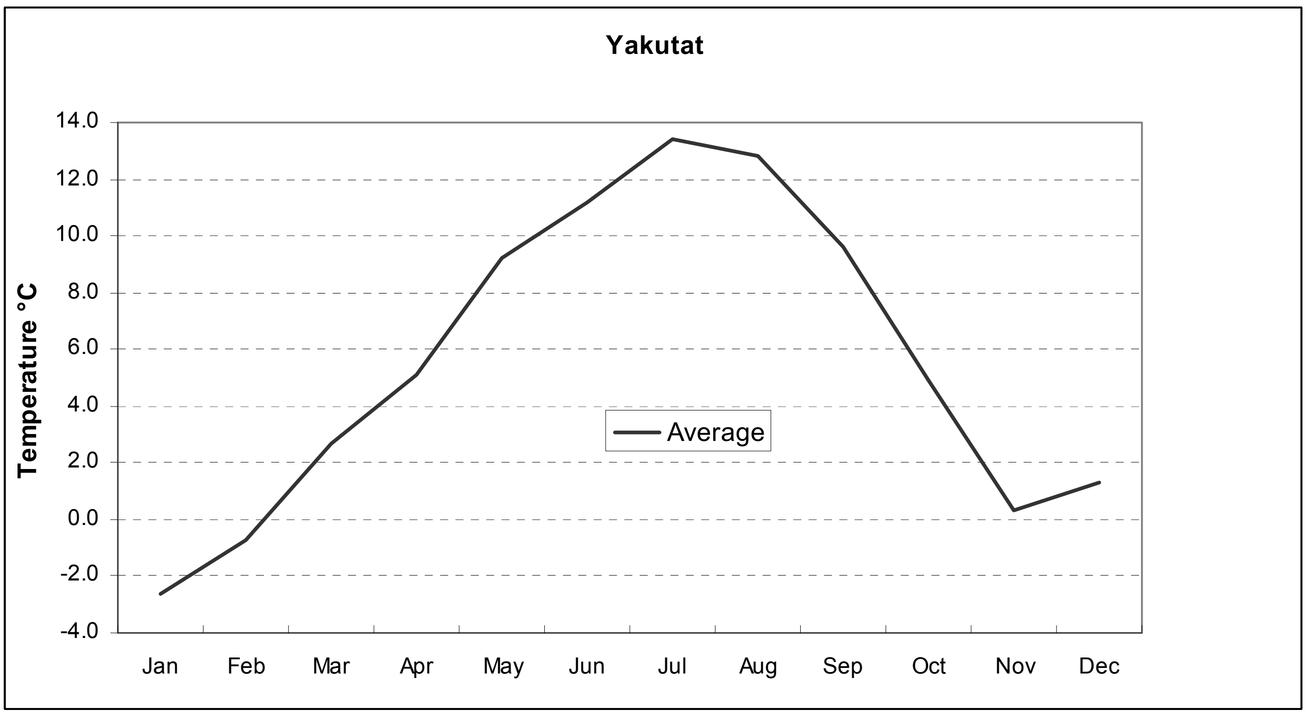


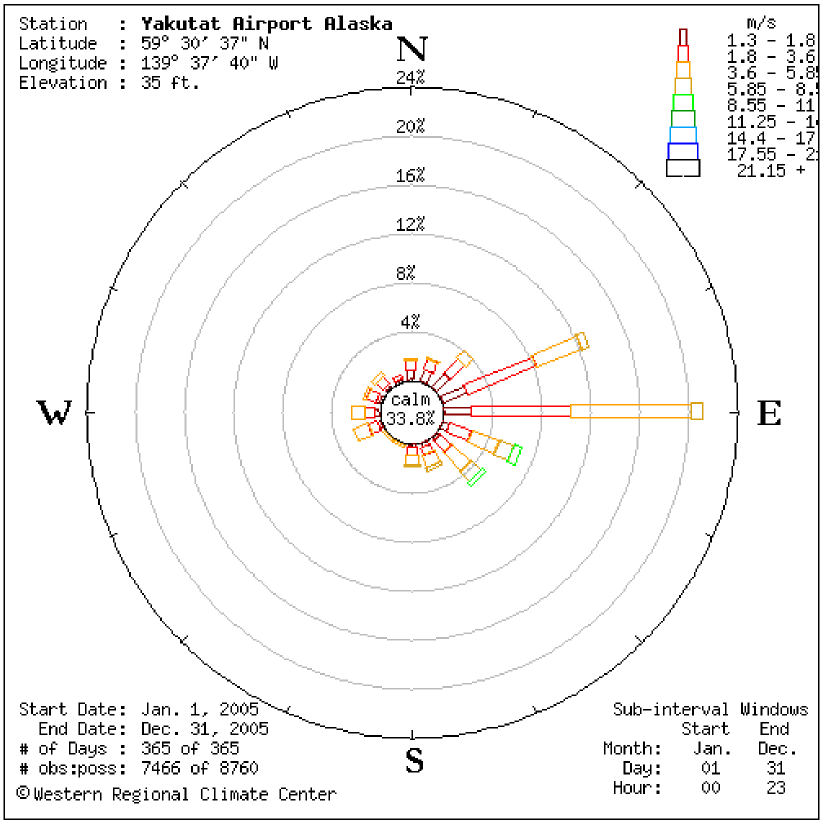

Station : Bering Glacier Alaska
Latitude : 60° 07′ 07" N
Longitude : 143° 17′ 00" W
Elevation : 75 ft.
N
E
S
W
12%
10%
8%
6%
4%
2%
calm
34.6%
m/s
1.3 - 1.8
1.8 - 3.6
3.6 - 5.85
5.85 - 8.55
8.55 - 11
11.25 - 14
14.4 - 17
17.55 - 21
21.15 +
Start Date: Jan. 1, 2005
End Date: Dec. 31, 2005
# of Days : 365 of 365
obs:poss: 8317 of 8760
© Western Regional Climate Center
Sub-interval Windows
Start End
Month: Jan. Dec.
Day: 01 31
Hour: 00 23

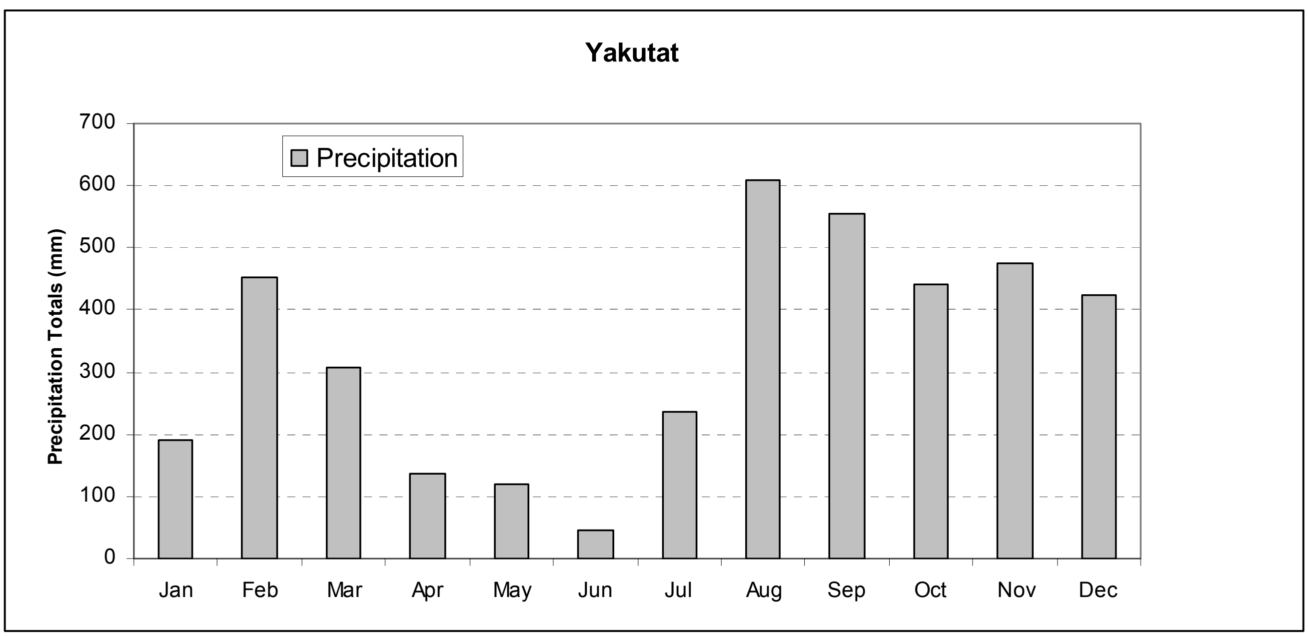

Bering Glacier Precipitation
Precipitation
Precipitation Totals (mm)
450.0
400.0
350.0
300.0
250.0
200.0
150.0
100.0
50.0
0.0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

Yakutat Airport – Elevation 9m (30')

	Air Temp °C	Relative Humidity %	Wind Speed m/s	Wind Direction °	Precipitation Totals
	Average	Average	Average	Average	mm
Jan	-2.6	84.1	2.1	56.2	192.0
Feb	-0.7	91.4	2.6	70.3	452.1
Mar	2.7	82.7	3.1	86.0	307.3
Apr	5.1	77.0	2.2	96.9	137.4
May	9.2	75.5	1.9	89.0	119.6
Jun	11.2	81.0	1.8	96.1	46.7
Jul	13.4	87.0	2.0	95.3	236.0
Aug	12.8	88.7	2.4	86.8	608.3
Sep	9.6	90.5	2.2	77.2	554.0
Oct	4.9	87.4	2.2	61.8	442.2
Nov	0.3	86.5	2.7	68.6	475.2
Dec	1.3	88.5	2.5	61.9	423.7



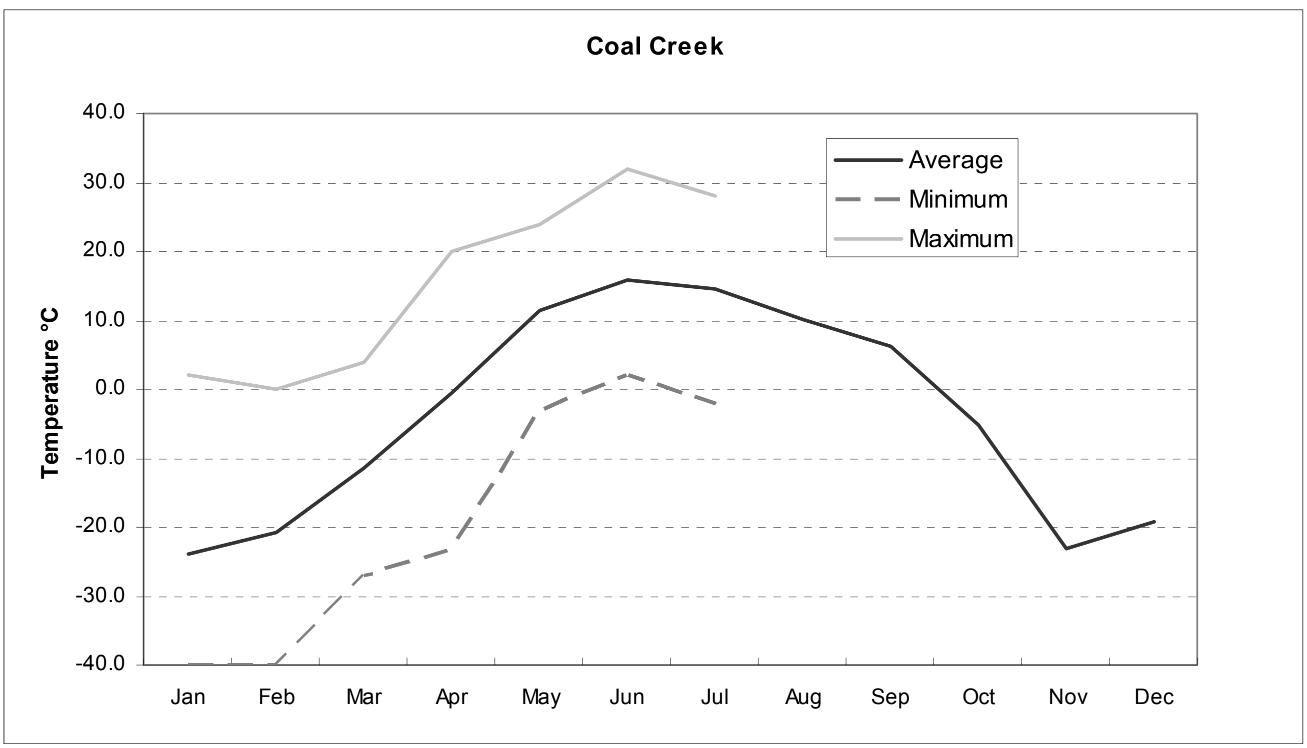

Station : Yakutat Airport Alaska
Latitude : 59° 30′ 37" N
Longitude : 139° 37′ 40" W
Elevation : 35 ft.
N
E
S
W
24%
20%
16%
12%
8%
4%
calm
33.8%
m/s
1.3 - 1.8
1.8 - 3.6
3.6 - 5.8
5.85 - 8.
8.55 - 11
11.25 - 1
14.4 - 17
17.55 - 2
21.15 +
Start Date: Jan. 1, 2005
End Date: Dec. 31, 2005
# of Days : 365 of 365
obs:poss: 7466 of 8760
©Western Regional Climate Center
Sub-interval Windows
Start End
Month: Jan. Dec.
Day: 01 31
Hour: 00 23

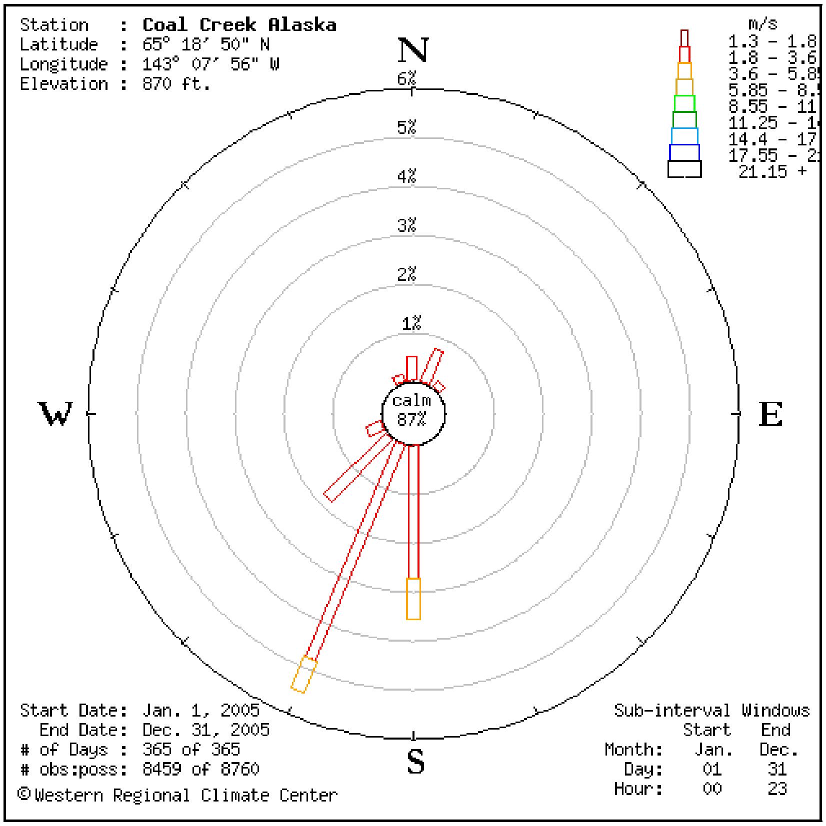

Yakutat
Precipitation
Precipitation Totals (mm)
700
600
500
400
300
200
100
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

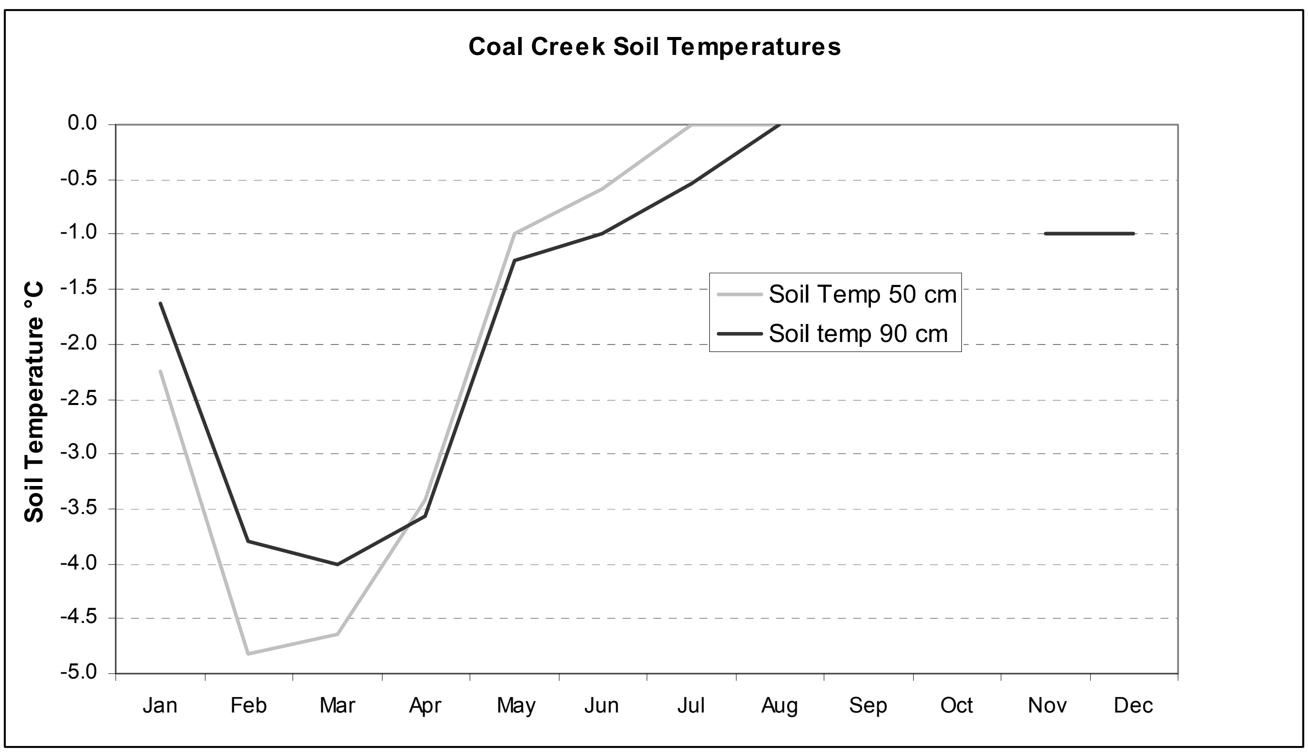
Appendix D- Yukon – Charley Rivers National Preserve Station Data

Coal Creek – Elevation 292m (958 ‘)

	Air Temp °C	Air Temp °C	Air Temp °C	Relative Humidity %	Wind Speed m/s	Wind Direction °	Wind Gust m/s	Surface Temp °C	Soil Temp 50 cm	Soil Temp 90cm
	Average	Minimum	Maximum	Average	Average	Average	Max	Average	Average	Average
Jan	-23.8	-40.0	2.0	70.5	0.6	170.5	1.5	-17.5	-2.2	-1.6
Feb	-20.9	-40.0	0.0	75.1	0.6	151.5	1.3	-15.5	-4.8	-3.8
Mar	-11.5	-27.0	4.0	72.5	1.0	177.5	1.8	-8.9	-4.6	-4.0
Apr	-0.6	-23.0	20.0	59.2	1.1	168.9	1.9	-4.0	-3.4	-3.6
May	11.4	-3.0	24.0	60.3	0.8	167.4	1.8	9.6	-1.0	-1.2
Jun	15.9	2.0	32.0	51.7	0.8	162.4	1.8	14.6	-0.6	-1.0
Jul	14.4	-2.0	28.0	65.2	0.8	181.2	1.8	13.4	0.0	-0.5
Aug	10.0	0.0	23.0	79.1	0.9	177.1	2.1	8.4	0.0	0.0
Sep	6.2			85.8	0.8	157.2	2.4	5.0		
Oct	-5.3			86.1	1.3	171.7	2.9	-1.8		
Nov	-23.1	-34.0	6.0	79.6	1.4	185.9	3.0	-7.2	-1.0	-1.0
Dec	-19.2	-39.0	33.0	84.6	0.2	89.5	0.8	-9.4	-1.0	-1.0

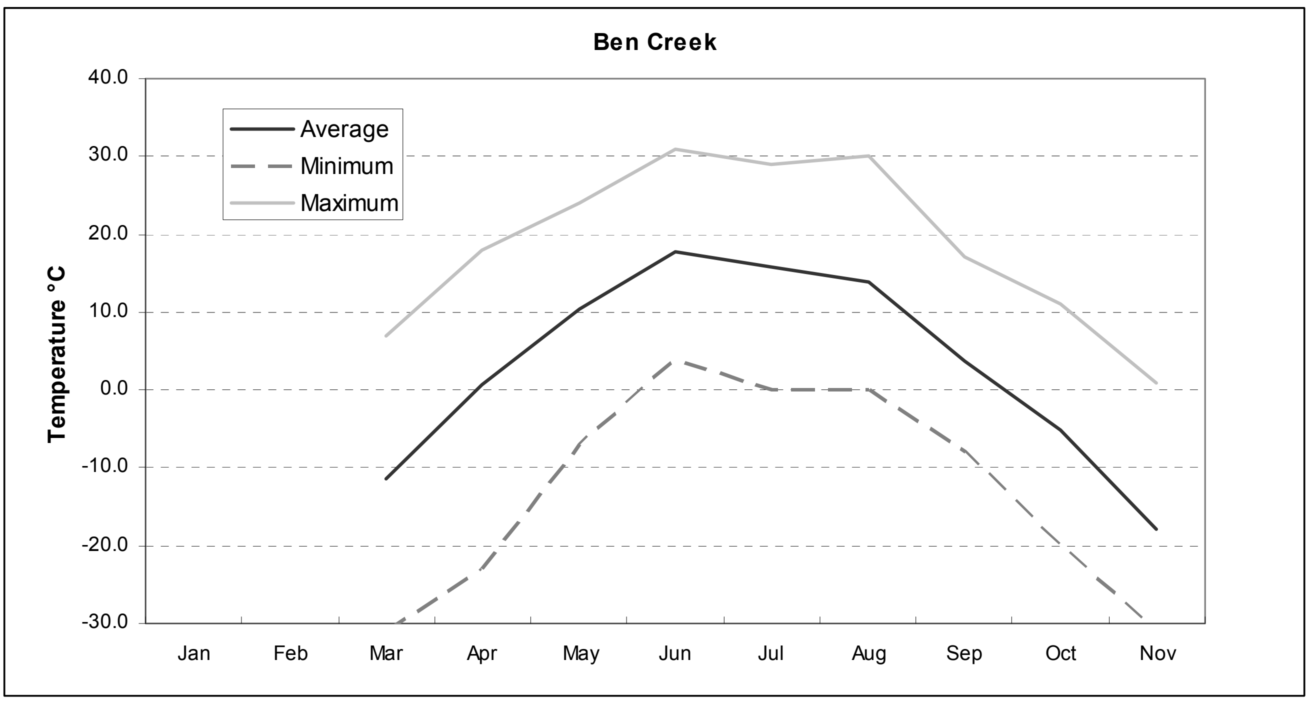


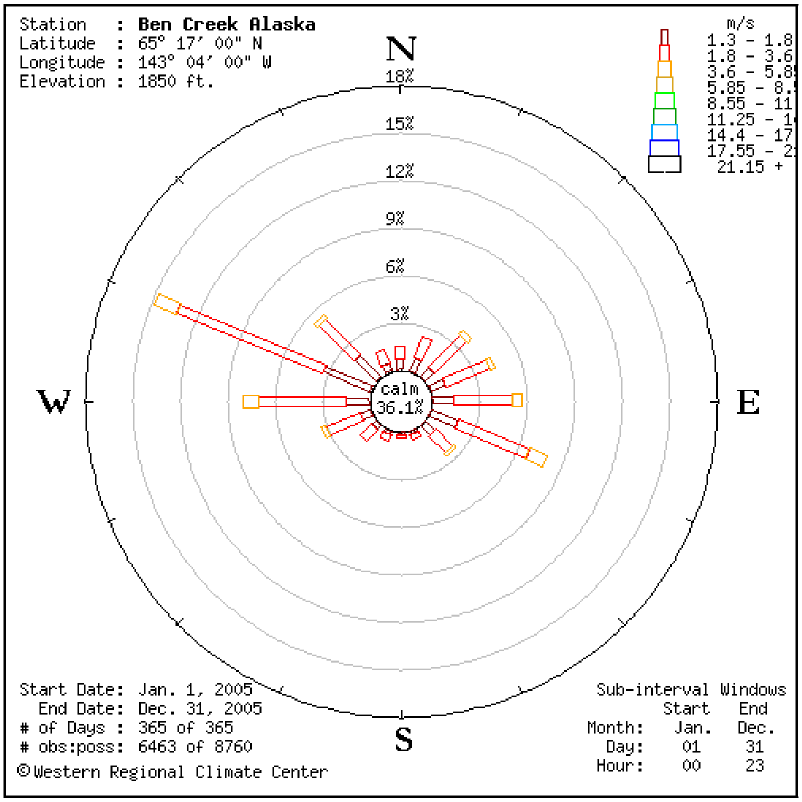

Station : Coal Creek Alaska
Latitude : 65° 18′ 50" N
Longitude : 143° 07′ 56" W
Elevation : 870 ft.
N
E
S
W
6%
5%
4%
3%
2%
1%
calm
87%
m/s
1.3 - 1.8
1.8 - 3.6
Start Date: Jan. 1, 2005
End Date: Dec. 31, 2005
# of Days : 365 of 365
obs:poss: 8459 of 8760
©Western Regional Climate Center
Sub-interval Windows
Start End
Month: Jan. Dec.
Day: 01 31
Hour: 00 23

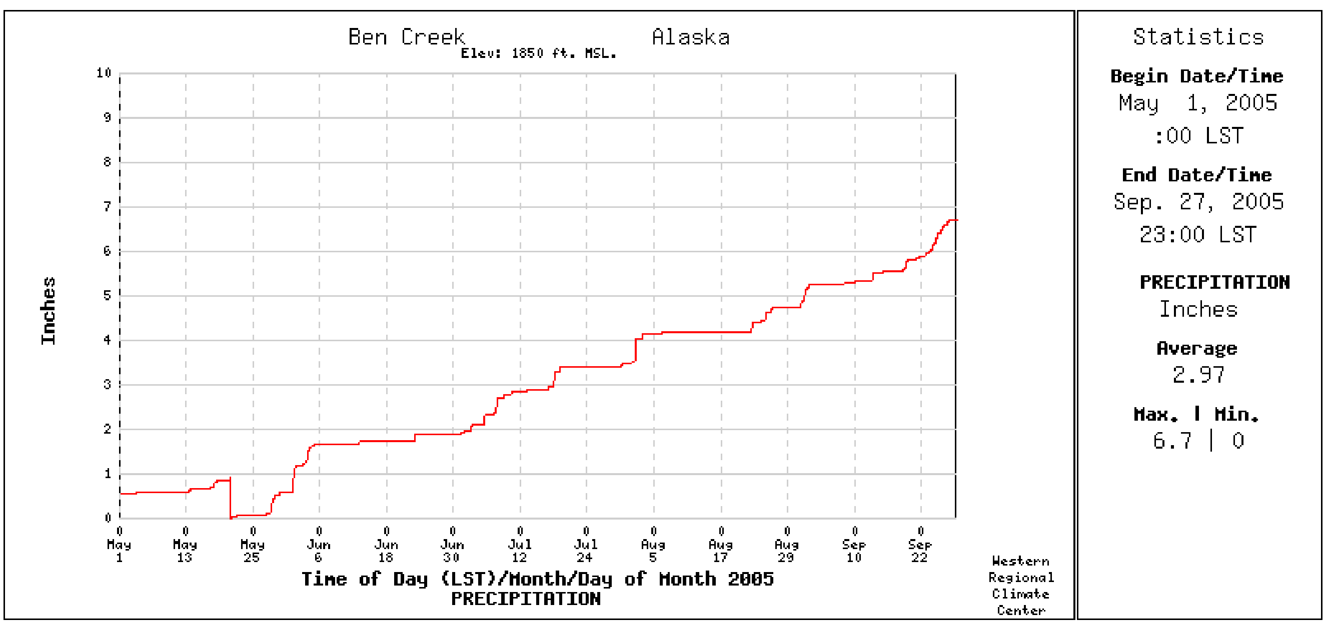

Coal Creek Soil Temperatures
Soil Temperature °C
0.0
-0.5
-1.0
-1.5
-2.0
-2.5
-3.0
-3.5
-4.0
-4.5
-5.0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Soil Temp 50 cm
Soil temp 90 cm

Ben Creek RAWS – Elevation 564m (1850')

	Air Temp °C	Air Temp °C	Air Temp °C	Relative Humidity %	Wind Speed m/s	Wind Direction °	Wind Gust m/s	Surface Temp °C	Precip mm
	Average	Minimum	Maximum	Average	Average	Average	Max	Average	Total
Jan									
Feb									
Mar	-11.3	-31.0	7.0	65.5	2.0	213.7	3.8	-9.0	
Apr	0.7	-23.0	18.0	49.8	2.0	184.7	4.0	-1.4	
May	10.4	-7.0	24.0	56.9	1.8	200.4	4.0	11.4	30.5
Jun	17.8	4.0	31.0	47.0	1.8	199.2	4.1	19.2	22.6
Jul	15.8	0.0	29.0	61.4	1.7	215.8	3.9	16.3	40.1
Aug	13.8	0.0	30.0	64.2	1.5	189.3	3.4	14.0	41.9
Sep	3.8	-8.0	17.0	79.5	1.7	173.7	3.6	3.7	38.9
Oct	-5.2	-20.0	11.0	91.7	1.1	190.3	2.3	-5.3	
Nov	-17.9	-31.0	1.0	83.3	0.7	200.8	1.4	-16.0	
Dec									

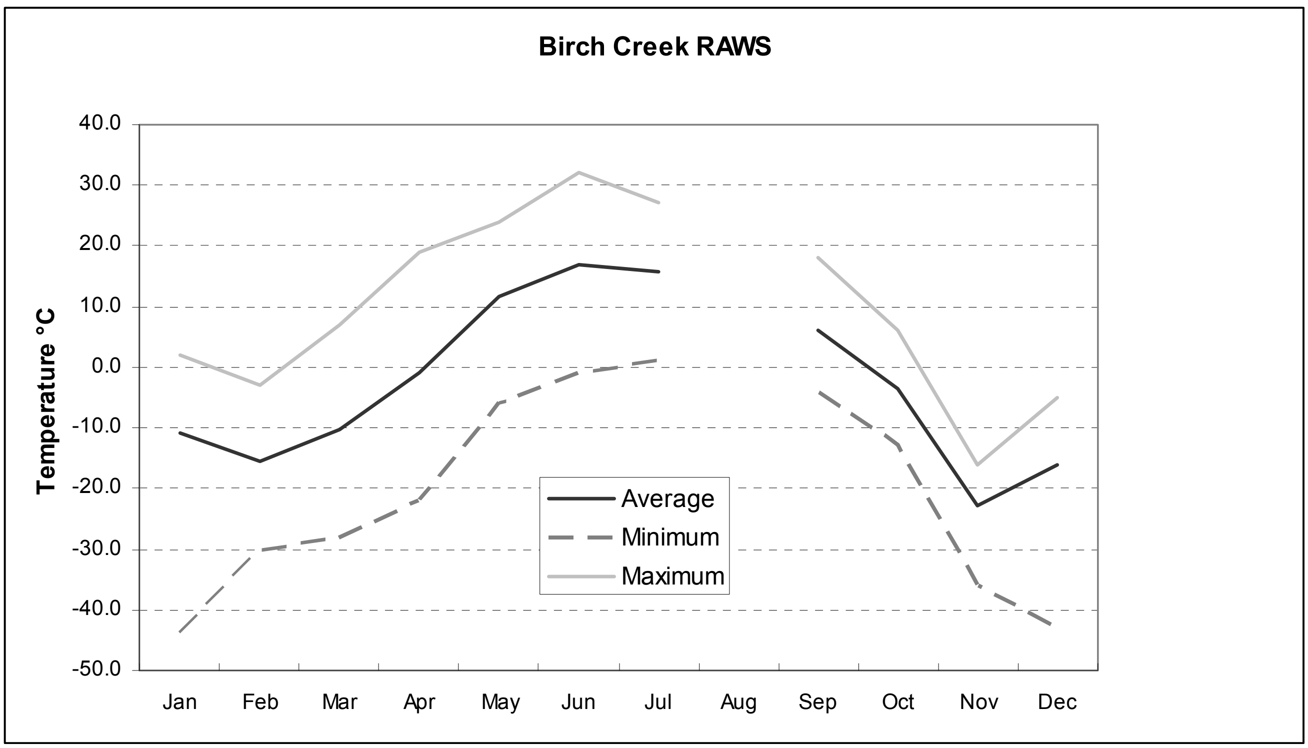


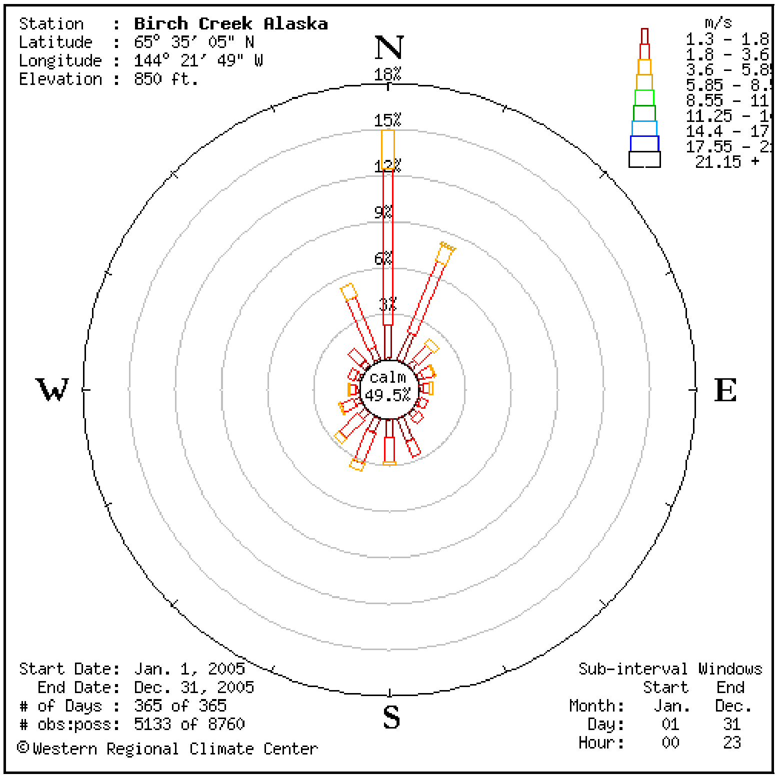

Station : Ben Creek Alaska
Latitude : 65° 17' 00" N
Longitude : 143° 04' 00" W
Elevation : 1850 ft.
N
E
S
W
18%
15%
12%
9%
6%
3%
calm
36.1%
m/s
1.3 - 1.8
1.8 - 3.6
21.15 +
Start Date: Jan. 1, 2005
End Date: Dec. 31, 2005
# of Days : 365 of 365
obs:poss: 6463 of 8760
©Western Regional Climate Center
Sub-interval Windows
Start End
Month: Jan. Dec.
Day: 01 31
Hour: 00 23

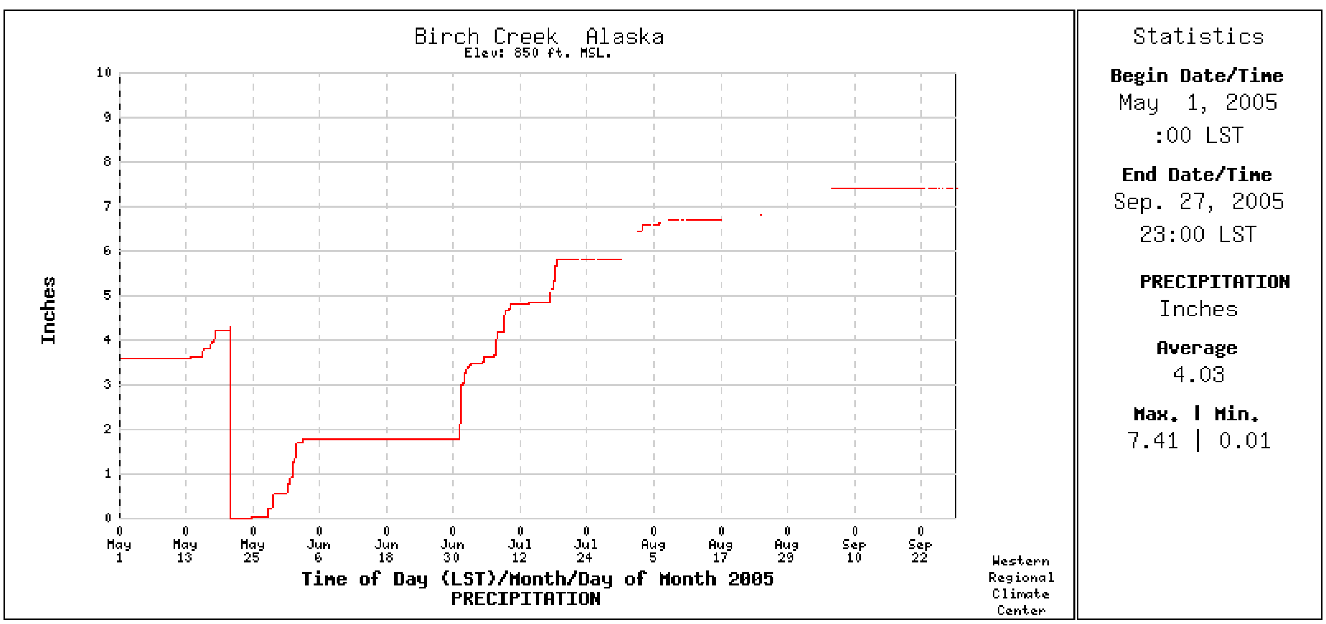

Ben Creek Alaska
Elev: 1850 ft. MSL.
Inches
Time of Day (LST)/Month/Day of Month 2005
PRECIPITATION
Western Regional Climate Center
Statistics
Begin Date/Time
May 1, 2005
:00 LST
End Date/Time
Sep. 27, 2005
23:00 LST
PRECIPITATION
Inches
Average
2.97
Max. | Min.
6.7 | 0

Birch Creek RAWS – Elevation 259m (850')

	Air Temp °C	Air Temp °C	Air Temp °C	Relative Humidity %	Wind Speed m/s	Wind Direction °	Wind Gust m/s	Surface Temp °C	Precip mm
	Average	Minimum	Maximum	Average	Average	Average	Max	Average	Total
Jan	-10.9	-44.0	2.0	69.1	1.2	186.2	3.0	10.0	
Feb	-15.6	-30.0	-3.0	70.6	0.4	161.3	1.4	2.6	
Mar	-10.4	-28.0	7.0	59.9	1.4	180.6	3.1	10.4	
Apr	-0.8	-22.0	19.0	52.5	1.3	169.4	3.0	28.9	
May	11.8	-6.0	24.0	56.8	1.6	176.0	3.7	55.0	37.1
Jun	16.9	-1.0	32.0	47.2	1.9	153.0	4.0	64.2	13.0
Jul	15.9	1.0	27.0	62.9	1.7	166.7	3.9	60.8	50.0
Aug	17.1	0.0	32.0	64.6	1.2	163.1	3.0	62.2	
Sep	6.2	-4.0	18.0	89.5	1.2	196.5	2.7	42.8	
Oct	-3.6	-13.0	6.0	86.7	1.1	175.3	2.4	26.2	
Nov	-22.7	-36.0	-16.0	69.4	0.5	146.5	1.2	2.2	
Dec	-16.0	-43.0	-5.0	82.8	0.0	225.6	0.1	18.0	




Station : Birch Creek Alaska
Latitude : 65° 35′ 05" N
Longitude : 144° 21′ 49" W
Elevation : 850 ft.
N
S
E
W
18%
15%
12%
9%
6%
3%
calm
49.5%
m/s
1.3 - 1.8
1.8 - 3.6
3.6 - 5.8
21.15 +
Start Date: Jan. 1, 2005
End Date: Dec. 31, 2005
# of Days : 365 of 365
obs:poss: 5133 of 8760
© Western Regional Climate Center
Sub-interval Windows
Start End
Month: Jan. Dec.
Day: 01 31
Hour: 00 23


Birch Creek Alaska
Elev: 850 ft. MSL.
Inches
Time of Day (LST)/Month/Day of Month 2005
PRECIPITATION
Western Regional Climate Center
Statistics
Begin Date/Time
May 1, 2005
:00 LST
End Date/Time
Sep. 27, 2005
23:00 LST
PRECIPITATION
Inches
Average
4.03
Max. | Min.
7.41 | 0.01