



# Annual Climate Summary 2013

## *Arctic Network*

Natural Resource Data Series NPS/ARCN/NRDS—2015/806



**ON THE COVER**

Photograph Howard Pass station in Noatak National Preserve.  
Photograph courtesy of Ken Hill/National Park Service

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Natural Resource Data Series NPS/ARCN/NRDS—2015/806

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# Contents

|                                                       | Page |
|-------------------------------------------------------|------|
| Figures.....                                          | iv   |
| Tables.....                                           | v    |
| Appendices.....                                       | v    |
| Executive Summary .....                               | vi   |
| Introduction.....                                     | 7    |
| Arctic Network Climate Overview .....                 | 8    |
| Methods.....                                          | 9    |
| Results.....                                          | 11   |
| ARCN RAWS .....                                       | 11   |
| Temperature.....                                      | 11   |
| Summer Precipitation .....                            | 12   |
| Snow and Precipitation (2012-2013 Season) .....       | 14   |
| Snotel Sites .....                                    | 14   |
| Remote Sensing of Snow Cover.....                     | 16   |
| Index Sites (Bettles, Kotzebue, Nome) .....           | 17   |
| Temperature.....                                      | 17   |
| Snow .....                                            | 21   |
| Alaska Statewide .....                                | 22   |
| Temperature.....                                      | 22   |
| Precipitation and Snow.....                           | 23   |
| Fire.....                                             | 25   |
| National and Global Synopsis .....                    | 25   |
| Climate Teleconnections .....                         | 26   |
| Discussion .....                                      | 27   |
| Status of Climate Monitoring in Network Parks .....   | 27   |
| Data management, quality control, and reporting ..... | 27   |
| Conclusion .....                                      | 29   |
| Literature Cited .....                                | 30   |

# Figures

|                                                                                                                                                                                     | Page |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|
| <b>Figure 1.</b> Map of climate station locations. Site numbers are given in Table 1.....                                                                                           | 10   |
| <b>Figure 2.</b> ARCN station mean annual air temperatures 2013. Red sites are GAAR, green Western Arctic (WEAR), and blue BELA.....                                                | 12   |
| <b>Figure 3.</b> ARCN station summer rainfall 2013. Red sites are GAAR, green WEAR, and blue BELA. ....                                                                             | 13   |
| <b>Figure 4.</b> Cumulative precipitation, snow depth, and SWE for Water Year 2013 (Oct. 1 – Sep.30) at Snotel stations Coldfoot, Atigun Pass, Kelly Station, and Pargon Creek..... | 15   |
| <b>Figure 5.</b> Maps of ARCN showing the dates of the end of the continuous snow season (CSS) in 2013 (top) and the median date for the 2000-2013 time period (bottom).....        | 16   |
| <b>Figure 6.</b> Standardized temperature anomaly time series plots for Bettles, Kotzebue, and Nome.....                                                                            | 18   |
| <b>Figure 7.</b> Daily temperature time series plots for 2013 for Bettles, Kotzebue, and Nome. ....                                                                                 | 19   |
| <b>Figure 8.</b> Monthly precipitation for 2013 compared to normal at Bettles, Kotzebue, and Nome.....                                                                              | 20   |
| <b>Figure 9.</b> Cumulative precipitation time series plots for 2013 at Bettles, Kotzebue, and Nome.....                                                                            | 21   |
| <b>Figure 10.</b> Cumulative snowfall at Bettles, Kotzebue, and Nome for August 2012 – July 2013.....                                                                               | 22   |
| <b>Figure 11.</b> Average temperatures in Alaska for 1918-2013.....                                                                                                                 | 23   |
| <b>Figure 12.</b> Statewide temperature departures for 2013 (left) and mean monthly temperature deviations for the 20 first order stations in Alaska by month (right). ....         | 23   |
| <b>Figure 13.</b> Statewide annual precipitation anomalies 1918-2013 .....                                                                                                          | 24   |
| <b>Figure 14.</b> Statewide precipitation departures from normal (left) and monthly deviations (right) for first order climate stations in Alaska.....                              | 24   |
| <b>Figure 15.</b> March 1 and May 1 snowpack percent of average for Alaska 2013 (NRCS 2014a). ....                                                                                  | 25   |
| <b>Figure 16.</b> Pacific Decadal Oscillation index based on NOAA's extended reconstruction of SSTs (ERSST Version 3) .....                                                         | 26   |
| <b>Figure 17.</b> Arctic Sea Ice extent 1979-2013. 2012 was the lowest seasonal minimum extent on record (NSIDC 2014). ....                                                         | 27   |

## Tables

|                                                                                                                                          | Page |
|------------------------------------------------------------------------------------------------------------------------------------------|------|
| <b>Table 1.</b> Weather stations included in this report.....                                                                            | 9    |
| <b>Table 2.</b> Monthly mean temperatures (°F) from ARCN stations 2013 <sup>1</sup> .....                                                | 11   |
| <b>Table 3.</b> Monthly rainfall (inches) from ARCN and Snotel stations in 2013 <sup>1</sup> . ....                                      | 12   |
| <b>Table 4.</b> Precipitation and snow summary statistics for Snotel stations in 2013. ....                                              | 14   |
| <b>Table 5.</b> Monthly mean temperature and departures from 1981-2010 normal<br>(parentheses) for index sites in ARCN in 2013 (°F)..... | 17   |
| <b>Table 6.</b> Monthly and annual precipitation (inches) and departures from normal (%) for<br>2013 at Bettles, Kotzebue, and Nome..... | 19   |
| <b>Table 7.</b> Monthly and annual snowfall (inches) and departures from normal (%) at<br>Bettles, Kotzebue, and Nome.....               | 21   |
| <b>Table 8.</b> Issues affecting data quality at ARCN stations in 2013.....                                                              | 28   |

## Appendices

|                                                                | Page |
|----------------------------------------------------------------|------|
| Appendix A. 2013 ARCN Climate Station Data Summary.....        | 33   |
| Appendix B. AWOS Station Summaries.....                        | 63   |
| Appendix C. Fire RAWS Station Summaries.....                   | 64   |
| Appendix D. 2013 Snotel Station Summaries .....                | 67   |
| Appendix E. 2013 Alaska Weather Highlights.....                | 69   |
| Appendix F. 2013 U.S. Weather Highlights .....                 | 70   |
| Appendix G. 2013 Worldwide Significant Climate Anomalies ..... | 71   |

## Executive Summary

The Arctic Network's climate monitoring program has established sixteen remote weather stations to monitor climate in Gates of the Arctic National Park and Preserve, Noatak National Preserve, Kobuk Valley National Park, Cape Krusenstern National Monument, and Bering Land Bridge National Preserve. The main goal of the program is to operate these remote sites for the long-term in order to help scientists and park managers understand the climate patterns across these large parks. There are three weather and climate stations near the parks operated by various state and federal agencies that are used as index sites to compare current climate conditions in the region to the climatological normal - the average weather conditions over a 30-year period. The current normal period is 1981-2010. This report summarizes the annual and monthly temperature and precipitation deviations for the index sites and compiles monthly and annual statistics for the sites with shorter records, including sixteen ARCN sites, six additional fire weather stations, four Snotel stations, and one airport weather site located in or near park boundaries. A brief synopsis of regional, national, and global climate conditions for 2013 is included for climatic context.

The variability in the temperature and precipitation patterns across the Arctic Alaska region in 2013 was striking. The mean annual temperature at the three index sites (Bettles, Kotzebue, Nome) averaged +0.2°F warmer than the 1981-2010 normal, but there was impressive variability between months and seasons. The mean annual temperatures at Kotzebue and Nome were 1.3°F and 0.2°F warmer than normal, while Bettles was -1.0°F cooler than normal for the year. Precipitation totals were near normal or above normal at each of the index sites. Bettles recorded 14.90 inches for the year, 103% of normal. Kotzebue had 11.00 inches (110% of normal) and Nome received 16.81 inches (133% of normal). Average annual temperatures mask the extreme variability experienced at most locations including a warm January, a cold spring season, and a warm, wet October period.

The mean annual temperature for Alaska was 1.7°F warmer than normal and the precipitation totals were 125% of normal. Nationally temperatures were 0.3°F above the 20<sup>th</sup> century average making it the 37<sup>th</sup> warmest year on record, while globally 2013 was tied with 2003 as the fourth warmest year on record since records began in 1880.

Between May and September of 2013, Arctic Network staff performed annual site maintenance at the sixteen network weather stations, two fire weather stations and one Natural Resources Conservation Service station. The Salmon River weather station was re-established in Kobuk Valley National Preserve in July 2013. The site had previously been damaged by wildlife and is now surrounded by an electric fence.

## Introduction

Gates of the Arctic National Park and Preserve (GAAR), Noatak National Preserve (NOAT), Kobuk Valley National Park (KOVA), Cape Krusenstern National Monument (CAKR) and Bering Land Bridge National Preserve (BELA) make up the Arctic Inventory and Monitoring Network (ARCN), covering about 19 million acres. The network was established to monitor key components of ecosystems of the parks and to provide that information back to park managers for use in stewardship of park resources. Climate is considered to be the most important broad-scale factor influencing ecosystems and therefore the natural resources of parks. Because global climate models indicate that climate change and variability will be greatest at high latitudes, climate monitoring is critical to understanding the changing conditions of park ecosystems.

There are three National Weather Service (NWS) stations in the ARCN region that have been in operation for 62 to over 100 years that were used as index sites to place current year regional weather conditions into climatological context. Monthly and annual statistics were compared to the latest climate normal period (1981-2010).

The ARCN parks represent a large portion of the mountainous environment of the northern portion of the state of Alaska and therefore provide an opportunity to understand climate gradients that have been, in the past, a challenge to instrument and monitor. The ARCN climate monitoring program deployed sixteen climate stations between 2011 and 2013, many at higher elevations, to capture elevational and latitudinal climate gradients within the parks, and to capture data in areas where there were no baseline references. These sites are referred to as ARCN RAWS (remote automated weather stations). For detailed information on station locations, station design, and maintenance schedules see the arctic Alaska network climate station maintenance report (Hill and Sousanes, 2014). There are eleven additional sites that are analyzed in this report: four SNOTEL sites, six fire RAWS, and one Federal Aviation Administration (FAA) Automated Weather Observing System (AWOS). The SNOTEL sites are within or near the park boundaries and provide representative year-round precipitation measurements. These sites are operated and maintained under an interagency agreement between the NPS and the Natural Resources Conservation Service (NRCS). The six fire RAWS are located within or near the park boundaries and are part of a much larger national fire program and are maintained under contract with the National Interagency Fire Center. Monthly weather statistics are generated for each of these sites; however, long-term trends will take time to develop.

The 2013 field season marked the first year of operational climate monitoring in ARCN parks. Annual maintenance was performed at 16 climate stations. Maintenance at the climate sites included sensor replacement, troubleshooting, upgrades, data downloads, and sensor calibrations. Station maintenance logs were used to keep track of the climate station inventory for the stations, which includes: sensors, data loggers, towers, solar panels, and batteries. Sensor and power performance were tracked and instrumentation was replaced as necessary. A station was re-established at Salmon River in Kobuk Valley National Park. The site had been removed in 2012 due to damage by wildlife. The station was reinstated with an electric fence. The Quartz Creek and Hoodoo Hill fire RAWS stations were also serviced this field season by ARCN staff; maintenance for this site and all other

NPS fire RAWs is usually done by the NPS radio shop. A maintenance report is completed after each field season to document the details of the site visits – these reports include the field notes, photos, logistics, and sensor metadata (Hill and Sousanes, 2014).

This is the first annual data report that summarizes the annual and monthly weather statistics of the most recent year for the Arctic Network Climate Monitoring Program.

### **Arctic Network Climate Overview**

The Arctic Network (ARCN) encompasses strong climate gradients, from the arctic maritime climates in BELA and CAKR where it borders the Bering and Chukchi seas to the strongly continental climates found in GAAR and eastern NOAT. Arctic network parklands constitute parts of the North Slope, Central Interior, and West Coast climate divisions as defined by Bieniek et al. (2012). A transitional climate region lies between the coast and the interior influenced by major mountain ranges which act not only as the environmental controls to drive climate but also contribute to the highly localized micro climates found in complex mountain terrain. Temperature inversions are common through much of the year as a result of low water vapor content, extended periods of snow cover, and low solar radiation. The climate gradients are intrinsic to the ecosystem patterns, and vegetative and faunal communities found in ARCN parks. Redmond and Simeral (2010) and Davey et al. (2007) provide a more detailed discussion of the climate of the Arctic Network.

The climate patterns of Alaska are primarily influenced by latitude, continentality, and elevation. The high latitude drives the seasonal pendulum of available solar radiation; areas farther north have limited incoming solar warmth in the winter and an abundance of available light in the summer. Major mountain ranges in the state act as barriers to the moisture spinning off of the Pacific Ocean to the south. The warm, moist air masses deposit precipitation on the windward sides of the mountains – rain at low elevations and snow at higher elevations. Large scale atmospheric and oceanic circulation patterns influence seasonal and annual weather patterns in the state, like the repositioning of the polar jet stream and the Aleutian low pressure system or the frequency of La Ninas and El Ninos (Papineau, 2001). Each of these can affect the regional patterns of storm tracks, prevailing winds, snowfall amounts, and the extent of sea ice (ACIA, 2004).

There are several large-scale climate patterns and indices that are of particular interest to Alaska, including the Pacific Decadal Oscillation (PDO) which is an index of sea surface temperatures in the North Pacific Ocean. Typical winter sea surface temperatures during the warm phase of the PDO are warmer off of the Gulf Coast of Alaska moderating air temperatures over Alaska (Hartmann and Wendler, 2005; Keen, 2013). The PDO appears to cycle through a warm and cool phase every 20 -30 years. Temperature trends that have shown climatic warming tend to be strongly biased by a sudden shift in 1976 from the cooler (negative) regime to a warmer regime. Since 2005 the index had been predominantly negative and air temperatures have been near or below normal – a possible indication of a phase shift from positive to negative. However, there appears to be more variability during the past few years. Large scale changes such as this may take a few decades to confirm.

While the PDO teleconnection seems to explain some of the temperature trends in arctic Alaska, the Arctic Ocean, and in particular the extent of sea ice will likely influence both temperature and

precipitation patterns in Alaska. In recent years there has been a continued significant reduction in the extent of the summer sea ice cover and the decrease in the amount of relatively older, thicker ice (NSIDC, 2012). Models predict that retreating sea ice will affect the temperature and ecosystems of adjacent lands. Additional changes to temperature and ecosystems may be driven by an increase in the amount of energy absorbed by vegetation and its transfer to the atmosphere (Chapin et al., 2005).

## Methods

Data were compiled from the index sites; the three long-term climate stations with the most complete records nearest the ARCN parks that represent the major climate regimes in the network. These stations have records for a sufficient number of years to compare 2013 data with the latest normal period, 1981-2010. Temperature, precipitation, and snowfall were analyzed for the long-term sites. Monthly temperature means and precipitation totals for 2013 are compiled and compared with the 1981-2010 normal values for each site.

Table 1 lists stations analyzed in this report. Data were compiled for sixteen ARCN stations in the parks (Appendix A), one FAA AWOS site at Anaktuvuk Pass (Appendix B), six fire RAWs stations (Appendix C), and four NRCS Snotel sites (Appendix D). During the annual site visits at ARCN sites, data were downloaded from each climate station and checked for quality. Errors or values outside a standard range were flagged and not used in the summary statistics. The quality checked data files were sent to the Western Regional Climate Center in October 2013 for archival purposes; there has been a lag between when these files are sent and when they were updated. A report on data quality is kept on file for each site. Monthly and annual means and totals were compiled for the climate variables measured at each location including, temperature, wind speed and direction, peak wind gust, relative humidity, solar radiation, soil temperatures, snow depth, and summer rainfall. Summary tables are included for ARCN, AWOS, Fire RAWs, and Snotel stations in Appendix A, B, C, and D respectively.

Most of the summaries, analyses, charts, and graphs included in this report from the National Oceanic and Atmospheric Administration (NOAA) and from the Natural Resources Conservation Service (NRCS) are in standard units; for consistency all data are presented in standard units.

**Table 1.** Weather stations included in this report. Index sites are highlighted in bold. Station start is the earliest date listed in NCDC system.

| Station Name   | Latitude      | Longitude       | Elevation (ft) | Station Type | Start Date  | Site No  |
|----------------|---------------|-----------------|----------------|--------------|-------------|----------|
| Anaktuvuk Pass | 68.134        | -151.743        | 2103           | AWOS         | Nov-02      | 5        |
| Asik           | 67.475        | -162.266        | 1329           | ARCN         | Jul-12      | 19       |
| Atigun Pass    | 68.130        | -149.480        | 4800           | Snotel       | Jan-83      | 1        |
| <b>Bettles</b> | <b>66.540</b> | <b>-151.310</b> | <b>643</b>     | <b>COOP</b>  | <b>1951</b> | <b>4</b> |
| Chimney Lake   | 67.714        | -150.585        | 3700           | ARCN         | Aug-12      | 3        |
| Coldfoot       | 67.250        | -150.180        | 1040           | Snotel       | Mar-95      | 2        |
| Devil Mtn.     | 66.296        | -164.520        | 285            | ARCN         | Aug-11      | 27       |
| Ells Creek     | 65.275        | -163.820        | 2318           | ARCN         | Sep-12      | 26       |

**Table 2 (continued).** Weather stations included in this report. Index sites are highlighted in bold. Station start is the earliest date listed in NCDC system.

| Station Name    | Latitude      | Longitude       | Elevation (ft) | Station Type | Start Date  | Site No   |
|-----------------|---------------|-----------------|----------------|--------------|-------------|-----------|
| Hoodoo Hill     | 65.595        | -163.411        | 1495           | Fire RAWS    | Jun-92      | 24        |
| Howard Pass     | 68.156        | -156.896        | 2062           | ARCN         | Jul-11      | 11        |
| Imelyak         | 67.545        | -157.077        | 3620           | ARCN         | Jul-12      | 12        |
| Kaluich         | 67.573        | -158.432        | 2411           | ARCN         | Jul-12      | 13        |
| Kavet Creek     | 67.139        | -159.044        | 235            | Fire RAWS    | Jun-92      | 15        |
| Kelly Station   | 67.930        | -162.280        | 310            | Snotel       | Jul-11      | 20        |
| Killik Pass     | 67.984        | -155.013        | 4360           | ARCN         | Aug-12      | 10        |
| <b>Kotzebue</b> | <b>66.867</b> | <b>-162.633</b> | <b>30</b>      | <b>COOP</b>  | <b>1897</b> | <b>21</b> |
| Kugururok       | 68.317        | -161.492        | 1020           | ARCN         | Jul-14      | 18        |
| Midnight Mtn.   | 65.820        | -164.543        | 2267           | ARCN         | Aug-11      | 28        |
| Mt. Noak        | 67.141        | -162.995        | 809            | ARCN         | Jul-11      | 22        |
| Noatak          | 68.071        | -158.704        | 985            | Fire RAWS    | Apr-90      | 14        |
| <b>Nome</b>     | <b>64.511</b> | <b>-165.440</b> | <b>13</b>      | <b>COOP</b>  | <b>1907</b> | <b>31</b> |
| Norutak Lake    | 66.833        | -154.333        | 800            | Fire RAWS    | Jun-92      | 8         |
| Pamichtuk Lake  | 67.766        | -152.164        | 3135           | ARCN         | Aug-12      | 7         |
| Pargon Creek    | 64.990        | -163.100        | 100            | Snotel       | Oct-00      | 23        |
| Quartz Creek    | 65.400        | -164.650        | 321            | Fire RAWS    | May-98      | 29        |
| Ram Creek       | 67.624        | -154.345        | 4100           | ARCN         | Aug-12      | 9         |
| Salmon River    | 67.460        | -159.841        | 1262           | ARCN         | Jul-11      | 16        |
| Serpentine      | 65.852        | -164.708        | 518            | ARCN         | Aug-11      | 30        |
| Sisiak          | 67.995        | -160.396        | 1823           | ARCN         | Jul-11      | 17        |
| Tahinichok      | 67.550        | -163.567        | 966            | ARCN         | Jul-11      | 25        |
| Umiat           | 69.370        | -152.136        | 267            | Fire RAWS    | Nov-07      | 6         |

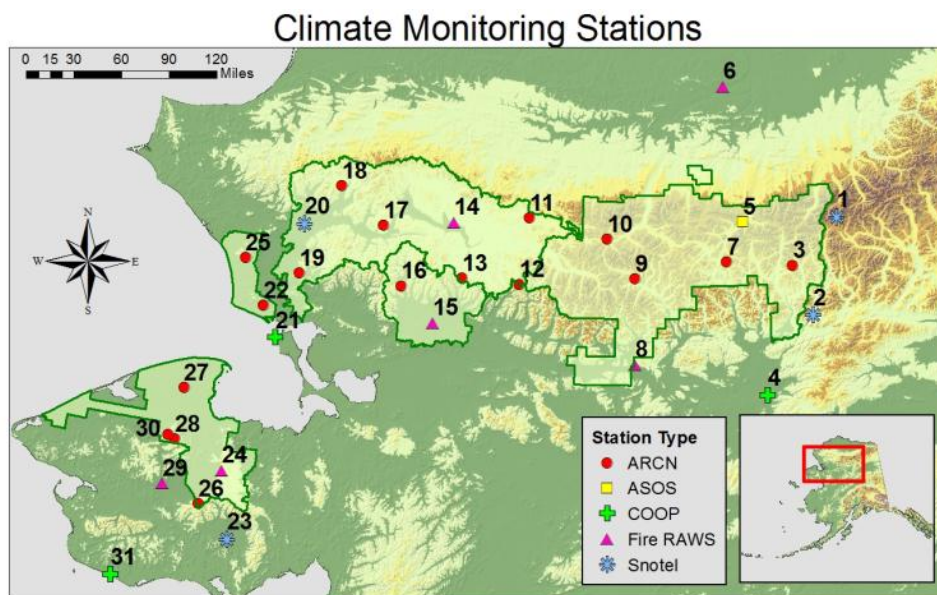


**Figure 1.** Map of climate station locations. Site numbers are given in Table 1.

# Results

## ARCN RAWS

### Temperature

Table 2 lists the monthly and annual temperatures for ARCN climate stations installed from 2011-2012. Additional parameters including wind speed, wind direction, solar radiation, snow depth, relative humidity, and soil temperature are provided in Appendix A. Due to their short record, deviations or departures from normal cannot be calculated for these sites.

**Table 2.** Monthly mean temperatures (°F) from ARCN stations 2013<sup>1</sup>.

| Station Name   | Jan  | Feb   | Mar | Apr  | May  | Jun  | Jul  | Aug  | Sep  | Oct  | Nov  | Dec  | Year |
|----------------|------|-------|-----|------|------|------|------|------|------|------|------|------|------|
| Asik           | 11.4 | 2.1   | 7.9 | 15.0 | 27.9 | 53.6 | 51.7 | 48.7 | 34.5 | 30.9 | 12.5 | 10.5 | 25.7 |
| Chimney Lake   | 2.8  | 2.3   | 4.6 | 7.3  | 26.6 | 52.1 | 50.7 | 44.9 | 30.0 | 25.8 | 4.6  | 3.9  | 21.4 |
| Devil Mtn.     | 6.8  | -10.0 | 2.0 | 11.9 | 26.1 | 50.4 | 51.4 | 47.9 | 36.0 | 32.7 | 15.6 | 8.9  | 23.5 |
| Ella Creek     | 8.7  | -3.9  | 5.7 | 11.6 | 24.5 | 49.1 | 47.8 | 45.3 | 31.6 | 28.5 | 12.7 | 10.0 | 22.8 |
| Howard Pass    | -6.5 | -16.0 | 3.4 | 3.4  | 24.1 | 51.8 | 51.8 | 44.8 | 30.5 | 28.5 | 6.9  | 3.2  | 19.1 |
| Imelyak        | 7.2  | 3.5   | 6.0 | 8.9  | 23.0 | 49.2 | 47.0 | 43.2 | 29.1 | 27.0 | 7.4  | 7.2  | 21.7 |
| Kaluich        | -3.2 | -9.9  | 3.3 | 5.0  | 24.3 | 51.2 | 50.2 | 44.6 | 30.2 | 27.1 | 5.9  | 2.8  | 19.5 |
| Killik Pass    | -2.2 | -3.9  | 2.1 | 3.6  | 20.9 | 47.9 | 46.8 | 40.5 | 26.0 | 23.0 | 2.2  | 2.3  | 17.6 |
| Mt. Noak       | 10.8 | -0.6  | 6.3 | 15.0 | 28.9 | 54.3 | 52.8 | 49.8 | 35.8 | 32.0 | 13.6 | 9.4  | 25.9 |
| Pamichtuk Lake | M    | M     | M   | M    | M    | 53.6 | 52.4 | 45.8 | 30.9 | 27.1 | 5.2  | 3.5  | X    |
| Ram Creek      | 0.9  | -1.1  | 2.6 | 6.7  | 24.0 | 50.8 | 49.0 | 43.3 | M    | M    | M    | M    | X    |
| Salmon River   | M    | M     | M   | M    | M    | M    | M    | M    | 33.8 | 29.0 | 7.9  | 4.7  | X    |
| Serpentine     | 6.4  | -11.6 | 4.9 | 12.9 | 28.4 | 52.8 | 53.5 | 49.2 | 37.2 | 34.5 | 16.5 | 8.5  | 24.7 |
| Sisiak         | 2.6  | -5.7  | 4.1 | 9.7  | 26.7 | 52.4 | 51.4 | 46.0 | 31.9 | 28.2 | 7.5  | 5.2  | 21.8 |
| Tahinichok     | 9.8  | -0.6  | 6.0 | 14.4 | 27.8 | 52.7 | 51.7 | 48.9 | 34.7 | 31.3 | 12.7 | 9.6  | 25.1 |

<sup>1</sup> Please note that the monthly values for individual sites may differ from those in the seasonal weather summaries –real-time transmitted data are used to generate the summaries, which may have some data gaps; <sup>2</sup> M=Missing due to wildlife damage; X=not calculated.

Among the ARCN stations, mean annual air temperatures (MAAT) ranged from 17.6°F at Killik Pass to 25.9°F at Mt. Noak (Table 2; Figure 2). February was the coldest month in 2013 at all ARCN stations. At 10:00 p.m. on February 21, an air temperature of -47.5°F and a sustained wind speed of 53.7 mph produced a wind chill at Howard Pass of -100°F, a possible state and national record. The coldest temperature among ARCN stations (-47.9°F) in 2013 was recorded during this event at Howard Pass (Appendix A). Note the large variation in winter temperatures between sites versus other seasons. The coldest monthly mean temperature was recorded at Howard Pass with an average temperature of -16.0°F in February. Stations in BELA were also particularly cold in February (-10.0°F at Devil Mtn.; -11.6°F at Serpentine). The warmest station in February was Imelyak with a monthly mean of 3.5°F. Due to its geographic position at a relatively high elevation (3620 feet) on the south side of the Brooks Range, Imelyak experiences strong inversions and is often warmer than nearby lower elevations.

Spring temperatures remained cold through most of May and all ARCN stations had monthly mean temperatures below freezing in May. Summer arrived rapidly in the arctic network and the warmest month was June at most stations. Average summer (June-August) temperatures ranged from 45.1°F at Killik Pass at the northwest corner of GAAR to 52.3°F at Mt. Noak in CAKR. The highest temperature of the year for the ARCN RAWS (85.7°F) was recorded at Mt. Noak in June. Normally, October is a transition month in the arctic when temperatures drop well below freezing and snow begins to accumulate. However, October 2013 was much warmer than normal and most ARCN stations were near or above freezing.

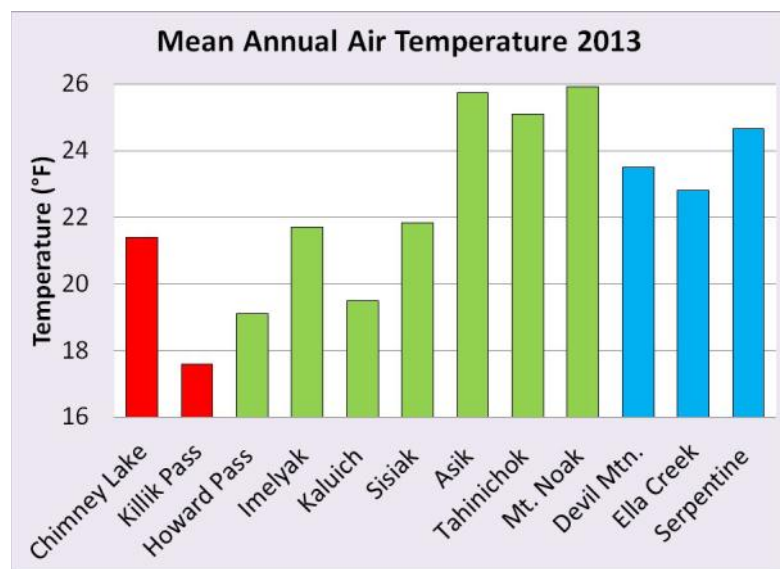


**Figure 2.** ARCN station mean annual air temperatures 2013. Red sites are GAAR, green Western Arctic (WEAR), and blue BELA.

### Summer Precipitation

ARNC stations measure rainfall with a standard tipping bucket, and are not heated. As a result, precipitation measurements are only reliable when temperatures are above freezing, typically June through August. Also, ARCN rain gages are currently not shielded from wind and therefore measurements may underestimate precipitation at exposed locations. NRCS Snotel sites (Appendix D) in or near the park boundaries provide a robust precipitation measurement in both summer and winter for comparison with ARCN stations. Table 3 summarizes summer rainfall measurements at ARCN and Snotel stations.

**Table 3.** Monthly rainfall (inches) from ARCN and Snotel stations in 2013<sup>1</sup>.

| Station Name | Station Type | June | July | August | Summer |
|--------------|--------------|------|------|--------|--------|
| Asik         | ARNC         | 2.06 | 3.06 | 1.86   | 6.98   |
| Chimney Lake | ARNC         | 1.36 | 1.62 | 1.71   | 4.69   |
| Devil Mtn.   | ARNC         | M    | M    | 1.85   | M      |
| Ella Creek   | ARNC         | M    | M    | 3.55   | M      |

**Table 3 (continued).** Monthly rainfall (inches) in 2013.

|                       |        |      |      |      |      |
|-----------------------|--------|------|------|------|------|
| <b>Howard Pass</b>    | ARCN   | 0.02 | 1.39 | 0.71 | 2.12 |
| <b>Imelyak</b>        | ARCN   | 1.32 | 3.11 | 3.69 | 8.12 |
| <b>Kaluich</b>        | ARCN   | 1.02 | 1.77 | 2.18 | 4.97 |
| <b>Killik Pass</b>    | ARCN   | 1.72 | 1.02 | 0.95 | 3.69 |
| <b>Mt. Noak</b>       | ARCN   | 0.42 | 2.71 | M    | M    |
| <b>Pamichtuk Lake</b> | ARCN   | 1.21 | 0.74 | 0.97 | 2.92 |
| <b>Ram Creek</b>      | ARCN   | 2.09 | 0.72 | 0.95 | 3.76 |
| <b>Salmon River</b>   | ARCN   | M    | M    | M    | M    |
| <b>Serpentine</b>     | ARCN   | 0.40 | 0.88 | 3.36 | 4.64 |
| <b>Sisiak</b>         | ARCN   | M    | 1.38 | 3.45 | M    |
| <b>Tahinichok</b>     | ARCN   | M    | 2.21 | 3.16 | M    |
| <b>Atigun Pass</b>    | Snotel | 2.00 | 1.90 | 3.90 | 7.80 |
| <b>Coldfoot</b>       | Snotel | 0.70 | 2.70 | 1.40 | 4.80 |
| <b>Kelly Station</b>  | Snotel | 1.70 | 2.30 | 3.30 | 7.30 |
| <b>Pargon Creek</b>   | Snotel | 1.50 | 2.40 | 0.50 | 4.40 |

<sup>1</sup> Please note that the monthly values for individual sites may differ from those in the seasonal weather summaries –real-time transmitted data are used to generate the summaries, which may have some data gaps; <sup>2</sup> M=Missing due to wildlife damage;

Summer (June-August) rainfall measurements were highly variable in 2013 and ranged from 2.12 inches at Howard Pass to 8.12 inches at Imelyak (Table 3; Figure 3). The highest monthly total was 3.90 inches recorded at the Atigun Pass Snotel station in August. Ella Creek, Imelyak, Serpentine, Sisiak, Tahinichok, and Kelly Station also recorded monthly totals over 3.0 inches in August. Localized (convective) summer rain showers are common in mountainous regions and likely explain the high degree of spatial and temporal variability. A longer period of record is necessary to determine local and regional precipitation patterns in ARCN, and the potential limitations of unshielded gages in very exposed and windy locations.

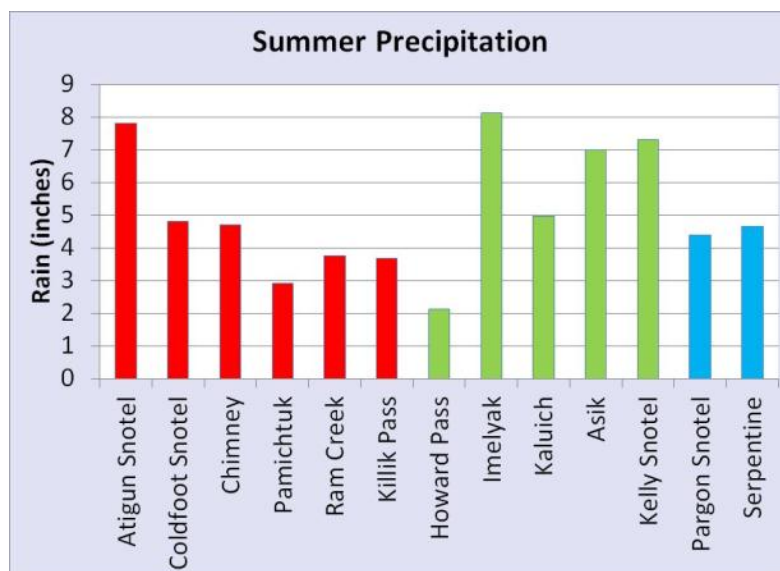


**Figure 3.** ARCN station summer rainfall 2013. Red sites are GAAR, green WEAR, and blue BELA.

## ***Snow and Precipitation (2012-2013 Season)***

### ***Snotel Sites***

Year round precipitation is recorded at the snow telemetry (Snotel) sites at Coldfoot, Atigun Pass, Kelly Station, and Pargon Creek (Figure 1). Kelly Station is the only site located within park boundaries. The Coldfoot station is located on the Dalton highway south of the Brooks Range at 1040 feet and Atigun Pass is located at the Dalton highway on a pass at 4800 feet. Kelly Station is located on the Noatak River approximately 75 miles upriver from Kotzebue. Pargon Creek is located on the Seward Peninsula, southeast of Bering Land Bridge National Preserve. The Snotel sites provide an accurate representation of winter snow water equivalent at remote sites as well as summer rainfall. The data from these sites are based on the ‘water year’ running from October 1 through September 30.

**Table 4.** Precipitation and snow summary statistics for Snotel stations in 2013.

| Site                 | Winter Precip.<br>(% of normal) | Annual Precip.<br>(% of normal) | Peak Snow Depth<br>Inches (Date) | Peak SWE<br>Inches (Date) | Snow On  | Snow Off |
|----------------------|---------------------------------|---------------------------------|----------------------------------|---------------------------|----------|----------|
| <b>Coldfoot</b>      | 4.3 (51%)                       | 12.6 (69%)                      | 21 (Apr. 11)                     | 4.0 (May 9)               | 12/13/12 | 5/23/13  |
| <b>Atigun Pass</b>   | 6.5 (77%)                       | 17.1 (74%)                      | 45 (May 19)                      | --                        | 9/6/12   | 6/16/13  |
| <b>Kelly Station</b> | 5.3 ( )                         | 15.5 ( )                        | 18 (May 20)                      | 4.0 (May 21)              | 10/29/12 | 5/27/13  |
| <b>Pargon Creek</b>  | 5.1 (70%)                       | 9.8 (72%)                       | 10 (Mar. 14)                     | --                        | 11/27/12 | 5/21/13  |

Note: Standard procedure for NRCS sites is to summarize by water year (Oct. – Sep.). The winter season is defined as October 1 – May 1. SWE is not measured at Atigun Pass or Pargon Creek. “Normals” are not calculated at Kelly Station due to the short duration of the record.

For water year 2013, the Coldfoot Snotel site recorded 4.3 inches of total winter precipitation from October 1, 2012 through May 1, 2013, which is 51% of the 1981-2010 normal. The total annual precipitation for the site was 12.6 inches; the winter snow accounted for 34% of the total annual precipitation. The period of continuous snow was from December 13 to May 23. Peak snow depth was 21 inches on April 11 with a SWE of 3.8 inches of water. Peak SWE occurred almost a month later with 4.0 inches on May 9 (Table 4).

The precipitation gage at Atigun Pass recorded 6.5 inches of precipitation from October 1, 2012 through May 1, 2013. This is 38% of the total annual precipitation (17.1 inches) for the 2013 water year. The annual precipitation was 74% of normal (Figure 4). The period of continuous snow at Atigun Pass was from September 6 to June 16.

Kelly Station received 5.3 inches of winter precipitation in the 2013 water year, about 34% of the annual total. Annual precipitation was 9.8 inches. Snow depth reached its maximum of 18 inches on May 20 with a water content of 4.0 inches. Snow cover persisted at Kelly from October 29 to May 27.

Pargon Creek was the driest of the four Snotel sites analyzed for the 2013 water year with 5.1 inches of winter precipitation and 9.8 inches of annual precipitation. The peak snow depth of 10 inches on March 14 was much shallower and earlier than normal. Melt-out also occurred earliest at Pargon Creek, on May 21.

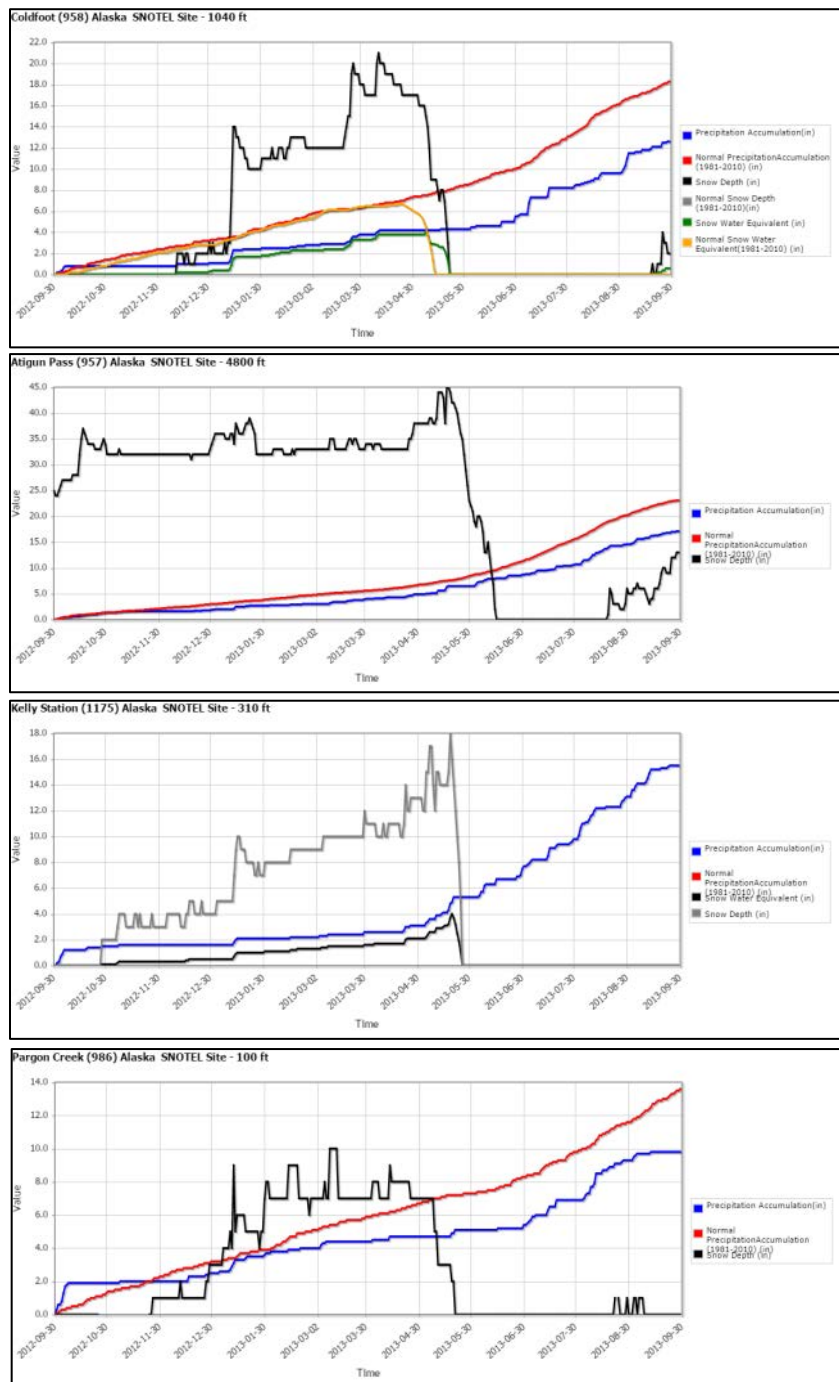


**Figure 4.** Cumulative precipitation, snow depth, and SWE for Water Year 2013 (Oct. 1 – Sep.30) at Snotel stations Coldfoot, Atigun Pass, Kelly Station, and Pargon Creek. SWE is not measured at Atigun Pass or Pargon Creek. “Normals” are not calculated at Kelly Station due to the short duration of the record. Graphs generated from NRCS (NRCS 2014b).

### **Remote Sensing of Snow Cover**

Swanson (2014) analyzed seasonal snow cover in ARCN using MODIS satellite data for the 2000-2013 time period. The spring of 2013 was unusually late over much of Alaska. However, the end of the continuous snow season (CSS) in ARCN was not uniformly late: the end of CSS was late in the northern Brooks Range foothills in GAAR, in CAKR, and in parts of western NOAT. Melt-out in north-central NOAT and BELA was near-normal or earlier than normal (Figure 5).

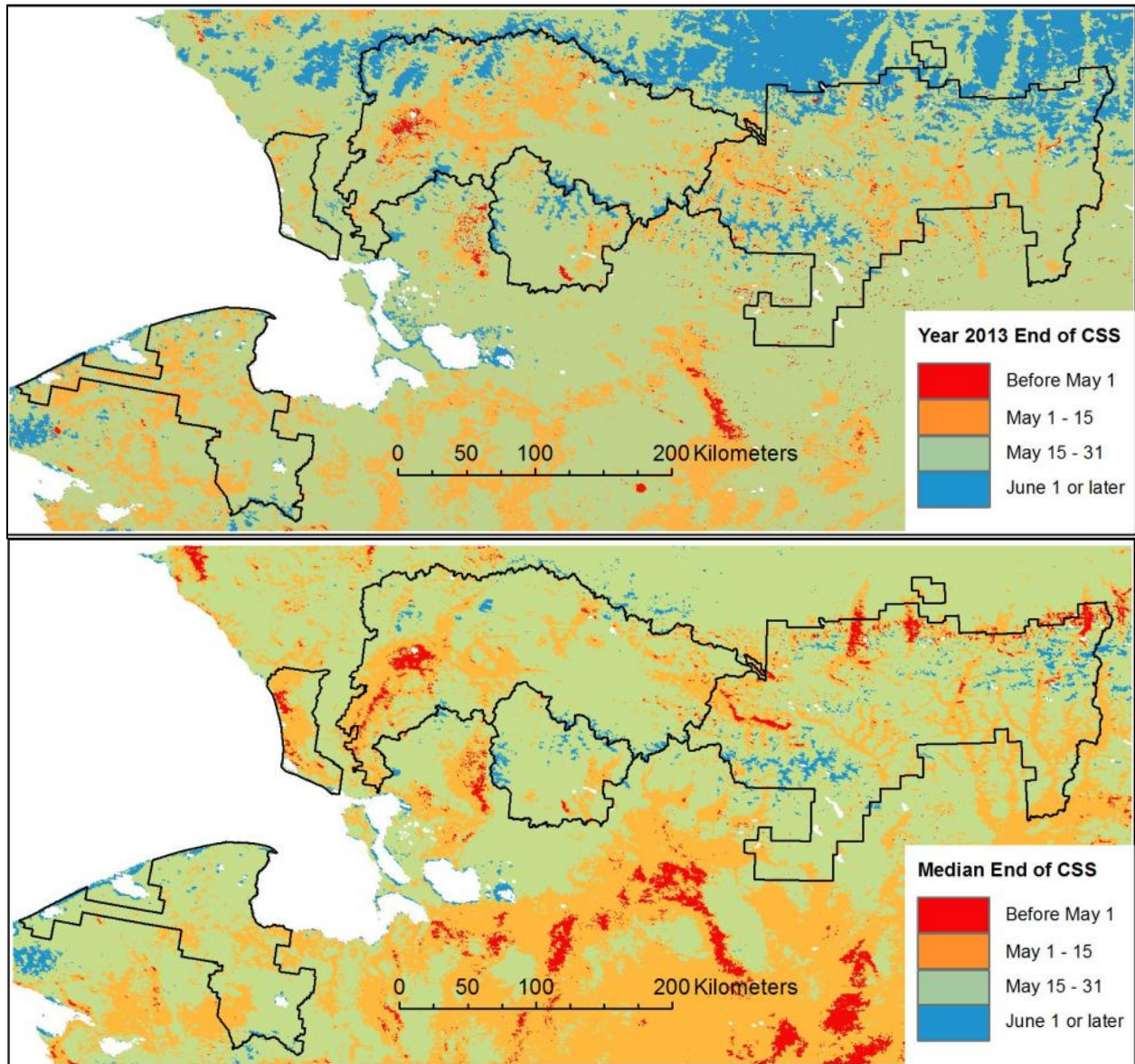


**Figure 5.** Maps of ARCN showing the dates of the end of the continuous snow season (CSS) in 2013 (top) and the median date for the 2000-2013 time period (bottom). Figures from Swanson (2014).

## Index Sites (Bettles, Kotzebue, Nome)

### Temperature

Overall, Bettles and Nome had mean annual air temperatures near the long-term normal. The mean annual air temperature of 24.2°F in Kotzebue was the 12<sup>th</sup> warmest on record. Temperatures were variable across index sites from month to month, but the positive temperature departure in January, a cold April in Bettles, and a warmer than normal October stand out (Table 5; Figure 6; Figure 7). The calendar year started out with warm temperatures; January was warmer than normal at each index site in the network, with monthly January temperatures on average 8.6 degrees warmer than normal. February was colder than normal in Kotzebue and Nome, but near the long-term average in Bettles.

**Table 5.** Monthly mean temperature and departures from 1981-2010 normal (parentheses) for index sites in ARCN in 2013 (°F).

| Station Name | Station ID | Jan     | Feb    | Mar    | Apr     | May    | Jun    | Jul    | Aug    | Sep    | Oct     | Nov    | Dec    | Year   |
|--------------|------------|---------|--------|--------|---------|--------|--------|--------|--------|--------|---------|--------|--------|--------|
| Bettles      | 500761     | -3.9    | -5.9   | 1.2    | 11.6    | 36.3   | 61.1   | 59.0   | 52.6   | 39.0   | 31.2    | -1.9   | -10.2  | 22.5   |
|              |            | (+6.1)  | (-0.9) | (-3.2) | (-11.7) | (-8.1) | (+2.6) | (-0.7) | (+0.1) | (-1.6) | (+12.3) | (-0.9) | (-4.5) | (-0.9) |
| Kotzebue     | 505076     | 8.7     | -8.2   | 1.6    | 9.4     | 26.4   | 50.8   | 56.5   | 54.0   | 39.4   | 34.5    | 11.9   | 5.9    | 24.2   |
|              |            | (+11.5) | (-7.4) | (+0.5) | (-3.9)  | (-5.5) | (+5.1) | (+1.9) | (+2.3) | (-2.9) | (+10.2) | (+2.8) | (+3.6) | (+1.5) |
| Nome         | 506496     | 13.5    | -0.2   | 8.5    | 16.3    | 31.1   | 49.1   | 51.6   | 53.0   | 39.9   | 35.6    | 18.8   | 14.3   | 27.6   |
|              |            | (+8.3)  | (-7.6) | (-1.8) | (-4.2)  | (-5.7) | (+1.3) | (-0.6) | (+2.9) | (-2.9) | (+6.9)  | (+1.9) | (+4.8) | (+0.3) |

The pattern shifted in March and air temperatures around the region cooled and remained that way through mid-May. Spring 2013 was unusually cold across the state and especially in the interior regions of the ARCN parks. Bettles temperatures were below normal each day from the beginning of April through mid-May. It was the third coldest April on record and the fifth coldest spring season (March-May) in Bettles. Daily mean temperatures were more than four standard deviations cooler than normal for a period in mid-May before a rapid warm-up the last week of May.

The average summer season (June-August) temperature was warmer than normal at Bettles (+2.6°F), Kotzebue (+3.1°F), and Nome (+1.2°F). Mid-June was particularly warm with all-time record high temperature records being tied in Nome (86°F) and Kotzebue (85°F) on June 19. Monthly temperatures for June were 2.3°F warmer than normal on average for the three sites. It was the fourth warmest June on record Kotzebue. July was warmer than normal at Kotzebue and near normal at Bettles and Nome. All of the index sites were warmer than normal in August with the largest deviation in Kotzebue where the monthly average temperature was almost 3°F warmer than normal.

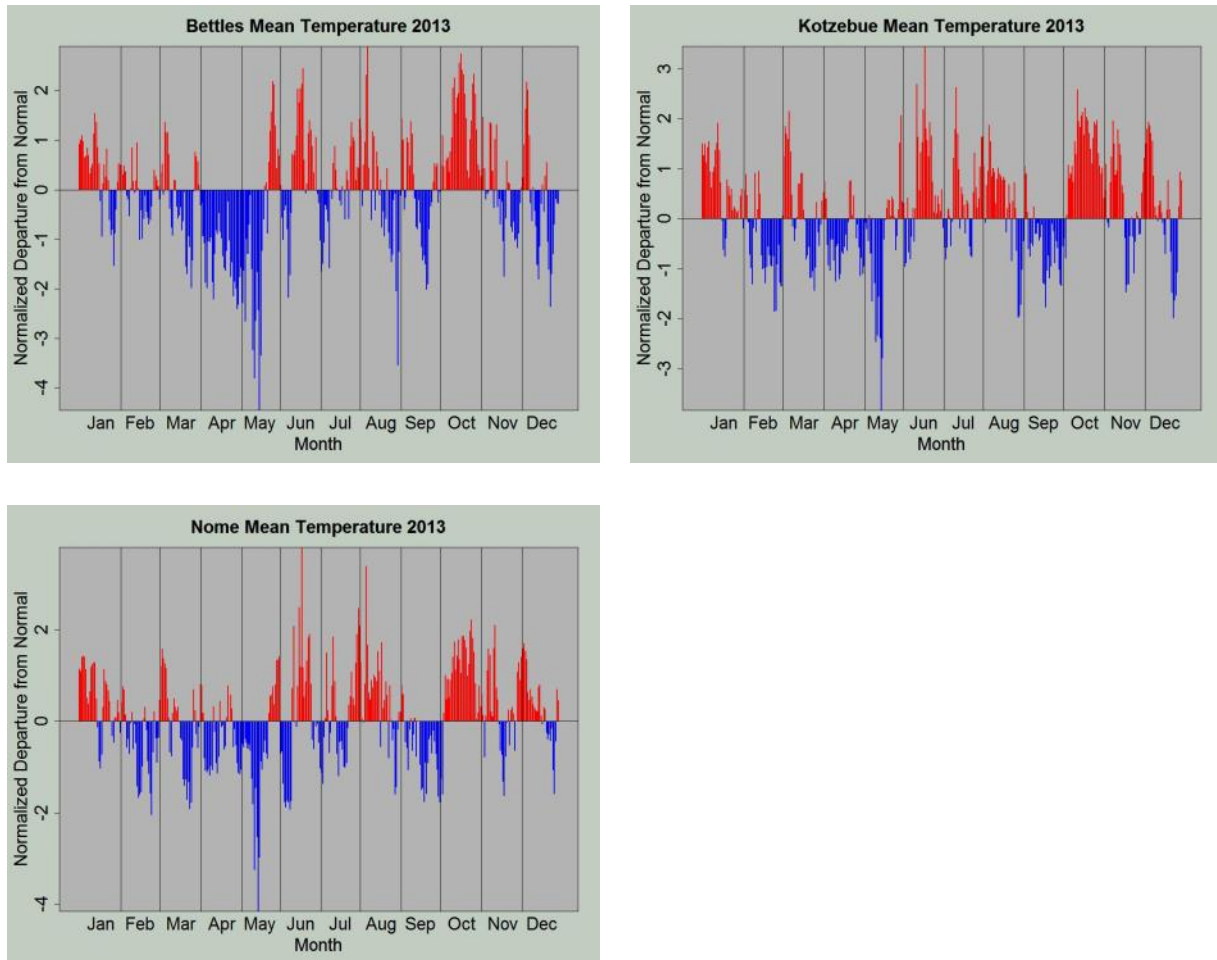


**Figure 6.** Standardized temperature anomaly time series plots for Bettles, Kotzebue, and Nome. Daily departures from normal were calculated by  $Departure\ from\ Normal = \frac{T_{obs} - T_{mean}}{SD}$  where  $T_{obs}$  = observed daily mean temperature,  $T_{mean}$  = mean daily temperature for 1981-2010 normal period, and  $SD$  = standard deviation of observations.

September was cooler than normal for most of the month at all index sites. The average monthly temperature was 39.0°F in Bettles, 39.4°F in Kotzebue, and 39.9°F in Nome. October was very warm, almost +10°F warmer than normal for the three sites on average. It was the warmest October on record for Bettles and Kotzebue, and the fourth warmest on record at Nome. Temperatures were cooler than normal at Bettles in November and December. In contrast, monthly average temperatures for Kotzebue and Nome were warmer than normal for the last two months of 2013.

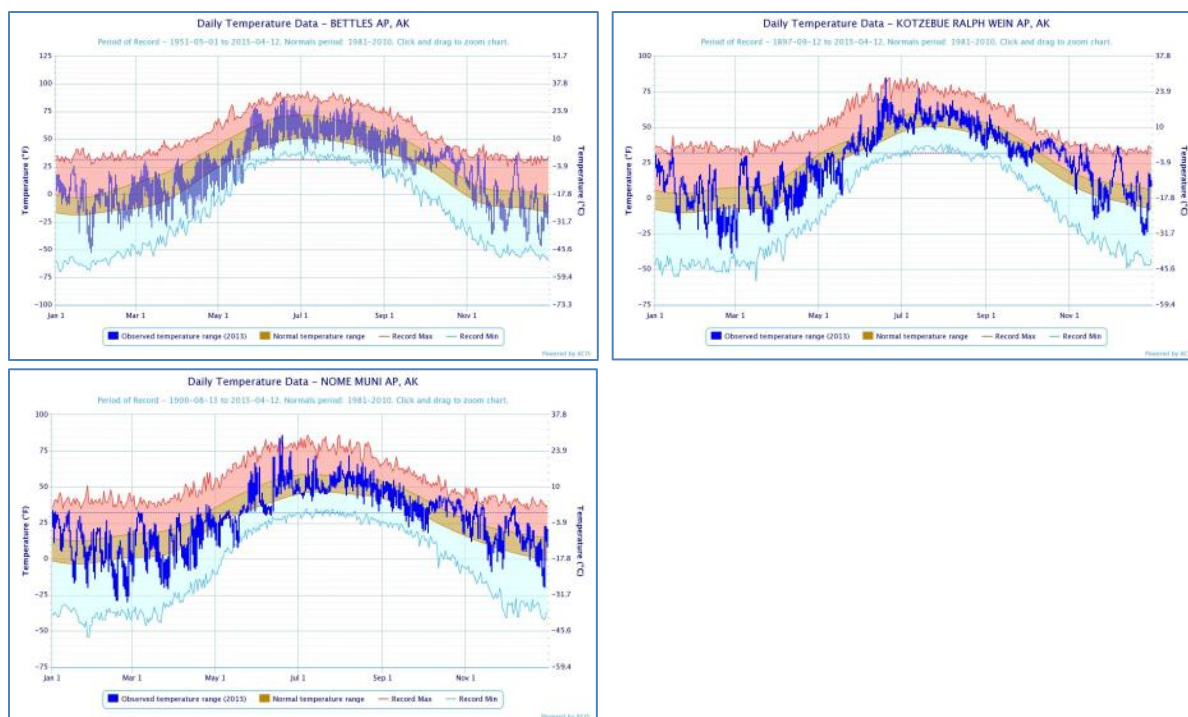


**Figure 7.** Daily temperature time series plots for 2013 for Bettles, Kotzebue, and Nome. The normal temperature range is shown in brown, record high temperatures outlined in red, and record minimums in light blue. 2013 observed temperatures are shown in dark blue. Figures were generated from the NOAA xmACIS system at xmacis.rcc-acis.org.

### Precipitation

Annual precipitation totals at the ARCN index sites varied from 103% of normal in Bettles to 133% of normal at Nome (Table 6). It was the 9<sup>th</sup> wettest year on record in Nome. January was a particularly wet month at all index sites (Figure 8). Total precipitation at Bettles was 1.86 inches, compared to a normal monthly total of 0.81 inches. Kotzebue and Nome each received more than an inch of precipitation during January and were 181% and 123% of normal respectively. Only about 1/3 of an inch of precipitation fell in February in Bettles and Nome, but Kotzebue had nearly an inch of precipitation and was 142% of normal for the month.

**Table 6.** Monthly and annual precipitation (inches) and departures from normal (%) for 2013 at Bettles, Kotzebue, and Nome.

| Station Name | Jan            | Feb            | Mar            | Apr           | May            | Jun            | Jul            | Aug            | Sep            | Oct            | Nov            | Dec            | Year            |
|--------------|----------------|----------------|----------------|---------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|-----------------|
| Bettles      | 1.86<br>(230%) | 0.35<br>(41%)  | 0.68<br>(117%) | 0.38<br>(63%) | 0.06<br>(7%)   | 0.77<br>(55%)  | 1.77<br>(75%)  | 1.23<br>(47%)  | 1.84<br>(96%)  | 3.03<br>(291%) | 2.83<br>(311%) | 0.55<br>(60%)  | 15.35<br>(103%) |
| Kotzebue     | 1.12<br>(181%) | 0.94<br>(142%) | 0.37<br>(84%)  | 0.31<br>(57%) | 0.86<br>(210%) | 0.91<br>(157%) | 1.28<br>(88%)  | 0.67<br>(31%)  | 2.02<br>(128%) | 1.61<br>(159%) | 1.22<br>(158%) | 0.75<br>(99%)  | 12.06<br>(110%) |
| Nome         | 1.16<br>(123%) | 0.36<br>(39%)  | 0.64<br>(98%)  | 0.30<br>(39%) | 1.79<br>(208%) | 2.53<br>(258%) | 2.12<br>(100%) | 4.21<br>(131%) | 1.98<br>(81%)  | 3.55<br>(220%) | 1.68<br>(138%) | 2.01<br>(186%) | 22.33<br>(133%) |

Precipitation was variable across index sites in the spring season (March-May). Seasonal precipitation was below normal at Bettles (54%) and above normal at Kotzebue (111%) and Nome (120%). Bettles received precipitation in late March and mid-April, but almost no rain or snow fell in May (Figure 9). Kotzebue was near-normal for precipitation in March and April, but steady accumulation May 4-21 brought the monthly total to 0.86 inches, the 7<sup>th</sup> wettest May on record. Nome had a dry April with only 0.30 inches of precipitation, and a wet May with 1.79 inches.

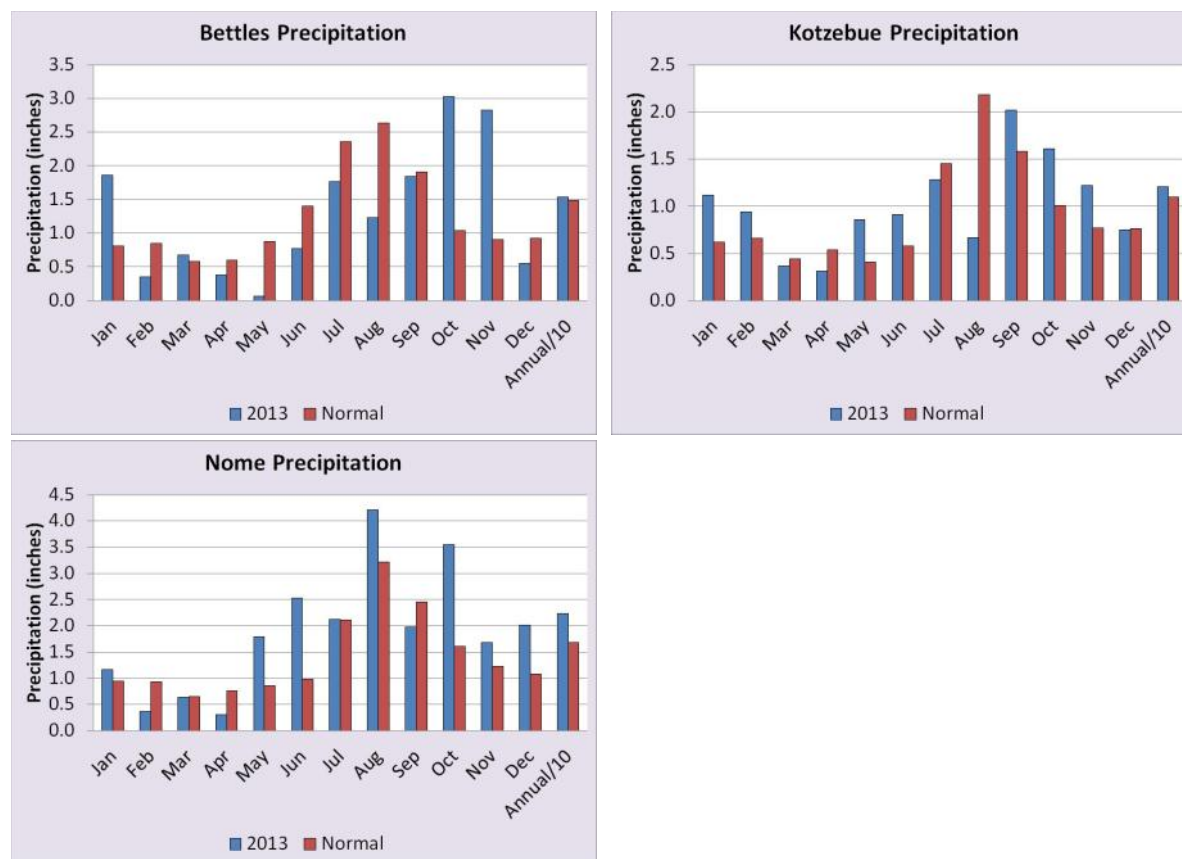


**Figure 8.** Monthly precipitation for 2013 compared to normal at Bettles, Kotzebue, and Nome. For scale, annual precipitation is plotted in tenths of inches.

There were also substantial differences in precipitation between index sites in the summer season. Total seasonal precipitation was below normal in Bettles (59%) and Kotzebue (68%), and above normal in Nome (140%). A total of 0.77 inches of precipitation fell in Bettles in June, only 55% of normal. July and August were also below normal expected values and the summer ended up with a total of 3.77 inches, the 11<sup>th</sup> driest on record. Kotzebue had a wet June with nearly an inch of precipitation. July was near-normal and August was dry with only 0.67 inches of precipitation for the month. Nome received over two inches of precipitation in June, only eight other Junes since 1907 have been wetter. July precipitation was near normal. August was wetter than normal with 4.21 inches.

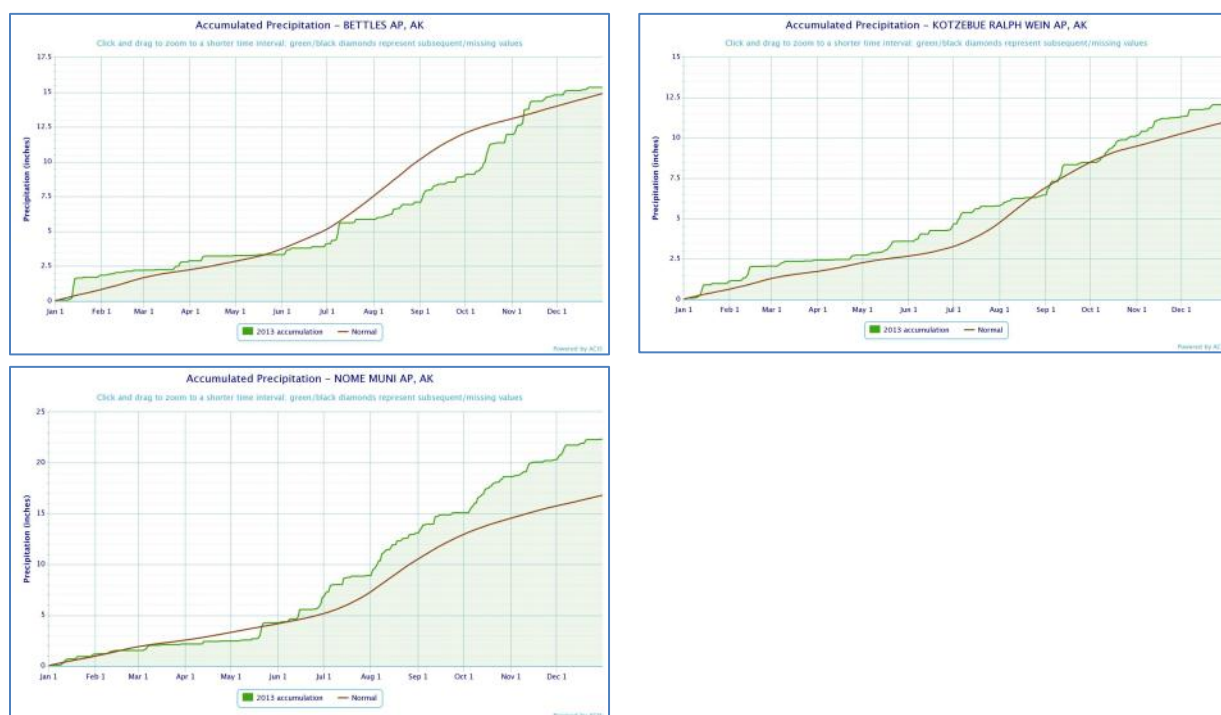


**Figure 9.** Cumulative precipitation time series plots for 2013 at Bettles, Kotzebue, and Nome. Normal precipitation shown as the brown line and 2013 precipitation is shown in green. Figures were generated from the NOAA xmACIS system at [xmaccis.rcc-acis.org](http://xmaccis.rcc-acis.org)

## Snow

For the 2012-2013 snow season (standard time period is August-July for NWS stations) total annual snowfall ranged from 36 inches in Kotzebue to 65.5 inches in Nome (Table 7). There was very little snowfall before mid-January at any of the index sites (Figure 10), which is much later than normal. The snowiest month in Bettles was January with 23.7 inches, 171% of normal. Due to cold temperatures, precipitation continued to fall as snow in Bettles through April and most of May. Total snowfall in Bettles was 54.7 inches, compared to a normal total of 98.9 inches.

**Table 7.** Monthly and annual snowfall (inches) and departures from normal (%) at Bettles, Kotzebue, and Nome. The National Weather Service summarizes annual snowfall for the August-July standard time period.

| Station Name | Aug   | Sep    | Oct     | Nov     | Dec     | Jan    | Feb    | Mar    | Apr     | May    | Jun    | Jul   | Year    |
|--------------|-------|--------|---------|---------|---------|--------|--------|--------|---------|--------|--------|-------|---------|
| Bettles      | 0.0   | 0.9    | 2.2     | 0.0     | 4.7     | 23.7   | 7.3    | 10.0   | 5.8     | 1.0    | 0.0    | 0.0   | 54.7    |
|              | (0.0) | (-1.6) | (-10.2) | (-16.1) | (-10.9) | (+9.8) | (-6.7) | (+0.7) | (-10.5) | (-0.3) | (0.0)  | (0.0) | (-44.2) |
| Kotzebue     | 0     | 0      | 0.7     | 0.9     | 2.5     | 9.4    | 9.4    | 3.7    | 3.1     | 6.3    | 0      | 0     | 36      |
|              | (0.0) | (-0.8) | (-5.4)  | (-9.6)  | (-9.0)  | (+0.3) | (-0.2) | (-2.2) | (-2.0)  | (+5.1) | (0.0)  | (0.0) | (-23.0) |
| Nome         | 0     | 0.3    | 2.1     | 0.2     | 14.7    | 16.5   | 7.5    | 9.1    | 4.5     | 10.8   | 0.1    | 0     | 65.5    |
|              | (0.0) | (-0.3) | (-2.5)  | (-11.9) | (+0.2)  | (+3.8) | (-4.7) | (+0.2) | (-3.0)  | (+8.5) | (-0.2) | (0.0) | (-9.6)  |

In Kotzebue, the 2012-2013 snowfall was 36 inches, which is 75% of normal. Only 4.1 total inches of snow fell between October and December. January and February were tied for the snowiest month of the year with 9.4 inches, which is near normal. March and April had 3.7 and 3.1 inches respectively, about 60% of normal for each month. Due to persistent cold temperatures in May an additional 6.3 inches of snow fell during the month compared to a normal total of only 1.2 inches.

Total snowfall in Nome was 65.5 inches for the season, 87% of normal. Unlike the other index sites, snowfall in December was near normal with 14.7 inches. January was the snowiest month in Nome with 16.5 inches which is 130% of normal. Only about half of the expected snowfall of 12.2 inches fell in February. March was near normal with 9.1 inches. Due to the cold temperatures through most of May, 10.8 inches of snow fell during the month which is more than October, November, and February combined.

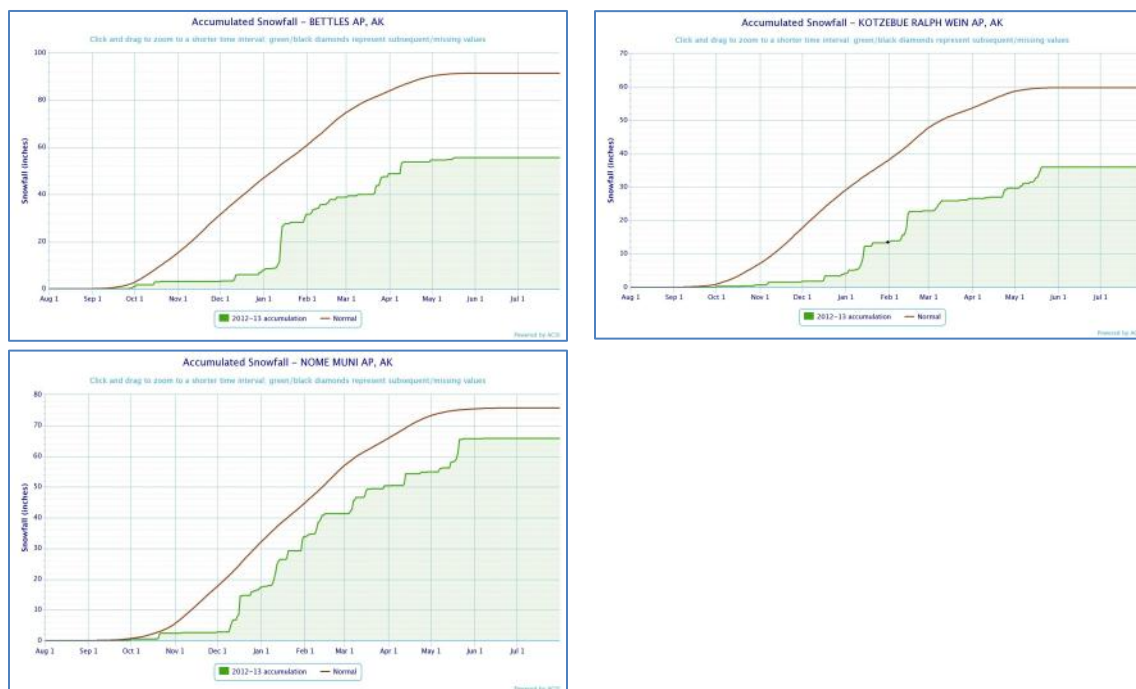


**Figure 10.** Cumulative snowfall at Bettles, Kotzebue, and Nome for August 2012 – July 2013. Normal snowfall is shown as the brown line and 2013 precipitation is shown in green. Figures were generated from the NOAA xMACIS system at [xmacis.rcc-acis.org](http://xmacis.rcc-acis.org).

## Alaska Statewide Temperature

According to National Climatic Data Center's (NCDC) State of the Climate Report for 2013, the average annual temperature for Alaska was 1.8°F above the 1971-2000 average and marked the 10<sup>th</sup> warmest year in the 95-year period of record for the state (Figure 11). The average annual temperature deviations for the first order stations in Alaska are shown in Figure 12. Based on the mean monthly temperature departures from normal, the warmest months of 2013, in decreasing order, were October (+7.4°F), January (+5.6°F), and June (+3.3°F), while April was the coldest

month with a mean monthly temperature deviation of -6.9°F. Warm temperatures and rainfall were recorded at many stations in mid-January. Green-up in Fairbanks was recorded on May 26, the latest on record. It was the warmest October on record for the state of Alaska.

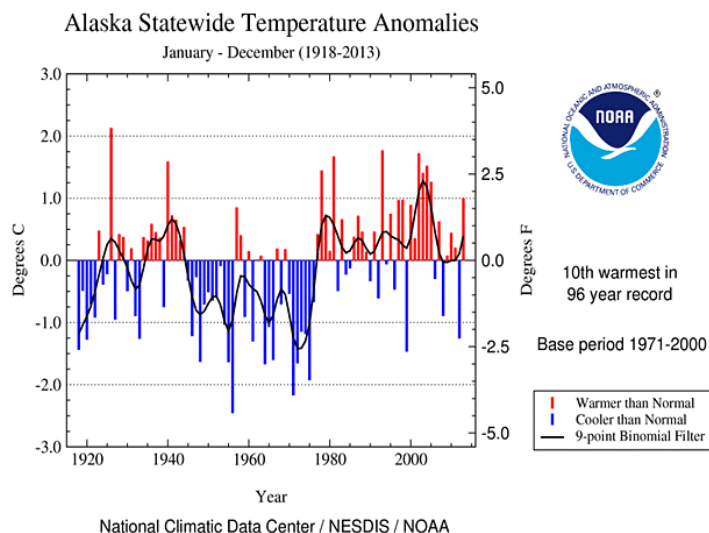


**Figure 11.** Average temperatures in Alaska for 1918-2013. Temperatures across Alaska in 2013 were 1.8° F above the 1971-2000 mean. Graph courtesy of NOAA (NOAA 2014a).

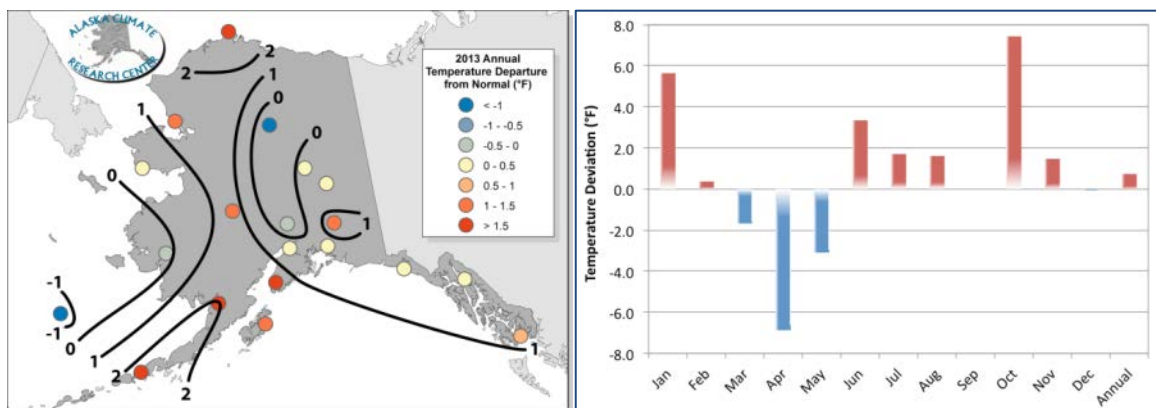


**Figure 12.** Statewide temperature departures for 2013 (left) and mean monthly temperature deviations for the 20 first order stations in Alaska by month (right). Graphs courtesy of the Alaska Climate Research Center (ACRC 2014).

### **Precipitation and Snow**

Precipitation statewide was 25.1% above average and ranked as the third wettest year on record, 1929 and 1963 were wetter (Figure 13). Note that the NCDC uses 1971-2000 as the normal base period for Alaska statistics. Spring precipitation statewide was 117% of normal; summer precipitation was near average, and the fall season precipitation totals statewide were 143% of average (Figure 14). The snowpack continued to grow late into the spring especially in the eastern

interior and southern areas of the state, while the northwest region had below normal snowpack (Figure 15). The cold spring led to later than normal breakup on many interior rivers. The rapid warm-up in late May resulted in ice jams, flooding, and substantial damage in the Yukon River communities of Eagle, Circle, and Galena. September and October were particularly wet in much of the state and ranked as the 5<sup>th</sup> and 3<sup>rd</sup> wettest on record respectively. December precipitation was 151% of normal for the state (NOAA 2014). Appendix E highlights Alaska weather extremes.

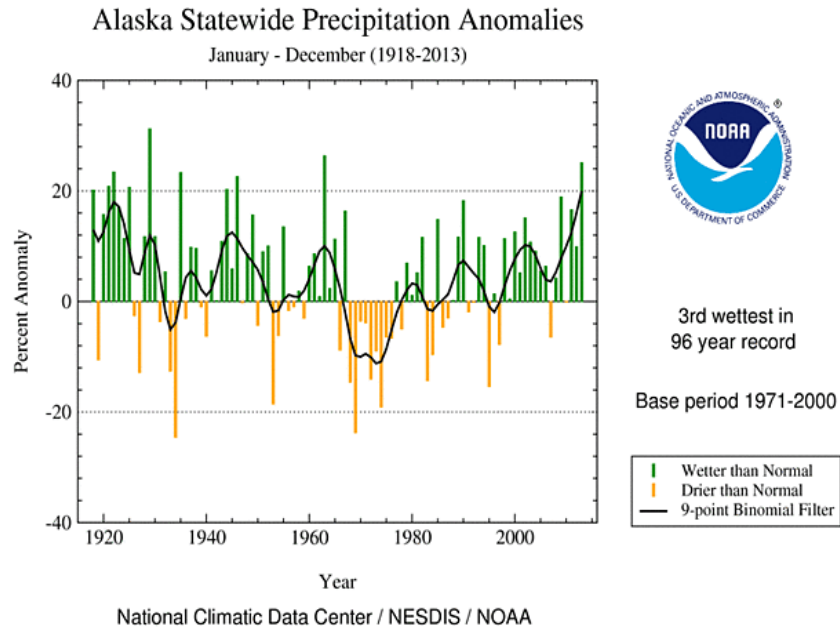


**Figure 13.** Statewide annual precipitation anomalies 1918-2013. Graph courtesy of NOAA (NOAA 2014a).

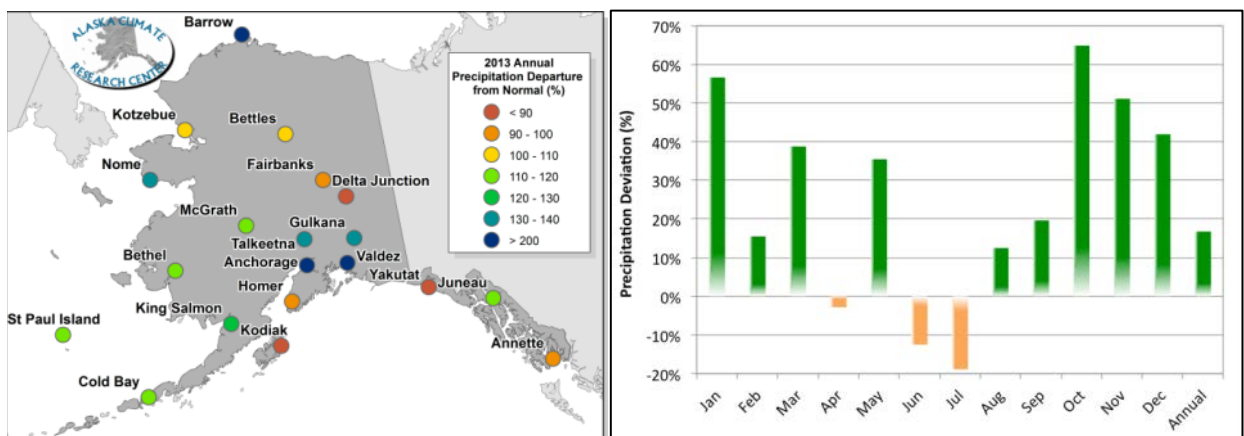


**Figure 14.** Statewide precipitation departures from normal (left) and monthly deviations (right) for first order climate stations in Alaska. Graphs courtesy of the Alaska Climate Research Center (ACRC 2014).

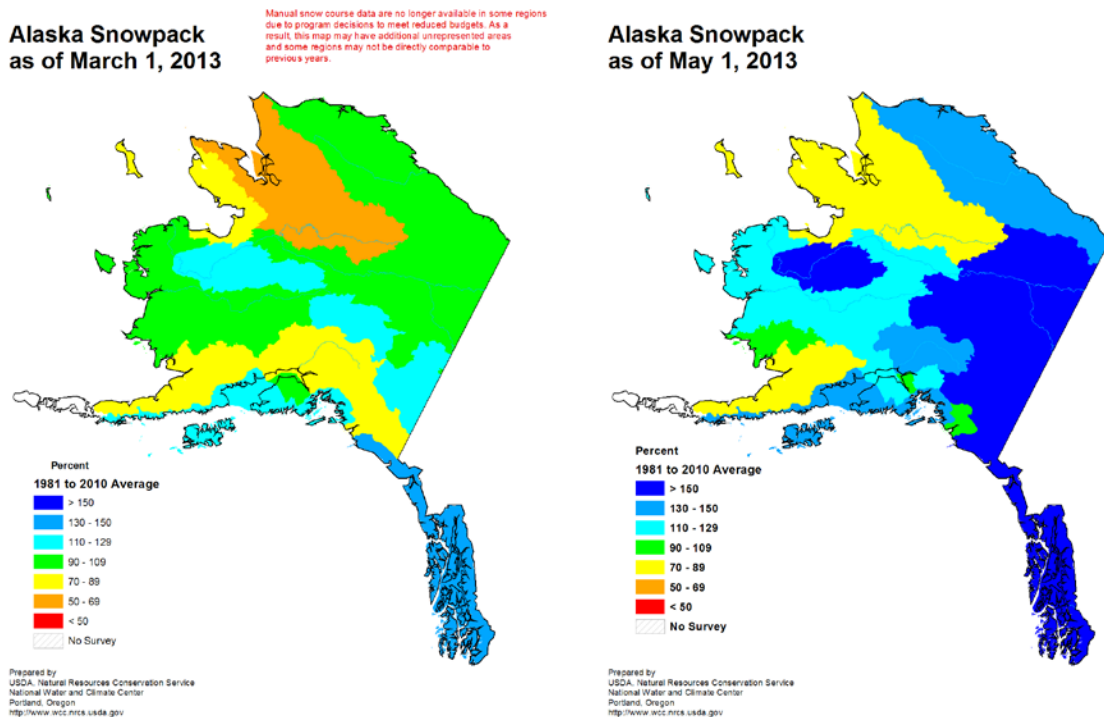


**Figure 15.** March 1 and May 1 snowpack percent of average for Alaska 2013 (NRCS 2014a).

## Fire

According to the Alaska Interagency Coordination Center (AICC), the hot dry conditions of 2013 were similar to the summer of 2004 when 6.4 million acres burned across the state, but the lack of lightning in the interior in 2013 kept natural fire starts to a minimum. Statewide there were a total of 613 wild land fires in 2013, with a total of 1,316,289 acres burned. Out of 613 reported fires, 211 were caused by lightning. The total area burned in the ARCN parks was 546 acres – all in Noatak National Preserve (AICC, 2014).

## National and Global Synopsis

Based on data from January through December, the average annual temperature for the contiguous U.S. for 2013 was 52.4°F, 0.3°F above the 20th century average. It was the 37th warmest year over the 199 year record (tied with 1980) (NOAA, 2014c). 2013 was 2.9°F cooler than 2012, the warmest year on record for the lower 48 states. The temperature trend for the lower 48 states is + 0.13 °F per decade since records began in 1895. The average precipitation total for the lower 48 states in 2013 was 31.17 inches, 2.03 inches above average, making it the 21st wettest year on record. The precipitation trend for the contiguous U.S. has increased by about 0.17 inches per decade over the past 119 years. Appendix F shows weather highlights for the U.S. in 2013.

Globally, the year 2013 ties with 2003 as the fourth warmest year globally since records began in 1880. Over land and ocean combined, 2013 was 1.1°F above the 20th century average of 57.0°F. Including data from 2013, the Earth is warming at a rate of 0.11°F per decade since 1880. Currently

the warmest year on record is 2010; 9 out of 10 of the warmest years on record have occurred since the start of the 21st century. Precipitation, globally, was near average, but varied from region to region (NOAA, 2014c). See Appendix G for more information on national and global climate anomalies.

### Climate Teleconnections

The El Nino Southern Oscillation index was in a neutral state during all of 2013. The Pacific Decadal Oscillation, an index of sea surface temperatures in the north Pacific was negative for all of 2013 indicating colder than normal sea surface temperatures off of Alaska's coast (NOAA, 2013b) (Figure 16) . The Arctic Sea Ice extent in September 2013 was greater than it has been in the last few years, but still below the 1981-2010 average (NSIDC 2014) (Figure 17).

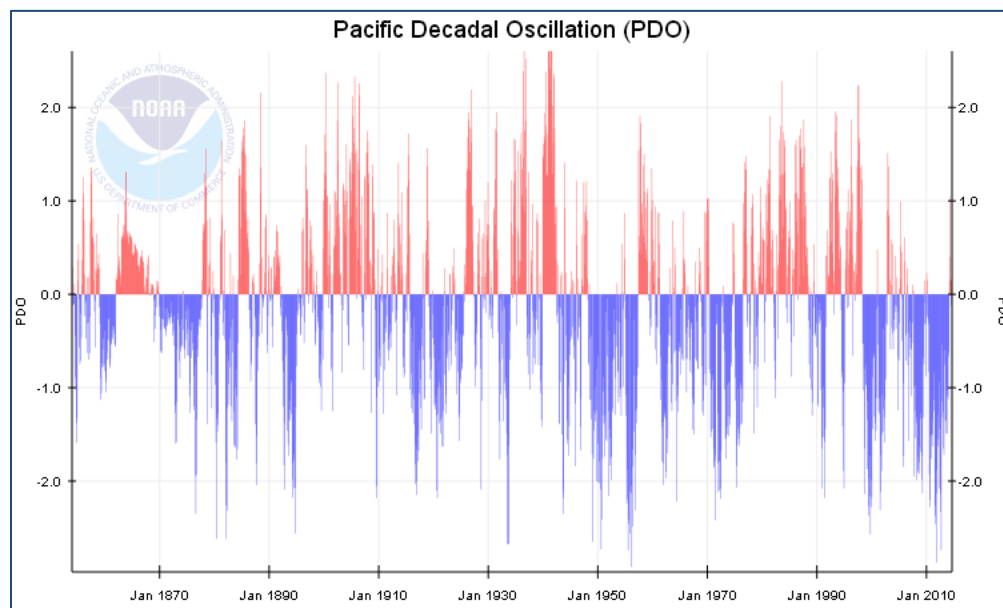


**Figure 16.** Pacific Decadal Oscillation index based on NOAA's extended reconstruction of SSTs (ERSST Version 3). Graph retrieved from <http://www.ncdc.noaa.gov/teleconnections/pdo.php> (NOAA, 2013b).

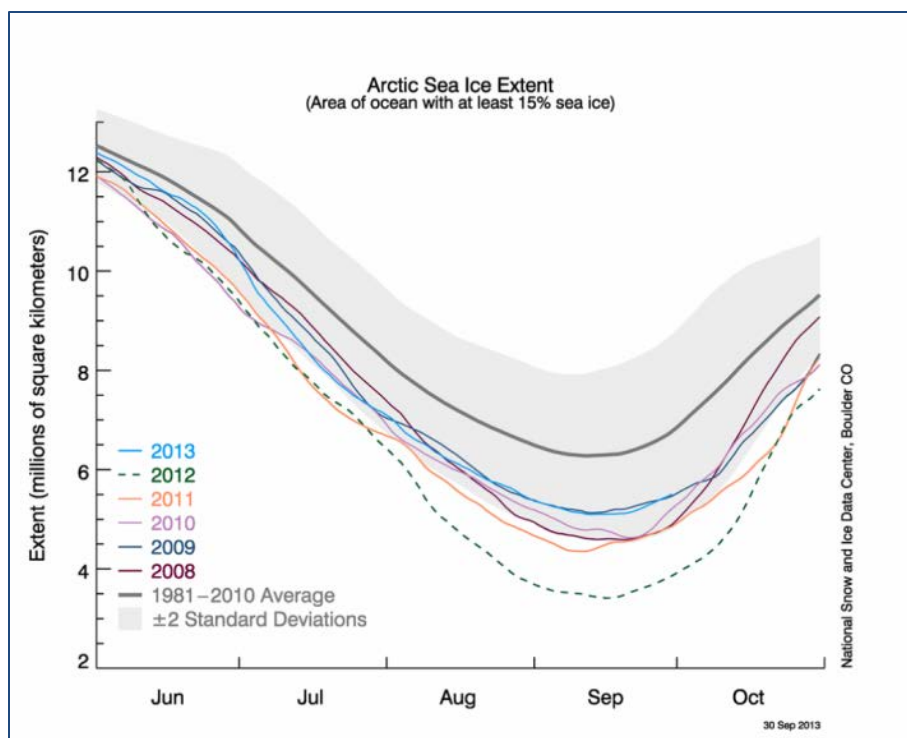


**Figure 17.** Arctic Sea Ice extent 1979-2013. 2012 was the lowest seasonal minimum extent on record (NSIDC 2014).

## Discussion

### Status of Climate Monitoring in Network Parks

In an attempt to better understand climate variation as well as long-term changes in park ecosystems, sixteen climate stations have been installed in the five ARCN parks since 2011. These ARCN climate are providing new information for areas that previously had little to no climate observations. These measurements are filling in some of the large spatial gaps in the network and provide information on climate patterns related to elevation and topography. The objective of the climate monitoring program is to monitor and record weather conditions at representative locations throughout ARCN in order to identify long and short-term trends, provide reliable climate data to other researchers, and to participate in large scale climate monitoring and modeling efforts beyond park boundaries. A critical element of the program is annual station maintenance. During the 2013 field season, one new I&M climate station was installed at Ella Creek, two stations were re-established (Midnight Mountain and Salmon River), and thirteen existing I&M stations were maintained (Figure 1). A summary of all maintenance work is described in detail in a separate report (Hill and Sousanes 2014).

### *Data management, quality control, and reporting*

The data from NWS index sites are available from the [National Climate Data Center](#). An interagency agreement is in place for the maintenance, data archiving, and data dissemination for the Snotel sites in the network. The data from the stations are transmitted hourly and available on-line at [National Water and Climate Center](#). The ARCN climate stations transmit via satellite and transmitted data are

available on the web from [MesoWest](#) and the [Western Regional Climate Center](#). Products that are available include daily and monthly summaries, time series graphs, wind rose graphs, data inventories, and station metadata. The raw data are also available for download through the ‘data lister’ tool on the WRCC website. These data are also ingested by multiple other networks and agencies and displayed in various formats. Station data are downloaded each year during field visits. Manual QA/QC procedures are performed on each dataset annually and corrections are compiled as a metadata file which is available from network staff. Table 11 summarizes issues affecting data quality at ARCN stations in 2013.

**Table 8.** Issues affecting data quality at ARCN stations in 2013. Acronyms are as follows: rain gage (RG), relative humidity (RH), snow depth (SD), soil temperature (SD).

| Station        | Date Begin | Date End   | Issue                                                                |
|----------------|------------|------------|----------------------------------------------------------------------|
| All stations   | 1/1/2013   | 12/31/2013 | Anomalous SD values deleted.                                         |
| Chimney Lake   | 9/6/2012   | 4/5/2013   | RH sensor damaged.                                                   |
| Chimney Lake   | 8/27/2013  | 4/5/2013   | ST-10 cm, ST- 50 cm sensors damaged.                                 |
| Chimney Lake   | 9/6/2012   | 4/5/2013   | SD sensor damaged/AT correction sensor damaged.                      |
| Devil Mtn.     | 5/27/2013  | 8/6/2013   | RG damaged/out of level; RH sensor damaged.                          |
| Devil Mtn.     | 9/2/2012   | 8/6/2013   | ST-20 cm sensor damaged.                                             |
| Devil Mtn.     | 8/23/2012  | 8/6/2013   | SD sensor damaged/AT correction sensor damaged.                      |
| Ella Creek     | 10/31/2012 | 8/7/2013   | RG missing - sensor blew away.                                       |
| Howard Pass    | 7/20/2012  | 7/17/2013  | RH sensor failed.                                                    |
| Howard Pass    | 7/16/2012  | 7/17/2013  | SD sensor damaged/AT correction sensor damaged.                      |
| Imelyak        | 7/21/2013  | 7/25/2014  | RH sensor failed.                                                    |
| Imelyak        | 7/20/2012  | 7/25/2014  | SD sensor failed.                                                    |
| Kaluich        | 7/21/2013  | 7/25/2014  | RH sensor failed.                                                    |
| Mt. Noak       | 10/31/2012 | 6/29/2013  | Wind, rain, solar radiation and SD data compromised by riming event. |
| Mt. Noak       | 7/15/2013  | 7/15/2014  | RG damaged by wildlife.                                              |
| Mt. Noak       | 7/9/2013   | 7/15/2014  | RH sensor damaged.                                                   |
| Mt. Noak       | 9/17/2012  | 6/29/2013  | ST-50 cm sensor damaged.                                             |
| Mt. Noak       | 6/29/2013  | 7/15/2014  | SD sensor suspect.                                                   |
| Pamichtuk Lake | 9/30/2012  | 5/28/2013  | Station damaged by wildlife. All sensors affected.                   |
| Ram Creek      | 8/9/2013   | 6/10/2014  | Station damaged by wildlife. Most sensors affected.                  |
| Salmon River   | 7/17/2013  | 8/27/2013  | All data missing. Datalogger failed.                                 |
| Salmon River   | 8/27/2013  | 7/24/2014  | Transmitted data only. Datalogger failed.                            |
| Sisiak         | 6/1/2013   | 7/1/2013   | RG damaged/out of level.                                             |
| Tahinichok     | 4/15/2013  | 6/30/2013  | RG, RH, SD sensor damaged.                                           |
| Tahinichok     | 7/31/2012  | 6/30/2013  | ST-10 cm, ST-20 cm, ST-50 cm sensors damaged.                        |

Significant changes in data archiving, quality control, and reporting methods are expected over time. All NPS Inventory and Monitoring networks monitor climate and a national protocol is being developed to provide guidance for data management and reporting. Currently for ARCN, cleaned datasets are sent to WRCC for archiving and are also available on request by network staff.

ARCN network staff produce seasonal weather summaries four times a year for BELA, GAAR, and WEAR that provide timely and relevant information on current weather statistics. These summaries are available from the network website or from the [Integrated Resource Management Application](#) (IRMA) portal. Annual maintenance reports are also available in IRMA which summarize all field procedures, logistics, metadata, and station specifications.

## Conclusion

The climate data for 2013 was compiled and summarized using ARCN data from the NPS sites and from index sites around the region. The results presented in this report identify anomalous weather patterns among long-term climate variability. Overall, Bettles and Nome had mean annual air temperatures near the long-term normal. The mean annual air temperature of 24.2°F in Kotzebue was the 12<sup>th</sup> warmest on record. Precipitation ranged from 103 to 133% above normal. It was the 9<sup>th</sup> wettest year on record in Nome. The variations in temperature and precipitation from season to season in 2013 were impressive; individual monthly statistics deviations from normal and seasonal statistics help characterize the extremes. January was warmer and wetter than normal at each index site in the network, with monthly January temperatures on average 8.6 degrees warmer than normal. Early season snow was late arriving however, and most of the arctic did not begin accumulating snow until mid-December. Spring 2013 was unusually cold across the state and especially in the interior regions of the ARCN parks. It was the third coldest April on record in Bettles. Summer temperatures were near or above normal. Precipitation was above average on the Seward Peninsula for most of the summer and fall months.

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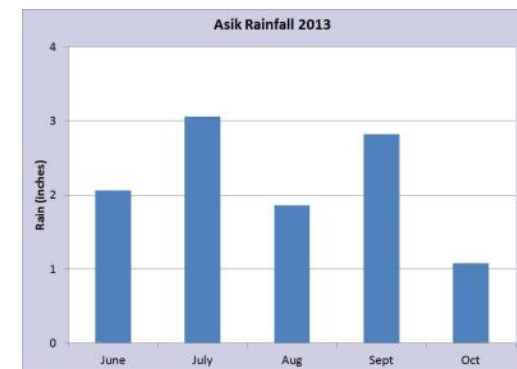
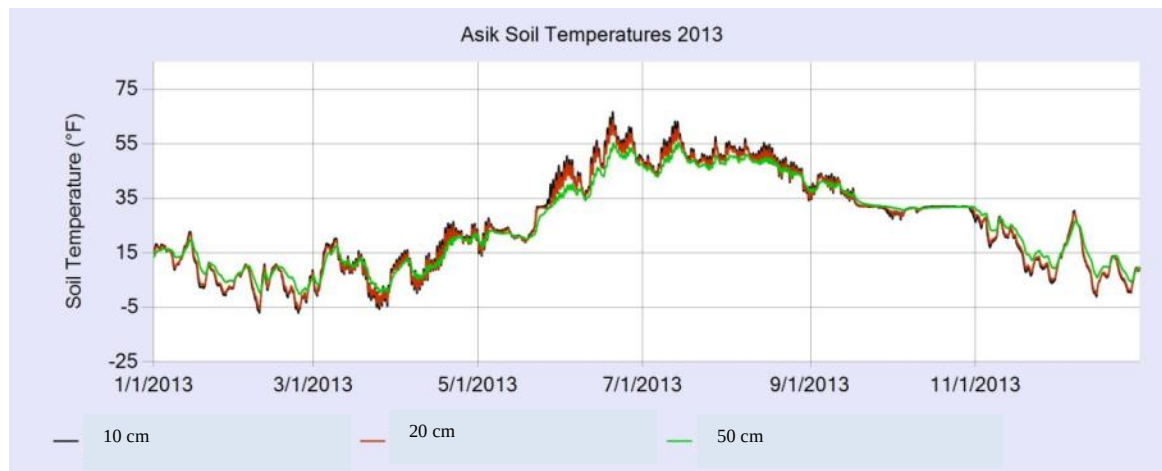
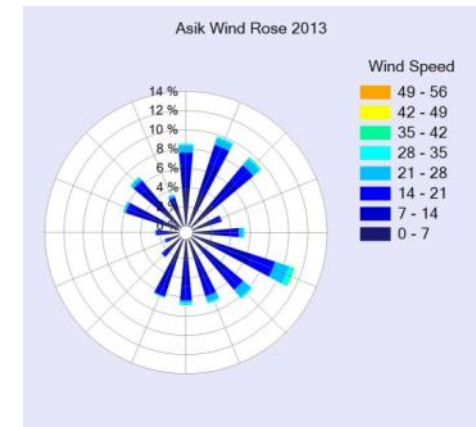
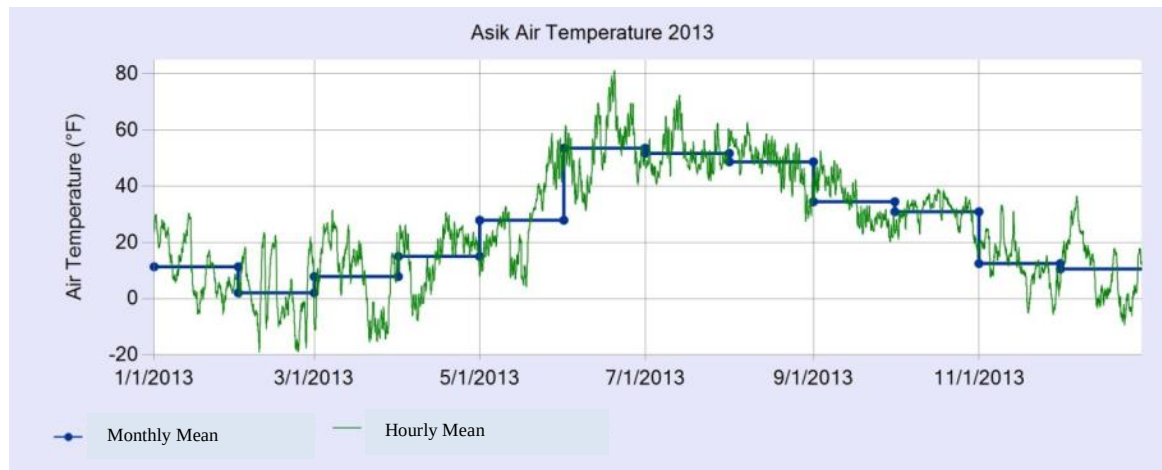
## Appendix A. 2013 ARCN Climate Station Data Summary

### Asik – Noatak National Preserve      Period of Record: July 2012 - present



Asik is located approximately 40 miles NE of Kotzebue at an elevation of 1329 feet. The station overlooks the Agashashok River to the SE. The site is located near gentle rounded hills with low alpine tundra. The site is near a geologic contact between limestone and metamorphic rock. Vegetation near the site is alpine tundra. Krummholz exists at nearby lower elevations. Temperatures ranged from -19.9°F to 82.1°F in 2013 with a mean annual air temperature of 25.7°F. Winds are generally highest in winter months and gusts were as high as 56 mph in 2013. The site location is likely wind scoured in winter

| Asik 2013     | Rain         | Air Temperature |             |               | Wind Speed  |               | Relative Humidity | Solar Radiation       | Snow Depth | Mean Soil Temperature |             |             |
|---------------|--------------|-----------------|-------------|---------------|-------------|---------------|-------------------|-----------------------|------------|-----------------------|-------------|-------------|
|               | (inches)     | (°F)            |             |               | (mph)       |               | (%)               | (KW m <sup>-2</sup> ) | (inches)   | (°F)                  |             |             |
| Month         | Total        | Absolute Min.   | Mean        | Absolute Max. | Mean        | Absolute Max. | Mean              | Total                 | Mean       | 10 cm                 | 20 cm       | 50 cm       |
| Jan           | 0.00         | -7.3            | 11.4        | 30.8          | 13.8        | 54.3          | 65                | 2                     | 2.2        | 10.0                  | 10.2        | 11.8        |
| Feb           | 0.00         | -19.9           | 2.1         | 24.8          | 9.4         | 38.9          | 68                | 18                    | 2.4        | 3.2                   | 3.6         | 5.8         |
| Mar           | 0.00         | -16.3           | 7.9         | 32.3          | 10.6        | 54.8          | 67                | 67                    | 2.2        | 7.8                   | 7.7         | 8.5         |
| Apr           | 0.02         | -8.7            | 15.0        | 33.6          | 10.5        | 48.5          | 61                | 135                   | 2.3        | 14.8                  | 14.3        | 13.7        |
| May           | 0.08         | 3.2             | 27.9        | 60.9          | 13.1        | 49.4          | 78                | 157                   | 3.7        | 26.2                  | 25.5        | 24.3        |
| Jun           | 2.06         | 31.2            | 53.6        | 82.1          | 8.4         | 38.6          | 65                | 158                   | 1.9        | 49.9                  | 48.7        | 44.6        |
| Jul           | 3.06         | 40.7            | 51.7        | 73.8          | 10.8        | 36.8          | 85                | 107                   | 0.0        | 51.1                  | 50.2        | 48.1        |
| Aug           | 1.86         | 27.2            | 48.7        | 63.6          | 8.1         | 31.2          | 77                | 99                    | 0.0        | 48.6                  | 48.0        | 46.9        |
| Sep           | 2.82         | 19.3            | 34.5        | 53.7          | 10.7        | 37.6          | 81                | 60                    | 0.0        | 35.9                  | 35.8        | 36.1        |
| Oct           | 1.08         | 14.0            | 30.9        | 39.3          | 11.2        | 44.8          | 92                | 18                    | 0.0        | 31.1                  | 31.2        | 31.5        |
| Nov           | 0.06         | -6.3            | 12.5        | 33.6          | 12.2        | 56.2          | 86                | 3                     | 0.1        | 16.7                  | 17.5        | 20.6        |
| Dec           | 0.29         | -10.8           | 10.5        | 36.7          | 9.8         | 40.9          | 75                | 0                     | 0.2        | 11.1                  | 11.3        | 13.2        |
| <b>Annual</b> | <b>11.33</b> | <b>-19.9</b>    | <b>25.7</b> | <b>82.1</b>   | <b>10.7</b> | <b>56.2</b>   | <b>75</b>         | <b>826</b>            | <b>1.3</b> | <b>25.7</b>           | <b>25.5</b> | <b>25.5</b> |



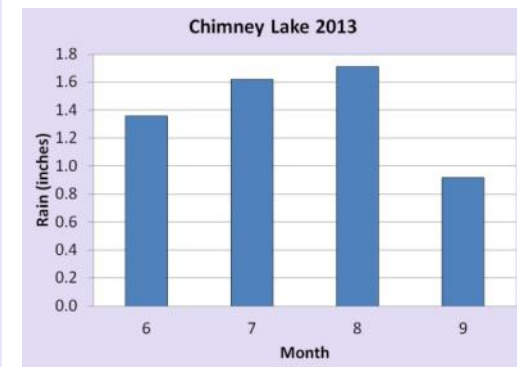
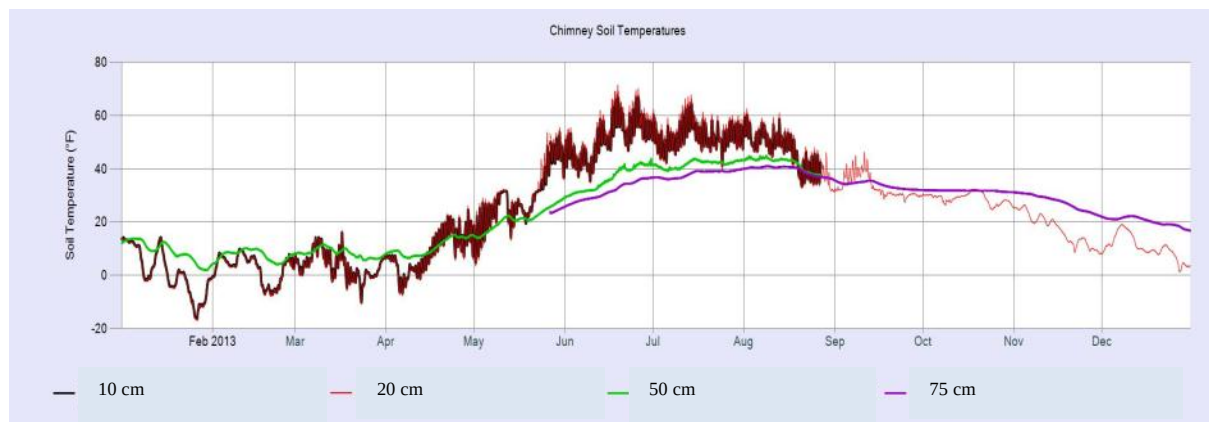
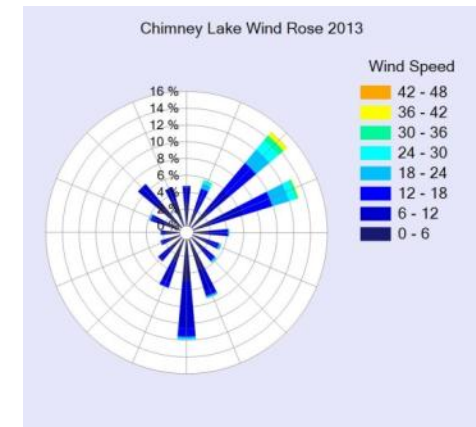
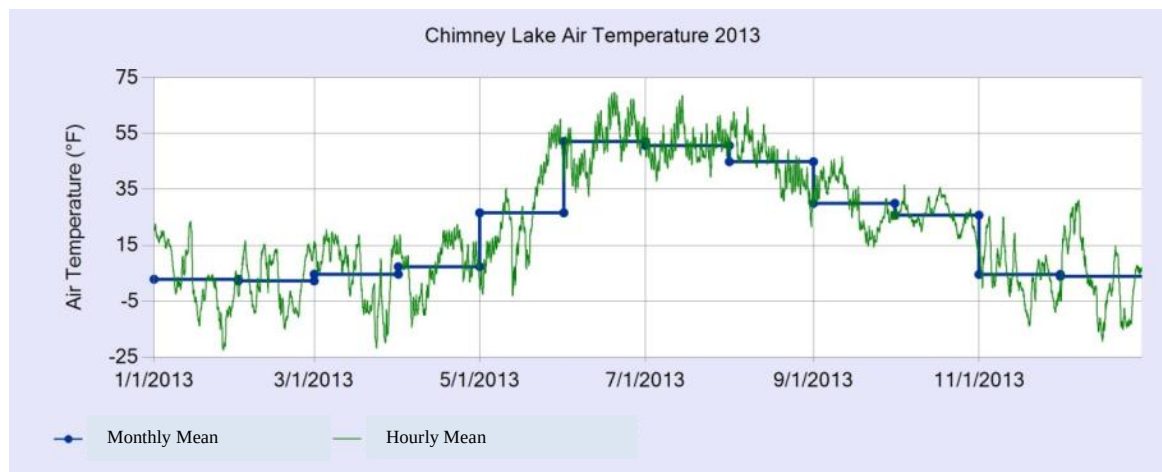
## Chimney Lake – Gates of the Arctic National Park and Preserve

### Period of Record: August 2012 - present



Chimney Lake station is located approximately 25 miles NW of Wiseman at an elevation of 3700 feet. The station overlooks the Clear River to the SW and is located near the southern terminus of the Chimney Mountain ridgeline. Vegetation is composed of open tundra with dwarf shrub, dry alpine tundra and rocky substrate. Temperatures ranged from -23.0°F to 72.4°F in 2013 with a mean annual air temperature of 21.4°F. Winds are generally highest in winter months and gusts were as high as 52 mph in 2013. Snow accumulates at the station, but is likely redistributed by wind and not necessarily representative of the surrounding area. See Table 8 for a data quality summary.

| Chimney Lake 2013  | Rain        | Air Temperature |             |               | Wind Speed |               | Relative Humidity | Solar Radiation       | Snow Depth | Mean Soil Temperature |             |          |          |
|--------------------|-------------|-----------------|-------------|---------------|------------|---------------|-------------------|-----------------------|------------|-----------------------|-------------|----------|----------|
|                    | (inches)    | (°F)            |             |               | (mph)      |               | (%)               | (KW m <sup>-2</sup> ) | (inches)   | (°F)                  |             |          |          |
| Month              | Total       | Absolute Min.   | Mean        | Absolute Max. | Mean       | Absolute Max. | Mean              | Total                 | Mean       | 10 cm                 | 20 cm       | 50 cm    | 75 cm    |
| Jan                | 0.00        | -23.0           | 2.8         | 24.3          | 12.8       | 47.4          | M                 | 3                     | M          | 1.4                   | 1.1         | 9.1      | X        |
| Feb                | 0.00        | -15.2           | 2.3         | 19.5          | 11.7       | 45.5          | M                 | 18                    | M          | 2.5                   | 2.2         | 7.3      | X        |
| Mar                | 0.00        | -22.2           | 4.6         | 23.7          | 8.9        | 50.1          | M                 | 72                    | M          | 3.5                   | 3.2         | 8.3      | X        |
| Apr                | 0.00        | -16.1           | 7.3         | 24.2          | 7.6        | 52.0          | 56                | 147                   | 0.9        | 8.4                   | 8.2         | 10.3     | X        |
| May                | 0.00        | -3.2            | 26.6        | 61.7          | 8.0        | 43.1          | 62                | 197                   | 0.8        | 28.6                  | 29.1        | 20.9     | X        |
| Jun                | 1.36        | 30.8            | 52.1        | 72.4          | 8.4        | 41.6          | 56                | 188                   | 0.0        | 51.0                  | 51.9        | 35.8     | 31.3     |
| Jul                | 1.62        | 37.0            | 50.7        | 70.5          | 7.5        | 34.4          | 75                | 147                   | 0.0        | 52.3                  | 52.8        | 41.8     | 38.0     |
| Aug                | 1.71        | 19.8            | 44.9        | 65.6          | 7.5        | 41.7          | 75                | 112                   | 0.0        | 47.2                  | 46.0        | 42.1     | 39.4     |
| Sep                | 0.92        | 12.9            | 30.0        | 78.7          | 7.9        | 33.5          | 85                | 57                    | 1.3        | M                     | 33.4        | M        | 33.9     |
| Oct                | 0.43        | 11.9            | 25.8        | 41.2          | 8.8        | 37.4          | 93                | 20                    | 2.9        | M                     | 29.0        | M        | 31.7     |
| Nov                | 0.00        | -13.5           | 4.6         | 25.5          | 9.4        | 49.4          | 81                | 4                     | 6.5        | M                     | 17.5        | M        | 27.6     |
| Dec                | 0.01        | -18.4           | 3.9         | 31.4          | 11.4       | 50.0          | 61                | 0                     | 8.2        | M                     | 10.3        | M        | 20.2     |
| <b>2013 Annual</b> | <b>6.05</b> | <b>-23.0</b>    | <b>21.4</b> | <b>72.4</b>   | <b>9.1</b> | <b>52.0</b>   | <b>X</b>          | <b>965</b>            | <b>X</b>   | <b>X</b>              | <b>23.9</b> | <b>X</b> | <b>X</b> |

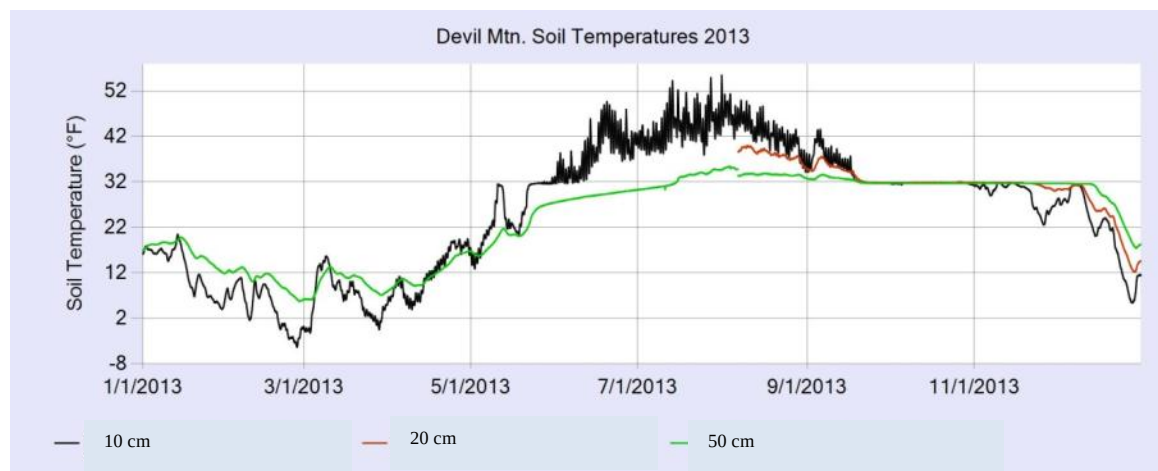
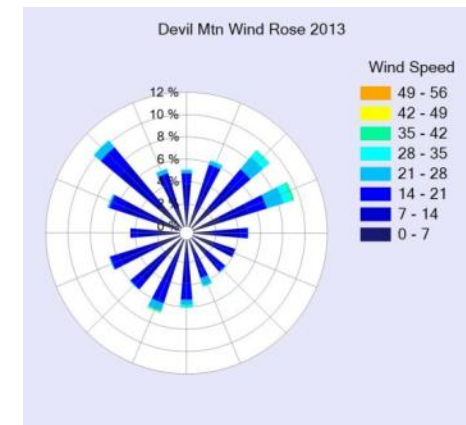
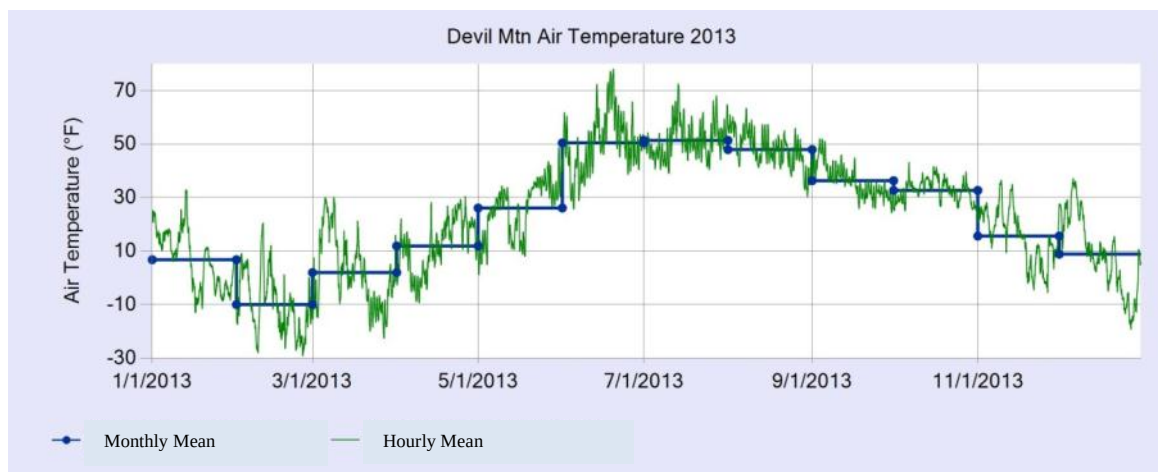


**Devil Mtn. – Bering Land Bridge National Preserve**  
**Period of Record: August 2011 – present**



Devil Mtn. is near the northern edge of the Seward Peninsula on a high point (elevation 285 feet). The site overlooks saturated lake areas in all directions. The landscape is tundra mat vegetation and volcanic rocks. Vegetation near the site includes grasses, shrubs, and tussock tundra. Temperatures ranged from -43.4°F to 78.7°F in 2013 with a mean annual air temperature of 23.5°F. Winds are persistent at the site and less than 2% of the hourly observations were considered calm in 2013. The average wind speed for the year was 13.5 mph. Snow redistribution by wind is common at the station and surrounding lowlands. See Table 8 for a data quality summary.

| Devil Mtn.<br>2013 | Rain     | Air Temperature |             |               | Wind Speed  |               | Relative Humidity | Solar Radiation       | Snow Depth | Soil Temperature |          |             |
|--------------------|----------|-----------------|-------------|---------------|-------------|---------------|-------------------|-----------------------|------------|------------------|----------|-------------|
|                    | (inches) | (°F)            |             |               | (mph)       |               | (%)               | (KW m <sup>-2</sup> ) | (inches)   | (°F)             |          |             |
| Month              | Total    | Absolute Min.   | Mean        | Absolute Max. | Mean        | Absolute Max. | Mean              | Total                 | Mean       | 10 cm            | 20 cm    | 50 cm       |
| Jan                | 0.00     | -39.3           | 6.8         | 32.9          | 18.0        | 43.3          | 90                | 4                     | M          | 2.8              | M        | 16.7        |
| Feb                | 0.00     | -43.4           | -10.0       | 20.6          | 10.2        | 32.8          | 84                | 18                    | M          | 5.7              | M        | 10.3        |
| Mar                | 0.00     | -28.9           | 2.0         | 30.2          | 14.4        | 34.9          | 89                | 49                    | M          | -1.1             | M        | 9.8         |
| Apr                | 0.00     | -22.1           | 11.9        | 31.9          | 14.7        | 30.5          | 85                | 135                   | M          | 11.5             | M        | 12.0        |
| May                | 0.47     | 2.8             | 26.1        | 50.0          | 16.9        | 43.3          | 94                | 182                   | M          | 24.4             | M        | 21.4        |
| Jun                | M        | 26.4            | 50.4        | 78.7          | 13.1        | 26.6          | M                 | 180                   | M          | 37.1             | M        | 29.0        |
| Jul                | M        | 37.5            | 51.4        | 73.9          | 12.7        | 27.6          | M                 | 141                   | M          | 41.6             | M        | 32.5        |
| Aug                | 1.85     | 33.4            | 47.9        | 64.4          | 10.9        | 20.8          | 90                | 110                   | 0.8        | 41.8             | 38.1     | 33.9        |
| Sep                | 2.24     | 23.1            | 36.0        | 53.5          | 12.7        | 27.8          | 90                | 64                    | 0.7        | 35.0             | 34.0     | 32.5        |
| Oct                | 1.45     | 14.9            | 32.7        | 44.1          | 12.8        | 34.1          | 98                | 21                    | 0.2        | 31.2             | 31.9     | 31.7        |
| Nov                | 0.24     | -3.0            | 15.6        | 37.1          | 13.0        | 55.6          | 94                | 6                     | M          | 22.1             | 31.6     | 31.7        |
| Dec                | 0.68     | -24.6           | 8.9         | 38.2          | 11.8        | 33.5          | 91                | 1                     | M          | 9.1              | 24.7     | 27.8        |
| <b>2013</b>        | <b>X</b> | <b>-43.4</b>    | <b>23.5</b> | <b>78.7</b>   | <b>13.5</b> | <b>55.6</b>   | <b>X</b>          | <b>910</b>            | <b>X</b>   | <b>25.5</b>      | <b>X</b> | <b>24.2</b> |



\*Summer rainfall data unavailable due to damage by wildlife. See Table 8 for data quality summary.

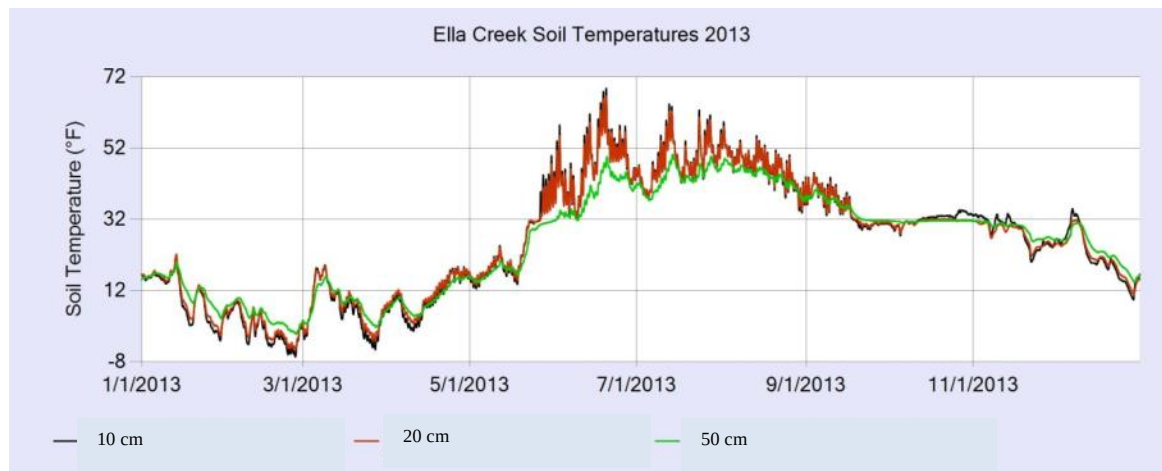
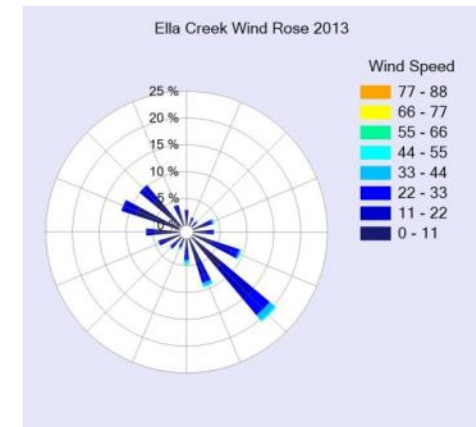
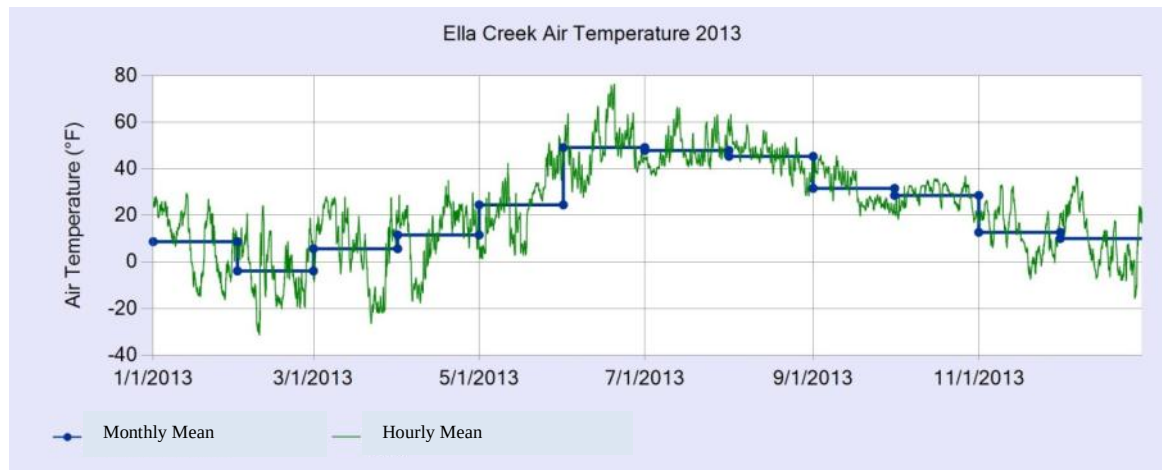
## Ella Creek – Bering Land Bridge National Preserve

### Period of Record: September 2012 - present



Ella Creek is located on the SE edge of BELA at an elevation of 2318 feet in a pass between Ella Creek and Pargon Creek in the Bendeleben Mountains. The landscape is a broad, flat-top expanse with little vegetation and is representative of the higher elevation mountainous terrain on the Seward Peninsula. Temperatures ranged from -31.5°F to 77.9°F in 2013 with a mean annual air temperature of 22.8°F. Inversions are common in winter months. Winds are persistent at the site. In 2013 there were frequent events with hourly averages greater than 60 mph with gusts as high as 84.1 mph. The average wind speed for the year was 16.3 mph. Snow redistribution by wind is common. See Table 8 for a data quality summary.

| Ella Creek<br>2013 | Rain     | Air Temperature  |             |                  | Wind Speed  |                  | Relative<br>Humidity | Solar<br>Radiation    | Snow<br>Depth | Soil Temperature |             |             |
|--------------------|----------|------------------|-------------|------------------|-------------|------------------|----------------------|-----------------------|---------------|------------------|-------------|-------------|
|                    | (inches) | (°F)             |             |                  | (mph)       |                  | (%)                  | (KW m <sup>-2</sup> ) | (inches)      | (°F)             |             |             |
| Month              | Total    | Absolute<br>Min. | Mean        | Absolute<br>Max. | Mean        | Absolute<br>Max. | Mean                 | Total                 | Mean          | 10 cm            | 20 cm       | 50 cm       |
| Jan                | X        | -16.9            | 8.7         | 31.3             | 19.5        | 84.1             | 86                   | 4                     | M             | 10.2             | 11.1        | 12.8        |
| Feb                | X        | -31.5            | -3.9        | 24.6             | 13.5        | 51.0             | 79                   | 20                    | M             | 0.8              | 1.9         | 4.7         |
| Mar                | X        | -27.1            | 5.7         | 31.9             | 16.8        | 71.5             | 86                   | 67                    | M             | 6.7              | 7.8         | 8.2         |
| Apr                | X        | -17.8            | 11.6        | 42.4             | 14.4        | 40.4             | 77                   | 134                   | M             | 9.9              | 10.9        | 10.0        |
| May                | M        | 0.4              | 24.5        | 56.3             | 19.7        | 79.3             | 90                   | 191                   | M             | 23.8             | 23.7        | 21.5        |
| Jun                | M        | 27.4             | 49.1        | 77.9             | 16.8        | 49.5             | 70                   | 175                   | M             | 47.8             | 47.1        | 39.2        |
| Jul                | M        | 36.6             | 47.8        | 68.4             | 17.0        | 40.3             | 90                   | 128                   | M             | 48.6             | 48.4        | 43.8        |
| Aug                | 3.55     | 27.8             | 45.3        | 65.6             | 13.8        | 41.6             | 90                   | 95                    | M             | 46.6             | 46.7        | 44.2        |
| Sep                | 1.40     | 19.7             | 31.6        | 46.7             | 14.1        | 31.6             | 97                   | 53                    | M             | 34.9             | 35.1        | 35.1        |
| Oct                | 1.57     | 16.0             | 28.5        | 38.3             | 16.0        | 51.9             | 99                   | 26                    | M             | 32.0             | 31.4        | 31.5        |
| Nov                | 0.10     | -7.5             | 12.7        | 32.8             | 18.0        | 65.9             | 94                   | 4                     | M             | 28.6             | 27.9        | 29.3        |
| Dec                | 1.01     | -18.8            | 10.0        | 38.5             | 15.9        | 50.4             | 82                   | 1                     | M             | 21.5             | 21.6        | 23.3        |
| <b>2013</b>        | <b>X</b> | <b>-31.5</b>     | <b>22.8</b> | <b>77.9</b>      | <b>16.3</b> | <b>84.1</b>      | <b>87</b>            | <b>898</b>            | <b>X</b>      | <b>26.1</b>      | <b>26.3</b> | <b>25.4</b> |



\*Summer rainfall data not available due to station damage. See Table 8 for data quality summary.

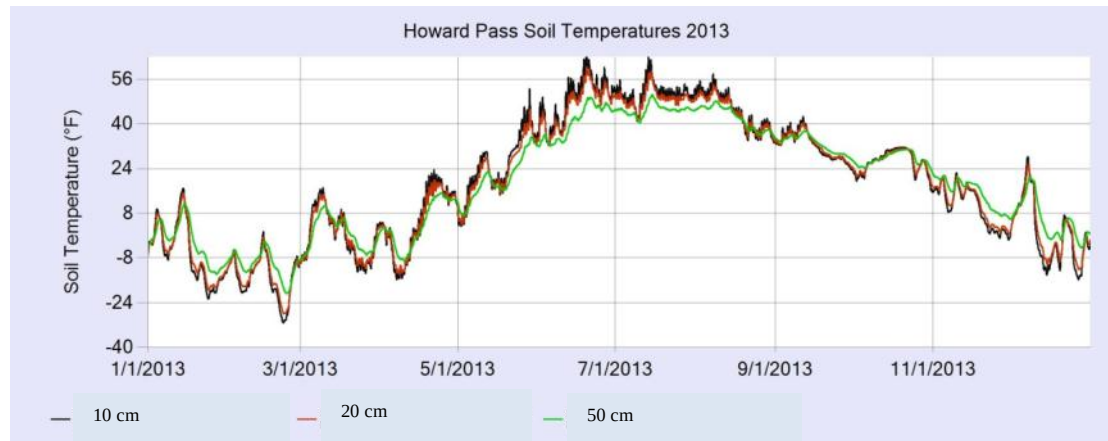
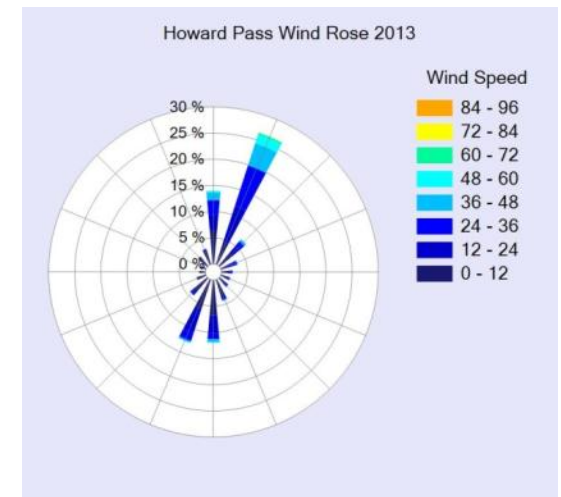
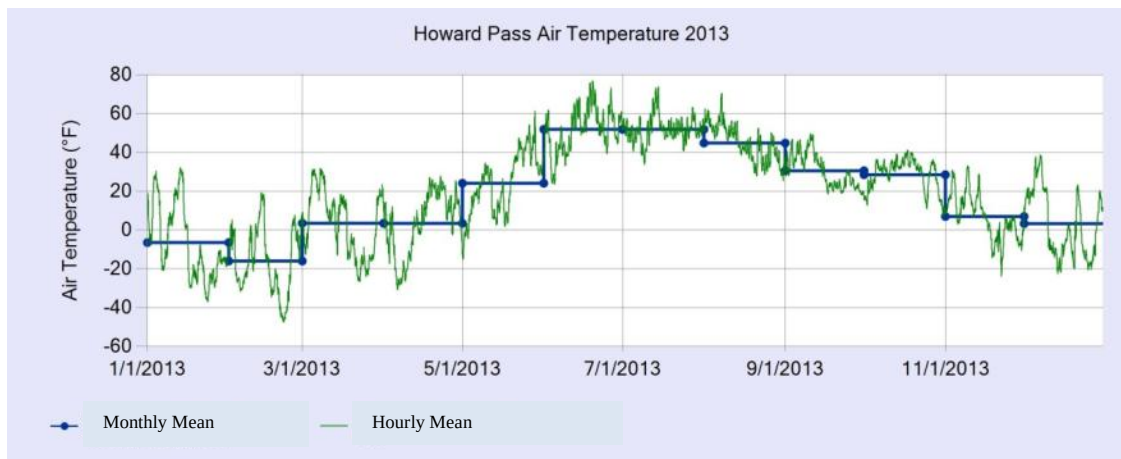
## Howard Pass – Noatak National Preserve

### Period of Record: July 2011 – present



The station is located on a rocky tor outcrop on the eastern flank of Howard Pass at an elevation of 2062 feet in the northwestern Brooks Range. The pass is an important caribou migration corridor and has been used by indigenous people for thousands of years. Vegetation near the site includes *Dryas* tundra, *Carex*, *Salix*, and *Cassiope*. The location is susceptible to both low temperatures and strong winds. Temperatures ranged from -47.9°F to 78.7°F in 2013 with a mean annual air temperature of 19.1°F. Cold temperatures and brisk northerly winds are Recorded wind chills were as low as -99.8°F in 2013, a possible record for the US and North America. The average wind speed for the year was 20.8 mph with gusts as high as 79.3 mph. See Table 8 for a data quality summary.

| Howard Pass<br>2013 | Rain        | Air Temperature |             |               | Wind Speed  |               | Wind Chill    |              | Relative Humidity | Solar Radiation       | Snow Depth | Soil Temperature |             |             |
|---------------------|-------------|-----------------|-------------|---------------|-------------|---------------|---------------|--------------|-------------------|-----------------------|------------|------------------|-------------|-------------|
|                     | (inches)    | (°F)            |             |               | (mph)       |               | (°F)          |              | (%)               | (KW m <sup>-2</sup> ) | (inches)   | (°F)             |             |             |
| Month               | Total       | Absolute Min.   | Mean        | Absolute Max. | Mean        | Absolute Max. | Absolute Min. | Mean         | Mean              | Total                 | Mean       | 10 cm            | 20 cm       | 50 cm       |
| Jan                 | 0           | -37.4           | -6.5        | 33.0          | 30.7        | 79.3          | -89.1         | -31.0        | M                 | 2                     | M          | -6.3             | -5.4        | -2.5        |
| Feb                 | 0           | -47.9           | -16.0       | 21.8          | 27.5        | 61.3          | -99.8         | -40.1        | M                 | 12                    | M          | -15.1            | -14.1       | -10.5       |
| Mar                 | 0           | -27.2           | 3.4         | 33.9          | 17.0        | 52.7          | -65.7         | -9.8         | M                 | 65                    | M          | 0.1              | 0.0         | 0.6         |
| Apr                 | 0.01        | -31.5           | 3.4         | 32.0          | 23.7        | 70.5          | -75.5         | -13.8        | M                 | 135                   | M          | 4.9              | 4.5         | 4.1         |
| May                 | 0.02        | -15.2           | 24.1        | 62.4          | 20.5        | 54.6          | -50.3         | 12.3         | M                 | 195                   | M          | 25.0             | 23.3        | 20.3        |
| Jun                 | 1.39        | 23.3            | 51.8        | 78.7          | 19.7        | 38.2          | 6.4           | 47.2         | M                 | 173                   | M          | 48.8             | 46.4        | 40.6        |
| Jul                 | 0.71        | 33.3            | 51.8        | 76.0          | 18.7        | 48.5          | 18.3          | 47.6         | M                 | 134                   | M          | 50.9             | 49.2        | 45.1        |
| Aug                 | 1.7         | 24.8            | 44.8        | 71.6          | 18.3        | 43.1          | 13.1          | 39.0         | 81                | 118                   | 0          | 44.8             | 44.1        | 42.3        |
| Sep                 | 0.97        | 17.6            | 30.5        | 49.9          | 19.4        | 49.5          | -2.0          | 21.1         | 87                | 55                    | 0          | 32.3             | 32.4        | 32.8        |
| Oct                 | 0.22        | 5.2             | 28.5        | 41.5          | 14.6        | 40.7          | -8.2          | 20.9         | 84                | 21                    | 0          | 26.4             | 26.6        | 27.5        |
| Nov                 | 0.01        | -24.5           | 6.9         | 33.8          | 19.6        | 57.2          | -61.5         | -7.2         | 78                | 4                     | 1          | 10.2             | 11.5        | 15.3        |
| Dec                 | 0.4         | -24.8           | 3.2         | 40.8          | 19.5        | 59.9          | -63.3         | -11.1        | 77                | 0                     | 1          | 0.5              | 1.7         | 5.6         |
| <b>Annual</b>       | <b>5.43</b> | <b>-47.9</b>    | <b>19.1</b> | <b>78.7</b>   | <b>20.8</b> | <b>79.3</b>   | <b>79.3</b>   | <b>-99.8</b> | <b>X</b>          | <b>913</b>            | <b>M</b>   | <b>18.8</b>      | <b>18.6</b> | <b>18.6</b> |



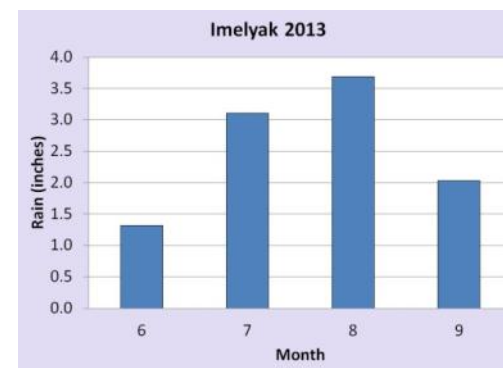
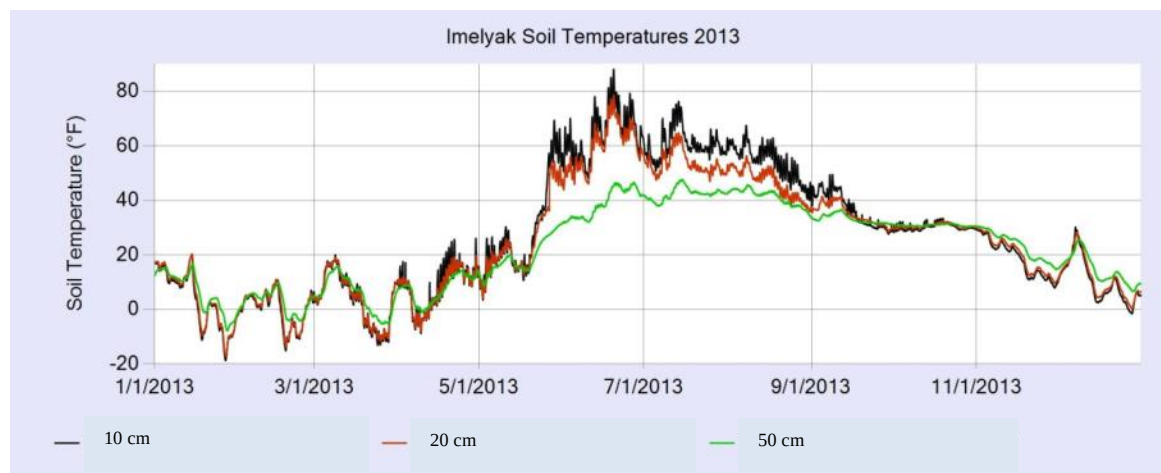
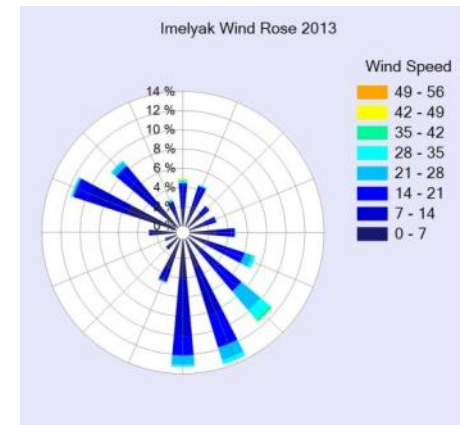
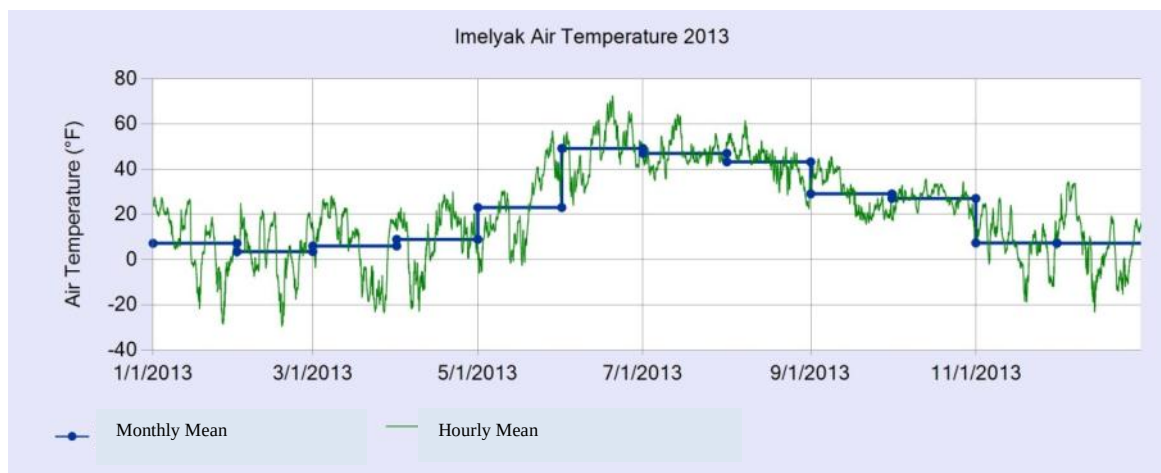
## Imelyak – Noatak National Preserve

### Period of Record: July 2012 - present



Imelyak is located on a broad mountain top at an elevation of 3620 feet and overlooks the Imelyak river valley to the north. The station is near the SE boundary of NOAT in the south-central Brooks Range. Vegetation near the site is low *Dryas* tundra with loamy soil. Temperatures ranged from -30.8°F to 74.1°F in 2013 with a mean annual air temperature of 21.7°F. Cold winters, cool summers, convective summer precipitation, and wind are characteristic of the site location. The site location is likely wind scoured in winter months. Among ARC/N sites, summer precipitation was highest at Imelyak in 2013. See Table 8 for a data quality summary.

| Imelyak<br>2013 | Rain         | Air Temperature  |             |                  | Wind Speed  |                  | Relative<br>Humidity | Solar<br>Radiation    | Snow<br>Depth | Soil Temperature |             |             |
|-----------------|--------------|------------------|-------------|------------------|-------------|------------------|----------------------|-----------------------|---------------|------------------|-------------|-------------|
|                 | (inches)     | (°F)             |             |                  | (mph)       |                  | (%)                  | (KW m <sup>-2</sup> ) | (inches)      | (°F)             |             |             |
| Month           | Total        | Absolute<br>Min. | Mean        | Absolute<br>Max. | Mean        | Absolute<br>Max. | Mean                 | Total                 | Mean          | 10 cm            | 20 cm       | 50 cm       |
| Jan             | 0.00         | -29.5            | 7.2         | 28.3             | 17.9        | 49.0             | 67                   | 2                     | M             | 3.3              | 4.2         | 6.4         |
| Feb             | 0.00         | -30.8            | 3.5         | 27.4             | 10.3        | 26.4             | 68                   | 17                    | M             | 0.0              | 0.6         | 2.5         |
| Mar             | 0.00         | -23.6            | 6.0         | 28.7             | 15.2        | 33.6             | 66                   | 70                    | M             | 3.5              | 3.8         | 5.1         |
| Apr             | 0.00         | -24.5            | 8.9         | 35.5             | 11.7        | 33.0             | 60                   | 149                   | M             | 8.4              | 7.6         | 7.5         |
| May             | 0.02         | -7.3             | 23.0        | 58.1             | 16.5        | 41.1             | 74                   | 194                   | M             | 28.0             | 25.1        | 19.2        |
| Jun             | 1.32         | 23.5             | 49.2        | 74.1             | 14.2        | 33.2             | 67                   | 190                   | M             | 64.7             | 59.7        | 38.9        |
| Jul             | 3.11         | 34.3             | 47.0        | 65.7             | 14.4        | 33.2             | M                    | 115                   | M             | 61.8             | 53.3        | 42.4        |
| Aug             | 3.69         | 21.0             | 43.2        | 63.4             | 13.1        | 22.8             | M                    | 112                   | M             | 54.1             | 46.5        | 41.1        |
| Sep             | 2.03         | 15.3             | 29.1        | 47.0             | 11.3        | 32.8             | M                    | 55                    | M             | 36.7             | 35.0        | 33.1        |
| Oct             | 0.19         | 10.4             | 27.0        | 36.0             | 17.5        | 40.1             | M                    | 22                    | M             | 30.3             | 30.5        | 30.8        |
| Nov             | 0.17         | -19.4            | 7.4         | 27.7             | 14.0        | 54.6             | M                    | 3                     | M             | 18.8             | 20.1        | 23.5        |
| Dec             | 0.32         | -24.5            | 7.2         | 35.8             | 14.0        | 40.2             | M                    | 0                     | M             | 10.3             | 11.4        | 14.6        |
| <b>2013</b>     | <b>10.85</b> | <b>-30.8</b>     | <b>21.7</b> | <b>74.1</b>      | <b>14.2</b> | <b>54.6</b>      | <b>X</b>             | <b>929</b>            | <b>X</b>      | <b>26.7</b>      | <b>25.0</b> | <b>22.2</b> |



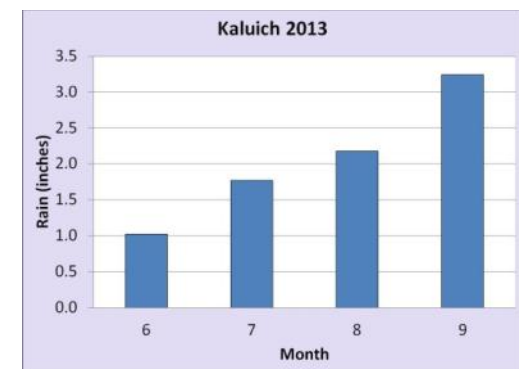
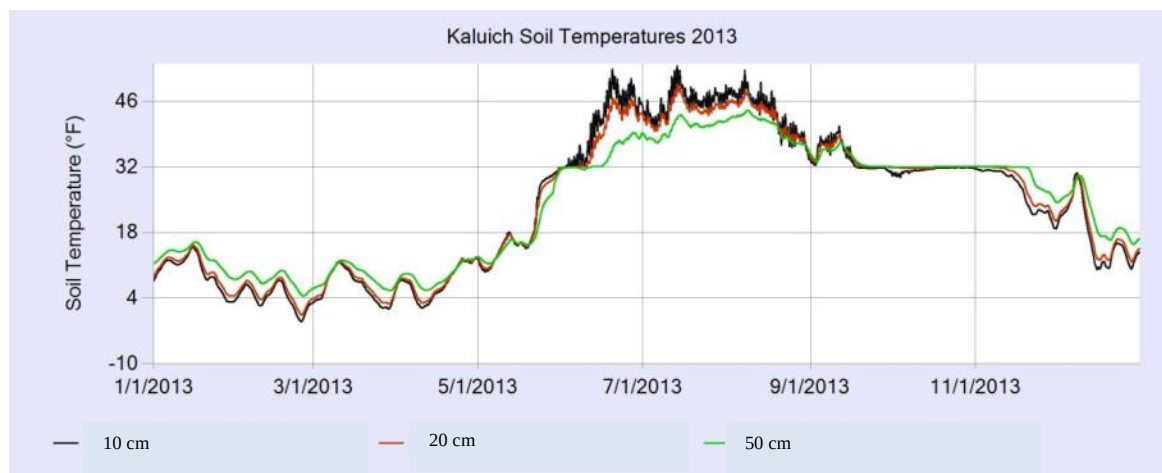
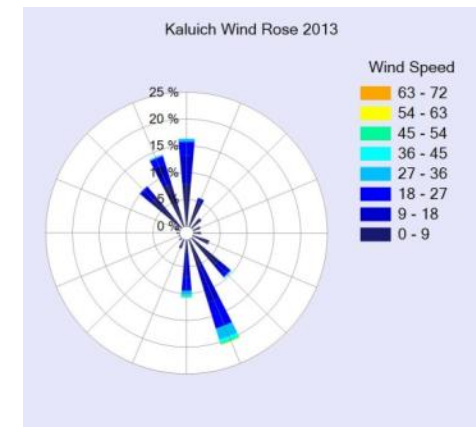
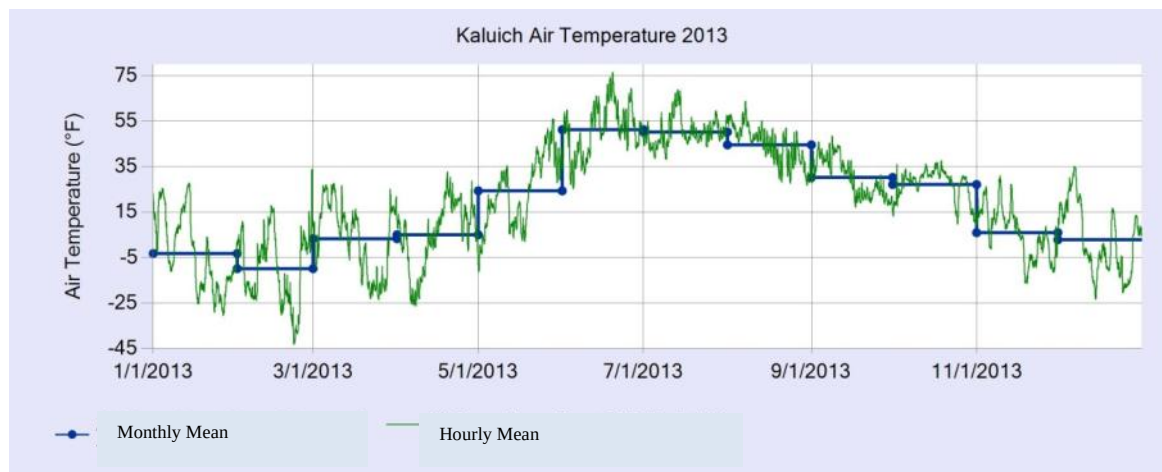
## Kaluich – Noatak National Preserve

### Period of Record: July 2012 - present



Kaluich is located 36 miles NW of Ambler village at an elevation of 2411 feet in the Baird Mountains. To the north, the station overlooks the Kaluich Creek drainage and the broad Noatak valley. The upper drainages of KOVA are visible to the south. Low tundra and rocky soil surround the site. Temperatures ranged from -43.5°F to 77.9°F in 2013 with a mean annual air temperature of 19.5°F. Cold winters, cool summers, and wind are characteristic of the site location. About a foot of snow accumulated at the site in 2013 and persisted through early June.

| Kaluich<br>2013 | Rain         | Air Temperature  |             |                  | Wind Speed  |                  | Relative<br>Humidity | Solar<br>Radiation    | Snow<br>Depth | Soil Temperature |             |             |
|-----------------|--------------|------------------|-------------|------------------|-------------|------------------|----------------------|-----------------------|---------------|------------------|-------------|-------------|
|                 | (inches)     | (°F)             |             |                  | (mph)       |                  | (%)                  | (KW m <sup>-2</sup> ) | (inches)      | (°F)             |             |             |
| Month           | Total        | Absolute<br>Min. | Mean        | Absolute<br>Max. | Mean        | Absolute<br>Max. | Mean                 | Total                 | Mean          | 10 cm            | 20 cm       | 50 cm       |
| Jan             | 0.00         | -30.8            | -3.2        | 27.9             | 11.0        | 42.9             | 81                   | 1                     | 12.0          | 9.4              | 10.3        | 12.7        |
| Feb             | 0.00         | -43.5            | -9.9        | 34.2             | 7.0         | 29.6             | 79                   | 8                     | 10.3          | 4.1              | 5.1         | 7.8         |
| Mar             | 0.00         | -24.6            | 3.3         | 30.6             | 8.7         | 42.8             | 74                   | 54                    | 10.6          | 6.3              | 7.0         | 8.7         |
| Apr             | 0.01         | -27.6            | 5.0         | 40.9             | 10.9        | 44.2             | 72                   | 126                   | 9.7           | 7.4              | 7.8         | 8.0         |
| May             | 0.05         | -11.9            | 24.3        | 58               | 15.8        | 60.3             | 78                   | 196                   | 7.0           | 18.9             | 18.6        | 9.0         |
| Jun             | 1.02         | 24.8             | 51.2        | 77.9             | 11.2        | 59.9             | 68                   | 182                   | 0.9           | 41.2             | 38.6        | 17.7        |
| Jul             | 1.77         | 38               | 50.2        | 70.8             | 12.7        | 40.6             | M                    | 130                   | 0.7           | 46.0             | 44.0        | 34.4        |
| Aug             | 2.18         | 26               | 44.6        | 65.6             | 10.0        | 33.7             | M                    | 102                   | 0.0           | 43.5             | 42.5        | 40.3        |
| Sep             | 3.24         | 16.9             | 30.2        | 49               | 10.5        | 37.7             | M                    | 46                    | 0.9           | 34.1             | 34.1        | 40.6        |
| Oct             | 3.22         | 8.7              | 27.1        | 38.7             | 8.0         | 47.6             | M                    | 15                    | 6.5           | 31.4             | 31.9        | 33.9        |
| Nov             | 0.00         | -17              | 5.9         | 31.3             | 10.6        | 74.9             | M                    | 2                     | 8.1           | 27.2             | 28.5        | 32.1        |
| Dec             | 1.50         | -24.2            | 2.8         | 35.5             | 9.4         | 62.1             | M                    | 0                     | 7.3           | 17.3             | 18.4        | 30.5        |
| <b>2013</b>     | <b>12.99</b> | <b>-43.5</b>     | <b>19.5</b> | <b>77.9</b>      | <b>10.5</b> | <b>74.9</b>      | <b>X</b>             | <b>864</b>            | <b>6.1</b>    | <b>24.0</b>      | <b>24.0</b> | <b>24.2</b> |



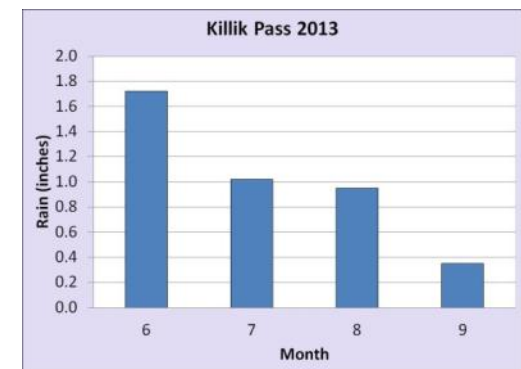
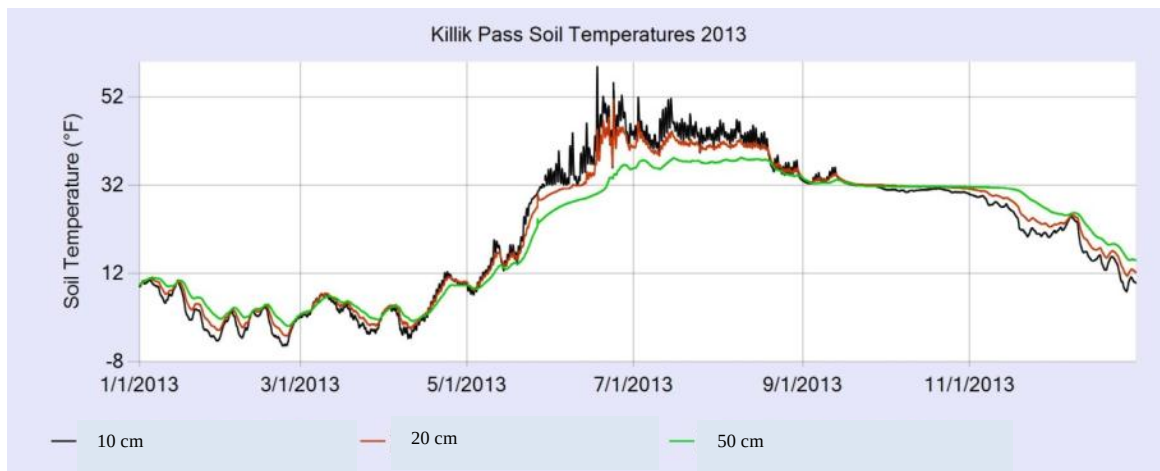
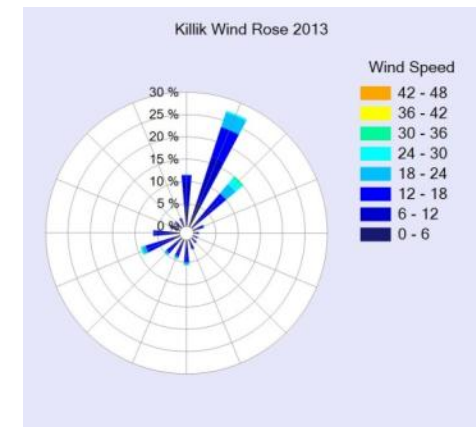
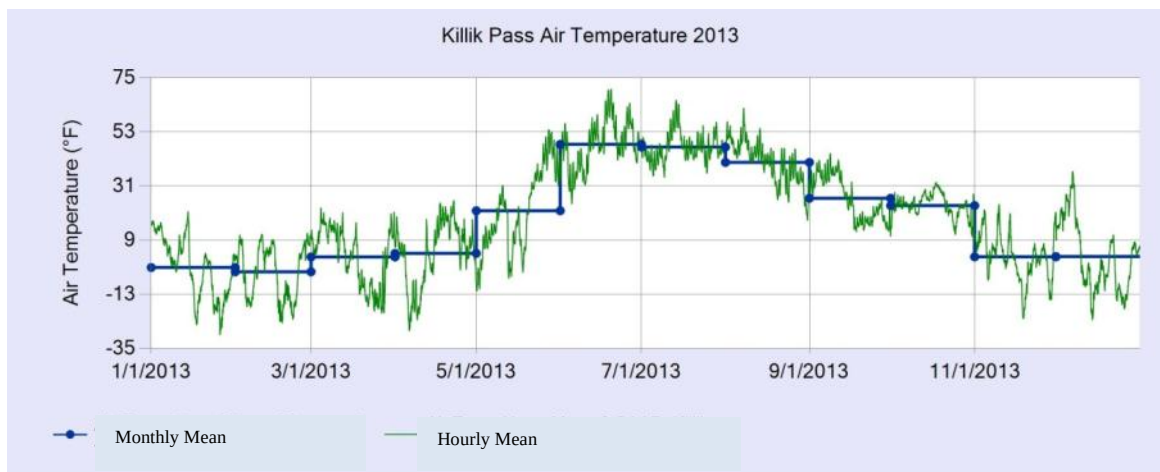
## Killik Pass – Gates of the Arctic National Park and Preserve

### Period of Record: August 2012 - present



Killik Pass is located in the NW corner of GAAR at an elevation of 4360 feet. The station overlooks the west-flowing Nigu River, the north-flowing Killik River, and the south-flowing Alatna River. The station is located in a transition area above low, wet tussock tundra and drier upland ridges. Although minimum winter temperatures were not as cold as many other ARCN sites in 2013, the annual mean temperature of 17.6°F at Killik Pass was the coldest site on average. Winds are also common at Killik with monthly averages above 10 mph each month. Snow is likely easily redistributed at the site due to cold temperatures and persistent winds.

| Killik Pass<br>2013 | Rain        | Air Temperature  |             |                  | Wind Speed  |                  | Relative<br>Humidity | Solar<br>Radiation    | Snow<br>Depth | Soil Temperature |             |             |
|---------------------|-------------|------------------|-------------|------------------|-------------|------------------|----------------------|-----------------------|---------------|------------------|-------------|-------------|
|                     | (inches)    | (°F)             |             |                  | (mph)       |                  | (%)                  | (KW m <sup>-2</sup> ) | (inches)      | (°F)             |             |             |
| Month               | Total       | Absolute<br>Min. | Mean        | Absolute<br>Max. | Mean        | Absolute<br>Max. | Mean                 | Total                 | Mean          | 10 cm            | 20 cm       | 50 cm       |
| Jan                 | 0.00        | -29.5            | -2.2        | 20.6             | 16.8        | 33.0             | 73                   | 3                     | 1.1           | 4.7              | 6.2         | 7.7         |
| Feb                 | 0.00        | -26.9            | -3.9        | 13.3             | 15.6        | 31.4             | 74                   | 20                    | 1.5           | 0.3              | 1.6         | 2.8         |
| Mar                 | 0.01        | -21.6            | 2.1         | 28.6             | 12.3        | 36.0             | 69                   | 59                    | 1.4           | 3.1              | 3.9         | 4.3         |
| Apr                 | 0.00        | -29.1            | 3.6         | 27.7             | 13.0        | 30.3             | 62                   | 157                   | 2.1           | 5.0              | 5.4         | 5.0         |
| May                 | 0.01        | -13.0            | 20.9        | 56.3             | 12.4        | 33.0             | 71                   | 211                   | 0.2           | 19.3             | 17.7        | 15.2        |
| Jun                 | 1.72        | 22.4             | 47.9        | 72.8             | 13.0        | 25.6             | 69                   | 169                   | 0.6           | 41.0             | 37.1        | 30.8        |
| Jul                 | 1.02        | 33.3             | 46.8        | 67.2             | 12.9        | 31.1             | 83                   | 131                   | 1.4           | 44.3             | 41.4        | 37.1        |
| Aug                 | 0.95        | 15.9             | 40.5        | 64.1             | 11.0        | 24.9             | 85                   | 108                   | 1.1           | 40.2             | 39.0        | 36.7        |
| Sep                 | 0.35        | 9.7              | 26.0        | 45.5             | 10.4        | 27.8             | 91                   | 53                    | 1.3           | 32.7             | 32.9        | 32.4        |
| Oct                 | 0.04        | 9.1              | 23.0        | 32.7             | 10.1        | 27.9             | 97                   | 19                    | 3.2           | 30.8             | 31.7        | 31.7        |
| Nov                 | 0.00        | -23.0            | 2.2         | 23.7             | 11.8        | 40.1             | 86                   | 3                     | 3.8           | 25.2             | 27.5        | 30.2        |
| Dec                 | 0.13        | -25.3            | 2.3         | 37.7             | 16.7        | 34.7             | 76                   | 0                     | 3.8           | 16.7             | 18.8        | 21.3        |
| <b>2013</b>         | <b>4.23</b> | <b>-29.5</b>     | <b>17.6</b> | <b>72.8</b>      | <b>13.0</b> | <b>40.1</b>      | <b>78</b>            | <b>933</b>            | <b>1.8</b>    | <b>22.1</b>      | <b>22.1</b> | <b>21.4</b> |

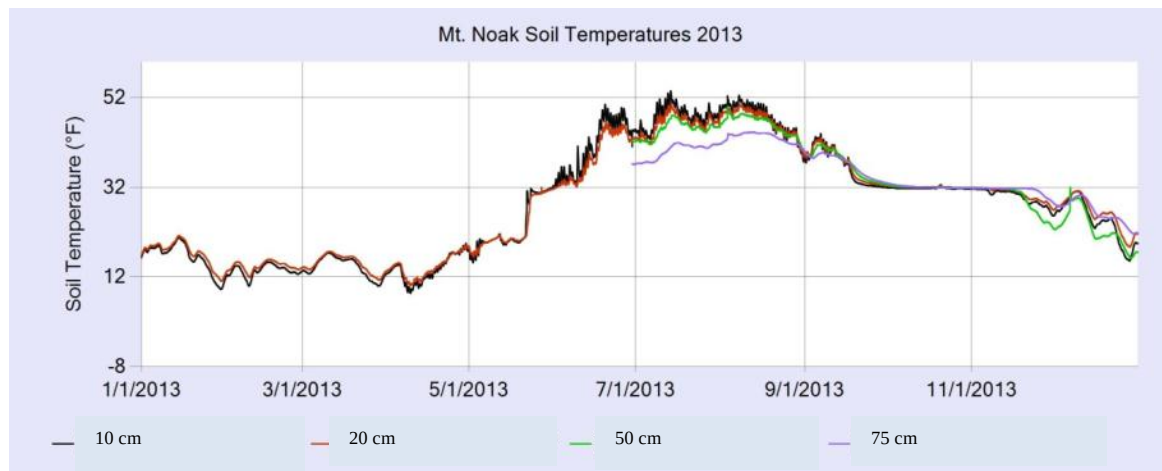
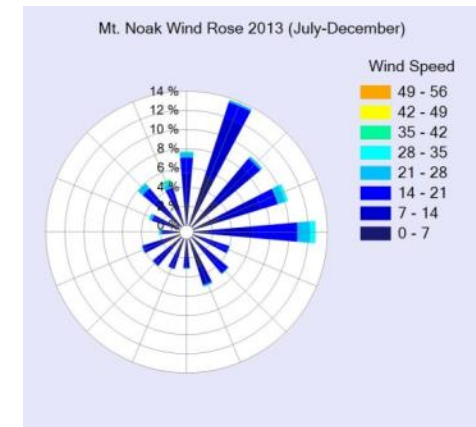
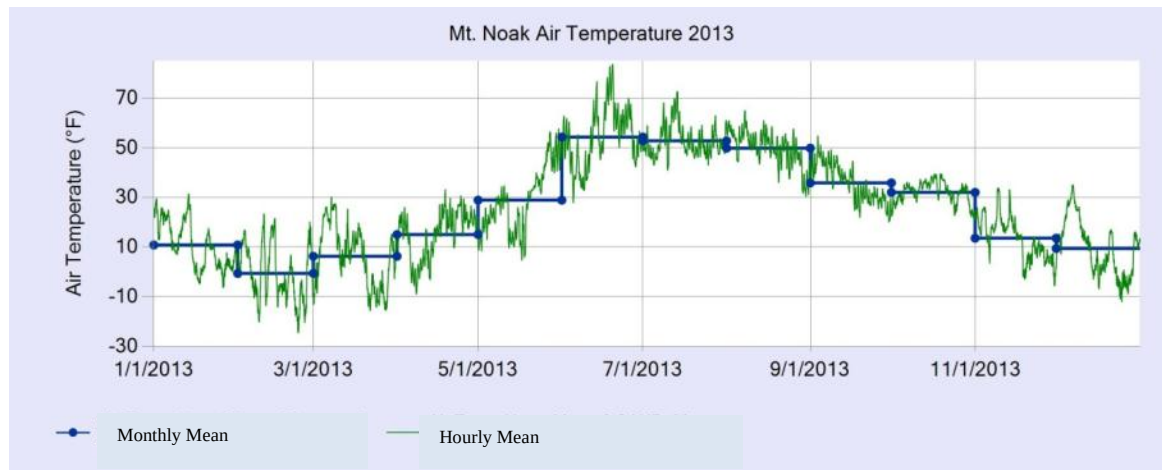


**Mt. Noak – Cape Krusenstern National Preserve**  
**Period of Record: July 2011 - present**



Mt. Noak station is located 20 miles NW of Kotzebue on a broad knoll at an elevation of 809 feet in CAKR. The location is influenced by the Chuckchi Sea which is less than 10 miles to the west. Vegetation at the site is low tundra. Temperatures ranged from -25.2°F to 85.7°F in 2013. Winter temperatures are somewhat moderated by the coastal influence compared to interior locations. Riming events are common in colder months. See Table 8 for a data quality summary.

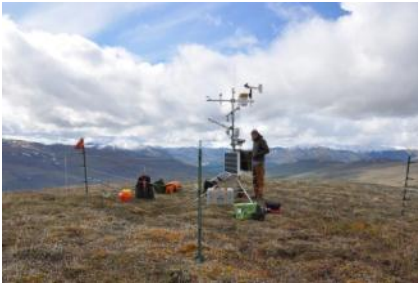
| Mt.<br>Noak<br>2013 | Rain     | Air Temperature  |             |                  | Wind Speed |                  | Relative<br>Humidity | Solar<br>Radiation    | Snow<br>Depth | Soil Temperature |             |          |          |
|---------------------|----------|------------------|-------------|------------------|------------|------------------|----------------------|-----------------------|---------------|------------------|-------------|----------|----------|
|                     | (inches) | (°F)             |             |                  | (mph)      |                  | (%)                  | (KW m <sup>-2</sup> ) | (inches)      | (°F)             |             |          |          |
| Month               | Total    | Absolute<br>Min. | Mean        | Absolute<br>Max. | Mean       | Absolute<br>Max. | Mean                 | Total                 | Mean          | 10 cm            | 20 cm       | 50 cm    | 75 cm    |
| Jan                 | M        | -8.5             | 10.8        | 31.9             | M          | M                | 69                   | M                     | M             | 16.4             | 17.3        | M        | M        |
| Feb                 | M        | -25.2            | -0.6        | 23.5             | M          | M                | 70                   | M                     | M             | 13.5             | 14.4        | M        | M        |
| Mar                 | M        | -16.8            | 6.3         | 30.7             | M          | M                | 70                   | M                     | M             | 14.2             | 15.0        | M        | M        |
| Apr                 | M        | -9.6             | 15.0        | 37.7             | M          | M                | 64                   | M                     | M             | 13.8             | 14.4        | M        | M        |
| May                 | M        | 4.3              | 28.9        | 58.7             | M          | M                | 78                   | M                     | M             | 23.3             | 23.0        | M        | M        |
| Jun                 | 0.42     | 26.5             | 54.3        | 85.7             | M          | M                | 64                   | M                     | M             | 41.0             | 38.9        | M        | M        |
| Jul                 | 2.71     | 40.8             | 52.8        | 74.0             | 8.7        | 24.2             | M                    | 134                   | 0.0           | 47.8             | 46.2        | 44.9     | 40.1     |
| Aug                 | M        | 29.5             | 49.8        | 65.3             | 8.0        | 32.9             | M                    | 113                   | 0.0           | 47.4             | 46.8        | 46.0     | 43.1     |
| Sep                 | M        | 19.4             | 35.8        | 55.9             | 10.7       | 34.9             | M                    | 67                    | 0.4           | 36.8             | 37.1        | 37.2     | 37.0     |
| Oct                 | M        | 19.9             | 32.0        | 40.1             | 12.1       | 32.7             | M                    | 20                    | 2.0           | 31.8             | 32.1        | 32.1     | 32.1     |
| Nov                 | M        | -6.8             | 13.6        | 34.2             | 13.4       | 49.6             | M                    | 4                     | M             | 30.0             | 30.6        | 29.6     | 31.4     |
| Dec                 | M        | -15.2            | 9.4         | 35.5             | 11.4       | 44.6             | M                    | 0                     | M             | 24.5             | 26.1        | 22.8     | 26.5     |
| <b>2013</b>         | <b>X</b> | <b>-25.2</b>     | <b>25.9</b> | <b>85.7</b>      | <b>X</b>   | <b>X</b>         | <b>X</b>             | <b>X</b>              | <b>X</b>      | <b>28.5</b>      | <b>28.6</b> | <b>X</b> | <b>X</b> |



\*Summer rainfall data unavailable due to damage by wildlife. See Table 8 for data quality summary.

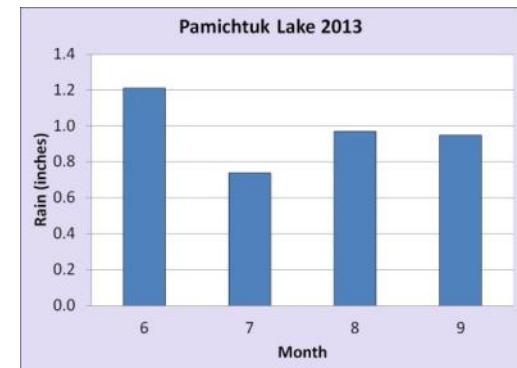
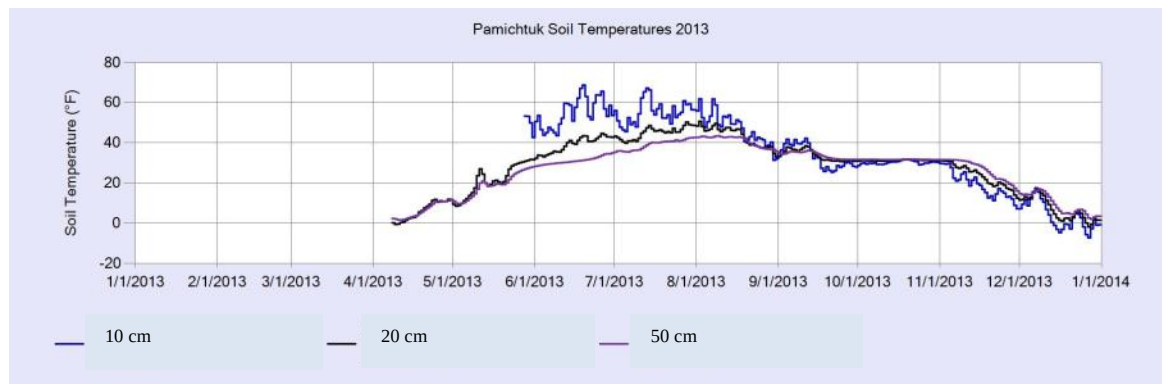
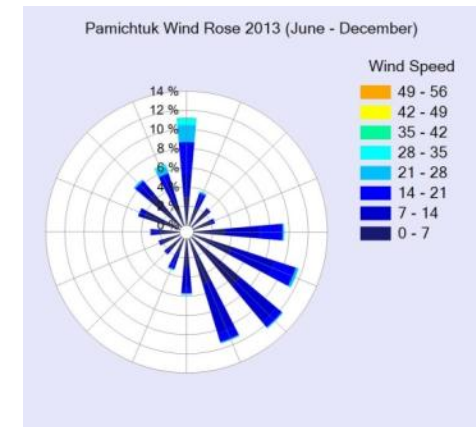
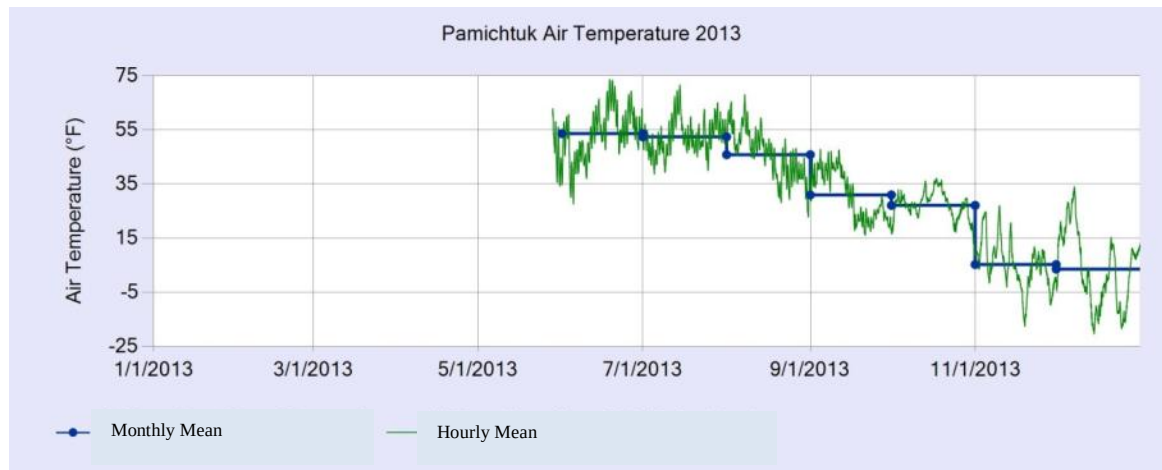
## Pamichtuk Lake – Gates of the Arctic National Park and Preserve

### Period of Record: August 2012 - present



The Pamichtuk Lake station is located in the Central Brooks Range near the headwaters of the John River at an elevation of 3135 feet. Pamichtuk Lake is located 2 miles to the west at an elevation of 1860 feet. Temperatures were as high as 75°F in June 2013. Average monthly soil temperatures at 50 cm ranged from 31.2°F in June to 40.9°F in August during summer 2013. The rain gage recorded about one inch of water each month in summer 2013. See Table 8 for a data quality summary.

| Pamichtuk Lake 2013 | Rain     | Air Temperature |          |               | Wind Speed |               | Relative Humidity | Solar Radiation       | Snow Depth | Soil Temperature |          |          |
|---------------------|----------|-----------------|----------|---------------|------------|---------------|-------------------|-----------------------|------------|------------------|----------|----------|
|                     | (inches) | (°F)            |          |               | (mph)      |               | (%)               | (KW m <sup>-2</sup> ) | (inches)   | (°F)             |          |          |
| Month               | Total    | Absolute Min.   | Mean     | Absolute Max. | Mean       | Absolute Max. | Mean              | Total                 | Mean       | 10 cm            | 20 cm    | 50 cm    |
| Jan                 | M        | M               | M        | M             | M          | M             | M                 | M                     | M          | M                | M        | M        |
| Feb                 | M        | M               | M        | M             | M          | M             | M                 | M                     | M          | M                | M        | M        |
| Mar                 | M        | M               | M        | M             | M          | M             | M                 | M                     | M          | M                | M        | M        |
| Apr                 | M        | M               | M        | M             | M          | M             | M                 | M                     | M          | M                | M        | M        |
| May                 | M        | M               | M        | M             | M          | M             | M                 | M                     | M          | M                | 21.4     | 19.0     |
| Jun                 | 1.21     | 26.9            | 53.6     | 75.0          | 8.8        | 29.0          | 55                | 190                   | 0.8        | 55.1             | 39.1     | 31.2     |
| Jul                 | 0.74     | 37.9            | 52.4     | 72.6          | 7.7        | 31.8          | 73                | 146                   | 1.5        | 55.1             | 45.1     | 39.1     |
| Aug                 | 0.97     | 22.2            | 45.8     | 69.2          | 8.4        | 39.1          | 74                | 111                   | 1.2        | 47.3             | 43.3     | 40.9     |
| Sep                 | 0.95     | 15.1            | 30.9     | 49.4          | 8.7        | 29.5          | 84                | 56                    | 1.0        | 33.3             | 33.7     | 33.8     |
| Oct                 | 0.29     | 7.4             | 27.1     | 37.8          | 8.2        | 36.8          | 93                | 19                    | 1.4        | 30.2             | 31.3     | 31.7     |
| Nov                 | 0.00     | -18.8           | 5.2      | 27.1          | 9.9        | 37.6          | 81                | 4                     | 1.4        | 19.0             | 23.6     | 26.6     |
| Dec                 | 0.00     | -21.3           | 3.5      | 34.8          | 8.3        | 43.8          | 67                | 0                     | 1.0        | 3.6              | 6.6      | 9.1      |
| <b>2013</b>         | <b>X</b> | <b>X</b>        | <b>X</b> | <b>75.0</b>   | <b>X</b>   | <b>X</b>      | <b>X</b>          | <b>X</b>              | <b>X</b>   | <b>X</b>         | <b>X</b> | <b>X</b> |



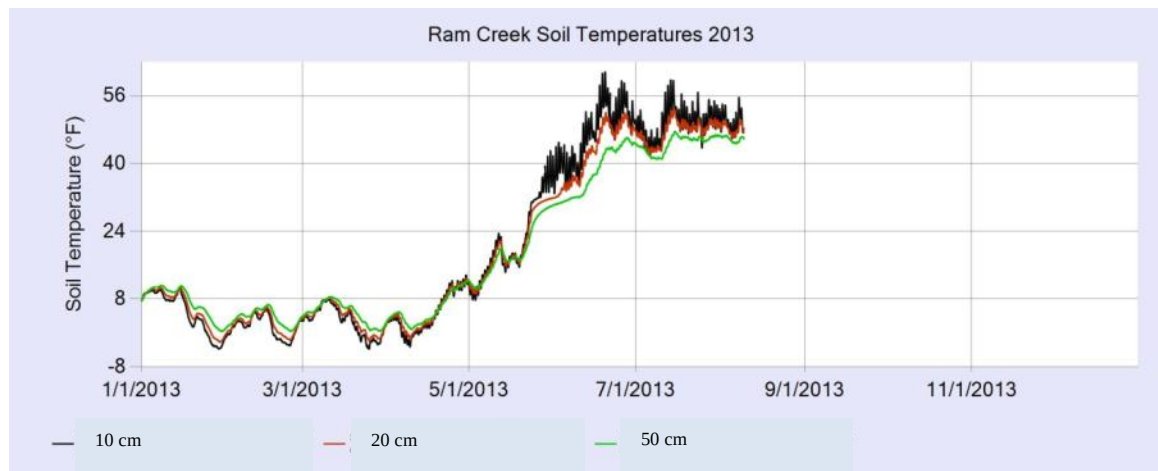
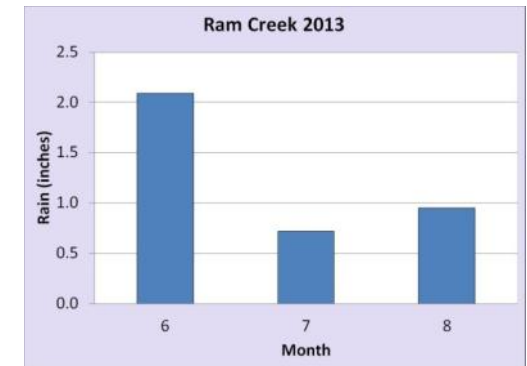
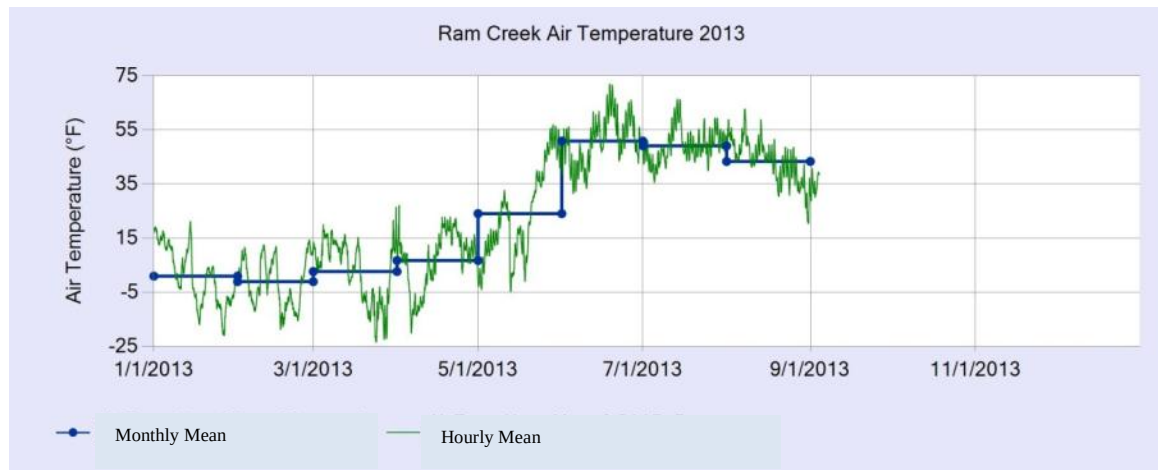
## Ram Creek – Gates of the Arctic National Park and Preserve

### Period of Record: August 2012 - present



Ram Creek is located in a mountainous region of central GAAR at an elevation of 4100 feet. The station is located on the SE edge of a ridgeline, with commanding views of the Alatna River to the south. Temperatures from January through August ranged from -23.8°F to 73.2°F. Inversions are common and moderate temperatures at higher elevations in winter. The station experiences moderate and consistent winds, with monthly means between 7.7 and 9.4 mph from January to July. See Table 8 for a data quality summary.

| Ram Creek<br>2013 | Rain     | Air Temperature  |          |                  | Wind Speed |                  | Relative<br>Humidity | Solar<br>Radiation    | Snow<br>Depth | Soil Temperature |          |          |
|-------------------|----------|------------------|----------|------------------|------------|------------------|----------------------|-----------------------|---------------|------------------|----------|----------|
|                   | (inches) | (°F)             |          |                  | (mph)      |                  | (%)                  | (KW m <sup>-2</sup> ) | (inches)      | (°F)             |          |          |
| Month             | Total    | Absolute<br>Min. | Mean     | Absolute<br>Max. | Mean       | Absolute<br>Max. | Mean                 | Total                 | Mean          | 10 cm            | 20 cm    | 50 cm    |
| Jan               | 0.00     | -22.3            | 0.9      | 21.4             | 9.4        | 32.1             | 69                   | 3                     | M             | 4.8              | 5.9      | 7.4      |
| Feb               | 0.00     | -19.7            | -1.1     | 14.6             | 7.7        | 32.2             | 72                   | 17                    | 9.8           | 1.3              | 2.2      | 3.5      |
| Mar               | 0.18     | -23.8            | 2.6      | 28.4             | 8.0        | 44.0             | 66                   | 56                    | 9.6           | 2.6              | 3.5      | 4.7      |
| Apr               | 0.02     | -21.2            | 6.7      | 31.5             | 7.7        | 33.9             | 58                   | 150                   | 9.7           | 4.6              | 5.0      | 5.5      |
| May               | 0.00     | -5.1             | 24.0     | 58.8             | 9.1        | 44.3             | 63                   | 208                   | 7.4           | 21.4             | 20.2     | 19.3     |
| Jun               | 2.09     | 30.8             | 50.8     | 73.2             | 8.9        | 34.0             | 60                   | 193                   | 0             | 47.1             | 42.6     | 37.8     |
| Jul               | 0.72     | 35.3             | 49.0     | 69.4             | 8.0        | 33.0             | 77                   | 148                   | 0             | 49.7             | 47.6     | 44.7     |
| Aug               | 0.95     | 20.0             | 43.3     | 64.6             | M          | M                | M                    | M                     | M             | M                | M        | M        |
| Sep               | M        | M                | M        | M                | M          | M                | M                    | M                     | M             | M                | M        | M        |
| Oct               | M        | M                | M        | M                | M          | M                | M                    | M                     | M             | M                | M        | M        |
| Nov               | M        | M                | M        | M                | M          | M                | M                    | M                     | M             | M                | M        | M        |
| Dec               | M        | M                | M        | M                | M          | M                | M                    | M                     | M             | M                | M        | M        |
| <b>2013</b>       | <b>X</b> | <b>X</b>         | <b>X</b> | <b>73.2</b>      | <b>X</b>   | <b>X</b>         | <b>X</b>             | <b>X</b>              | <b>X</b>      | <b>X</b>         | <b>X</b> | <b>X</b> |



\*Summer rainfall data unavailable due to damage by wildlife. See Table 8 for data quality summary.

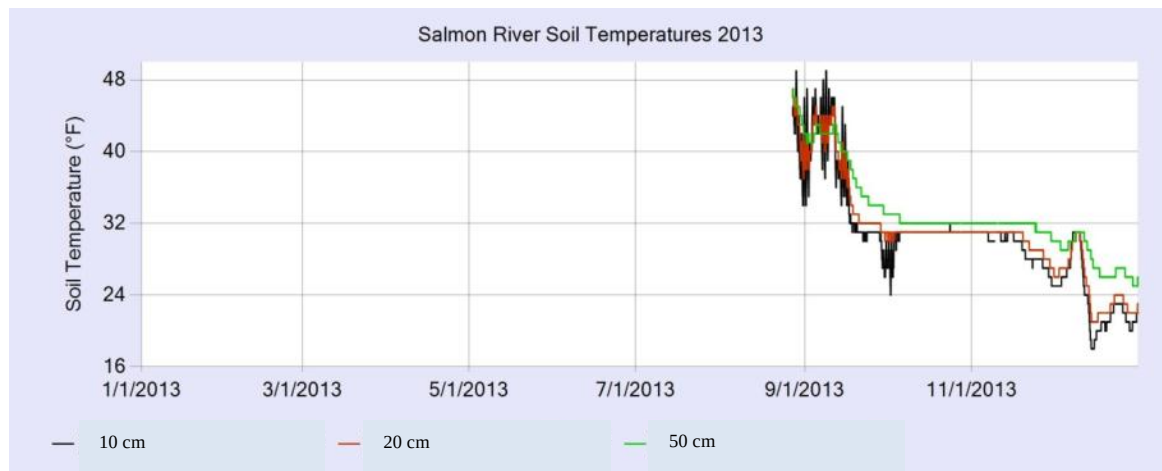
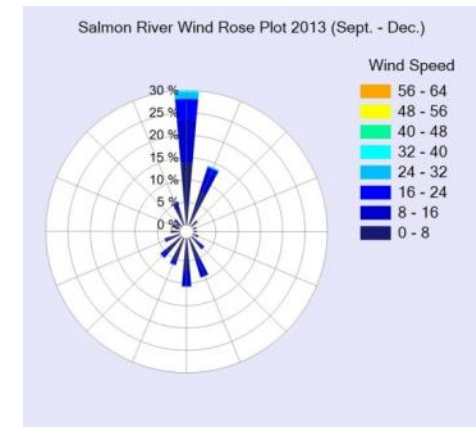
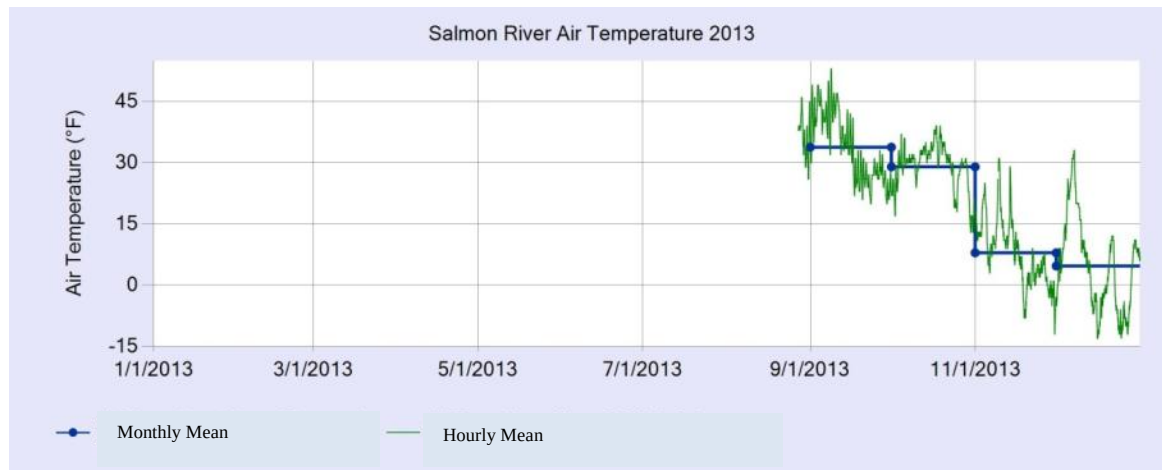
## Salmon River – Kobuk Valley National Preserve

### Period of Record: July 2011 - present



The Salmon River station is located at an elevation of 1262 feet, 35 miles NW of the Kobuk Valley Sand Dunes in the western Baird Mountains. The station overlooks the Salmon River to the south. Vegetation near the site is dwarf shrub tundra, dwarf birch, and some spruce krummholz in hollows. The station was destroyed by a bear shortly after initial installation in 2011 and reinstalled in summer 2013. See Table 8 for a data quality summary.

| Salmon River 2013 | Rain     | Air Temperature |          |               | Wind Speed |               | Relative Humidity | Solar Radiation       | Snow Depth | Soil Temperature |          |          |
|-------------------|----------|-----------------|----------|---------------|------------|---------------|-------------------|-----------------------|------------|------------------|----------|----------|
|                   | (inches) | (°F)            |          |               | (mph)      |               | (%)               | (KW m <sup>-2</sup> ) | (inches)   | (°F)             |          |          |
| Month             | Total    | Absolute Min.   | Mean     | Absolute Max. | Mean       | Absolute Max. | Mean              | Total                 | Mean       | 10 cm            | 20 cm    | 50 cm    |
| Jan               | M        | M               | M        | M             | M          | M             | M                 | M                     | M          | M                | M        | M        |
| Feb               | M        | M               | M        | M             | M          | M             | M                 | M                     | M          | M                | M        | M        |
| Mar               | M        | M               | M        | M             | M          | M             | M                 | M                     | M          | M                | M        | M        |
| Apr               | M        | M               | M        | M             | M          | M             | M                 | M                     | M          | M                | M        | M        |
| May               | M        | M               | M        | M             | M          | M             | M                 | M                     | M          | M                | M        | M        |
| Jun               | M        | M               | M        | M             | M          | M             | M                 | M                     | M          | M                | M        | M        |
| Jul               | M        | M               | M        | M             | M          | M             | M                 | M                     | M          | M                | M        | M        |
| Aug               | M        | M               | M        | M             | M          | M             | M                 | M                     | M          | M                | M        | M        |
| Sep               | 4.02     | 19.0            | 33.8     | 54.0          | 7.9        | 29.0          | 80                | 53                    | 0.1        | 36.3             | 37.1     | 38.6     |
| Oct               | 5.59     | 11.0            | 29.0     | 40.0          | 6.1        | 29.0          | 90                | 9                     | 4.4        | 30.7             | 31.0     | 32.2     |
| Nov               | 0.00     | -14.0           | 7.9      | 31.0          | 8.2        | 47.0          | 80                | 0                     | 12.1       | 29.4             | 30.2     | 31.8     |
| Dec               | 0.01     | -15.0           | 4.7      | 33.0          | 8.7        | 42.0          | 75                | 0                     | 16.3       | 23.6             | 24.7     | 27.9     |
| <b>2013</b>       | <b>X</b> | <b>X</b>        | <b>X</b> | <b>X</b>      | <b>X</b>   | <b>X</b>      | <b>X</b>          | <b>X</b>              | <b>X</b>   | <b>X</b>         | <b>X</b> | <b>X</b> |



\*Summer rain data unavailable due to damage by wildlife. See Table 8 for data quality summary.

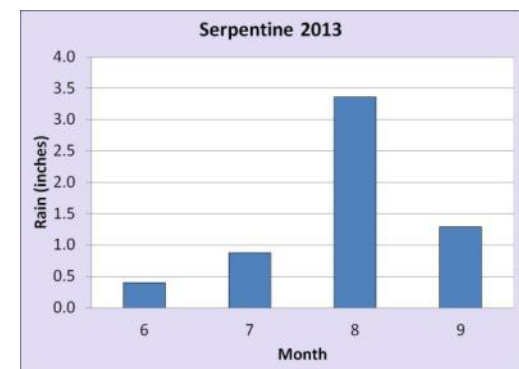
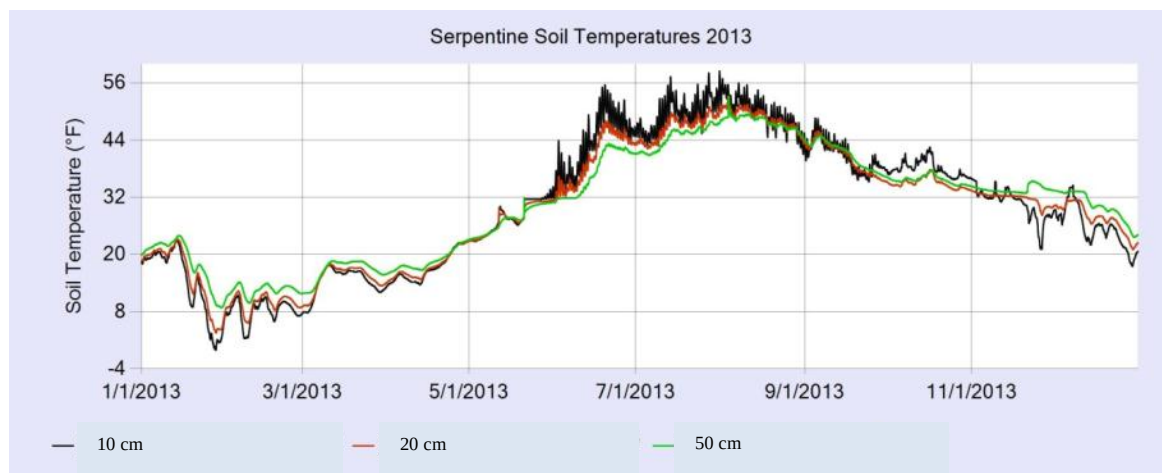
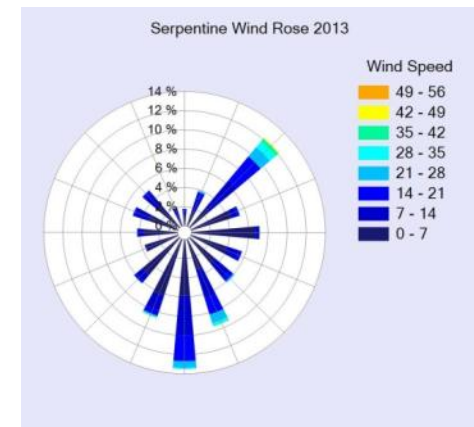
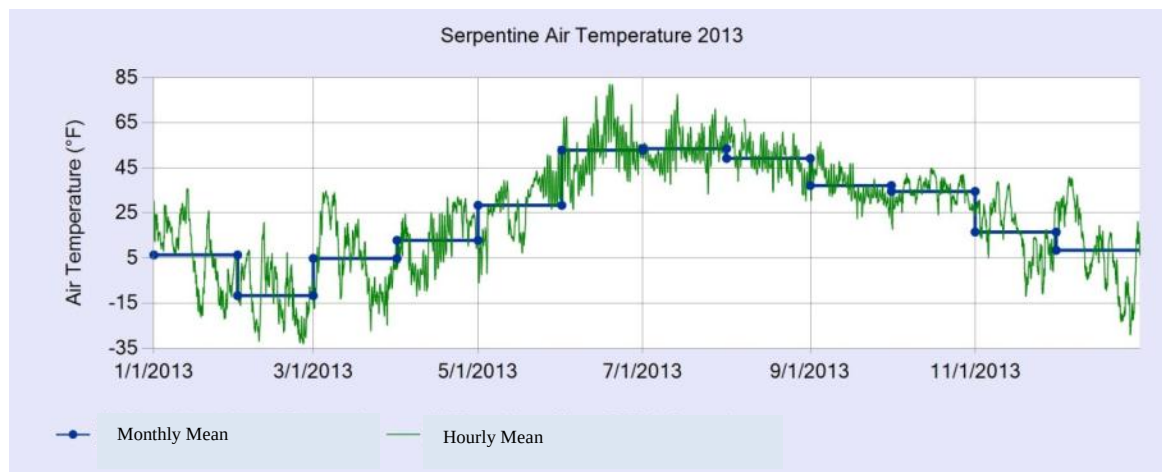
## Serpentine – Bering Land Bridge National Preserve

### Period of Record: August 2011 - present



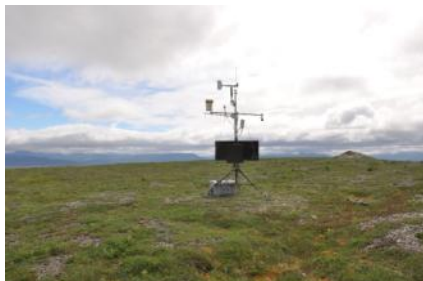
Serpentine is located in the central Seward Peninsula at an elevation of 518 feet. The site is surrounded by gentle, rolling hills and granite tors. Vegetation near the site is composed of dwarf birch, lichens, and low tundra. Temperatures ranged from –35.4°F to 83.4°F in 2013 with a mean annual air temperature of 24.7°F. Winds are moderate with a mean wind speed of 7.8 mph in 2013 and calm conditions 20% of the year. About 18 inches of snow accumulated at the site in 2013 and persisted through late May.

| Serpentine<br>2013 | Rain        | Air Temperature  |             |                  | Wind Speed |                  | Relative<br>Humidity | Solar<br>Radiation    | Snow<br>Depth | Soil Temperature |             |             |
|--------------------|-------------|------------------|-------------|------------------|------------|------------------|----------------------|-----------------------|---------------|------------------|-------------|-------------|
|                    | (inches)    | (°F)             |             |                  | (mph)      |                  | (%)                  | (KW m <sup>-2</sup> ) | (inches)      | (°F)             |             |             |
| Month              | Total       | Absolute<br>Min. | Mean        | Absolute<br>Max. | Mean       | Absolute<br>Max. | Mean                 | Total                 | Mean          | 10 cm            | 20 cm       | 50 cm       |
| Jan                | 0.00        | -25.0            | 6.4         | 36.6             | 11.7       | 57.1             | 76                   | 3                     | 1.1           | 14.0             | 15.6        | 18.4        |
| Feb                | 0.00        | -35.4            | -11.6       | 24.3             | 5.6        | 46.9             | 72                   | 20                    | 8.2           | 8.2              | 9.8         | 12.5        |
| Mar                | 0.00        | -28.7            | 4.9         | 35.3             | 7.4        | 42.8             | 71                   | 72                    | 13.7          | 14.3             | 15.0        | 16.6        |
| Apr                | 0.00        | -13.9            | 12.9        | 40.3             | 8.1        | 39.9             | 72                   | 136                   | 16.4          | 17.2             | 17.6        | 18.7        |
| May                | 0.04        | -9.2             | 28.4        | 55.9             | 11.1       | 45.6             | 78                   | 181                   | 12.7          | 27.8             | 27.5        | 27.3        |
| Jun                | 0.40        | 26.0             | 52.8        | 83.4             | 7.6        | 28.8             | 66                   | 173                   | 0.4           | 43.4             | 40.1        | 37.2        |
| Jul                | 0.88        | 31.8             | 53.5        | 79.9             | 7.2        | 29.8             | 76                   | 137                   | 0.7           | 49.4             | 46.7        | 44.5        |
| Aug                | 3.36        | 29.3             | 49.2        | 69.0             | 5.6        | 22.3             | 83                   | 93                    | 1.0           | 49.8             | 48.7        | 47.8        |
| Sep                | 1.29        | 19.6             | 37.2        | 58.1             | 5.9        | 38.1             | 83                   | 58                    | 1.1           | 40.7             | 40.4        | 40.9        |
| Oct                | 1.14        | 15.5             | 34.5        | 45.4             | 7.2        | 37.9             | 87                   | 22                    | 1.2           | 38.0             | 35.0        | 35.6        |
| Nov                | 0.47        | -16.6            | 16.5        | 39.3             | 8.6        | 58.3             | 79                   | 5                     | 1.8           | 30.7             | 31.8        | 33.7        |
| Dec                | 0.24        | -31.4            | 8.5         | 41.9             | 6.7        | 33.9             | 79                   | 1                     | 1.8           | 25.7             | 27.7        | 30.2        |
| <b>2013</b>        | <b>7.82</b> | <b>-35.4</b>     | <b>24.7</b> | <b>83.4</b>      | <b>7.8</b> | <b>58.3</b>      | <b>77</b>            | <b>903</b>            | <b>5.0</b>    | <b>30.1</b>      | <b>29.8</b> | <b>30.4</b> |



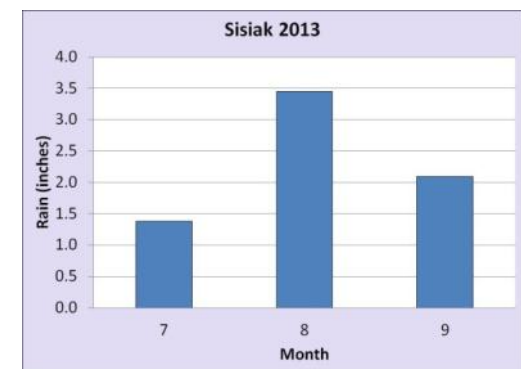
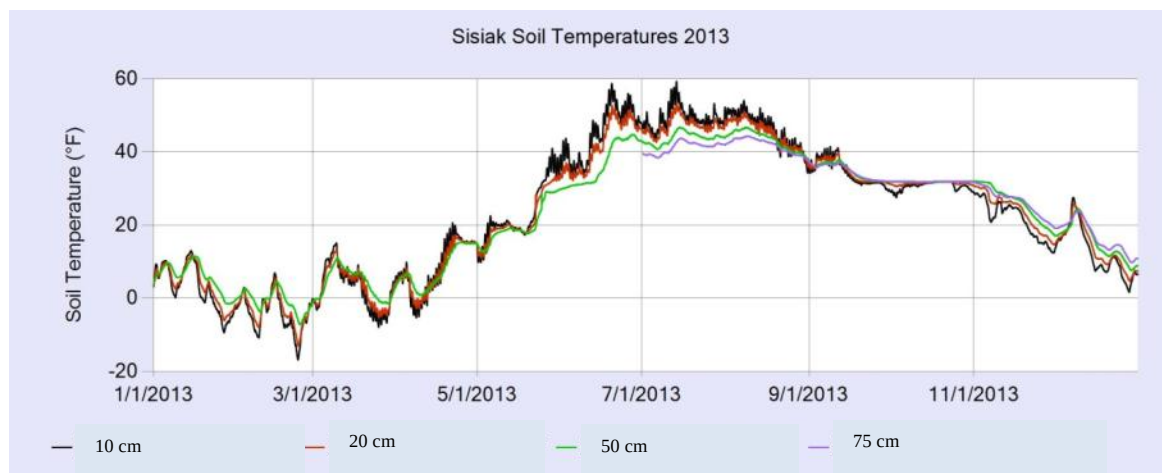
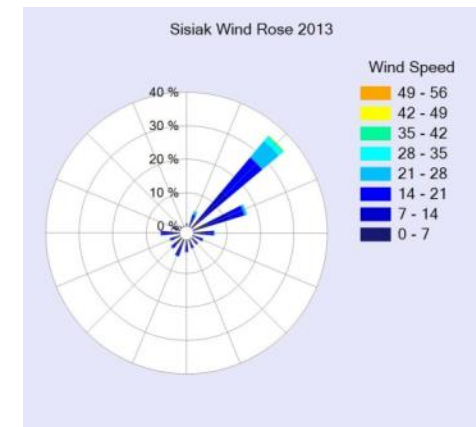
## Sisiak – Noatak National Preserve

### Period of Record: July 2011 - present



Sisiak overlooks the Noatak River about 100 miles upstream of Kotzebue. The station is located among rolling tundra at an elevation of 1823 feet. Expansive low plateaus extend in every direction with some higher peaks to the north. Vegetation is composed of dwarf shrub tundra with channery metamorphic rock. Temperatures ranged from  $-35.1^{\circ}\text{F}$  to  $81.2^{\circ}\text{F}$  in 2013 with a mean annual air temperature of  $21.8^{\circ}\text{F}$ . Winds averaged 12.2 mph in 2013. Snow likely does not accumulate at the site due to redistribution by wind in winter months.

| Sisiak<br>2013 | Rain     | Air Temperature        |             |                  | Wind Speed  |                  | Relative<br>Humidity | Solar<br>Radiation     | Snow<br>Depth | Soil Temperature       |             |             |             |
|----------------|----------|------------------------|-------------|------------------|-------------|------------------|----------------------|------------------------|---------------|------------------------|-------------|-------------|-------------|
|                | (inches) | ( $^{\circ}\text{F}$ ) |             |                  | (mph)       |                  | (%)                  | ( $\text{KW m}^{-2}$ ) | (inches)      | ( $^{\circ}\text{F}$ ) |             |             |             |
| Month          | Total    | Absolute<br>Min.       | Mean        | Absolute<br>Max. | Mean        | Absolute<br>Max. | Mean                 | Total                  | Mean          | 10 cm                  | 20 cm       | 50 cm       | 75 cm       |
| Jan            | 0.00     | -21.3                  | 2.6         | 28.8             | 19.7        | 52.0             | 71                   | 2                      | 0.5           | 2.8                    | 3.9         | 5.7         | X           |
| Feb            | 0.00     | -35.1                  | -5.7        | 19.9             | 17.0        | 46.0             | 72                   | 18                     | 0.5           | -4.3                   | -3.1        | -0.9        | X           |
| Mar            | 0.00     | -20.7                  | 4.1         | 27.2             | 10.9        | 30.5             | 70                   | 70                     | 0.6           | 2.7                    | 3.1         | 4.0         | X           |
| Apr            | 0.00     | -18.6                  | 9.7         | 30.2             | 12.3        | 43.8             | 65                   | 146                    | 1.1           | 8.3                    | 8.0         | 8.0         | X           |
| May            | 0.12     | -2.4                   | 26.7        | 60.6             | 11.1        | 33.9             | 74                   | 187                    | 1.4           | 23.1                   | 21.6        | 20.2        | X           |
| Jun            | M        | 26.4                   | 52.4        | 81.2             | 9.2         | 31.7             | 66                   | 170                    | 0.0           | 45.2                   | 41.9        | 36.7        | X           |
| Jul            | 1.38     | 39.8                   | 51.4        | 73.6             | 9.6         | 32.6             | 82                   | 119                    | 0.3           | 49.2                   | 47.1        | 43.7        | 41.2        |
| Aug            | 3.45     | 26.0                   | 46.0        | 62.0             | 9.7         | 27.4             | 80                   | 104                    | 0.0           | 45.9                   | 44.9        | 43.2        | 41.8        |
| Sep            | 2.09     | 17.9                   | 31.9        | 49.9             | 11.3        | 31.8             | 86                   | 56                     | 0.0           | 34.4                   | 34.6        | 34.7        | 34.6        |
| Oct            | 0.77     | 13.1                   | 28.2        | 37.1             | 11.7        | 36.6             | 96                   | 18                     | 0.0           | 30.7                   | 31.4        | 31.9        | 31.9        |
| Nov            | 0.00     | -12.9                  | 7.5         | 32.5             | 12.1        | 45.4             | 88                   | 3                      | 0.0           | 21.8                   | 24.0        | 26.3        | 26.6        |
| Dec            | 0.08     | -20.5                  | 5.2         | 36.5             | 11.8        | 36.6             | 81                   | 0                      | 0.0           | 12.5                   | 13.9        | 15.5        | 16.8        |
| <b>2013</b>    | <b>X</b> | <b>-35.1</b>           | <b>21.8</b> | <b>81.2</b>      | <b>12.2</b> | <b>52.0</b>      | <b>78</b>            | <b>892</b>             | <b>0.4</b>    | <b>22.9</b>            | <b>22.8</b> | <b>22.6</b> | <b>32.1</b> |



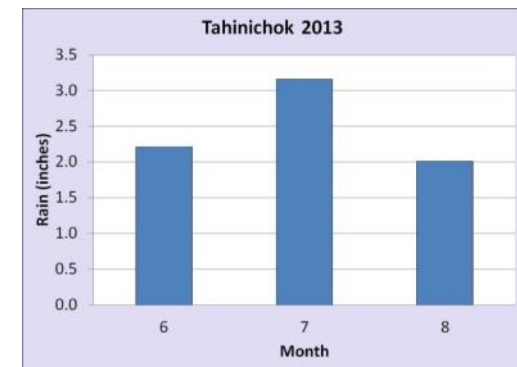
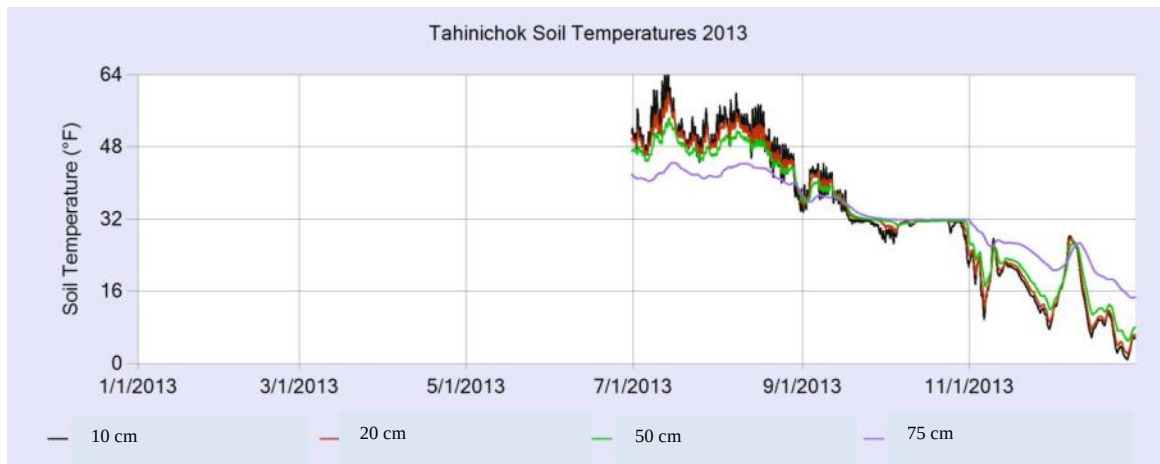
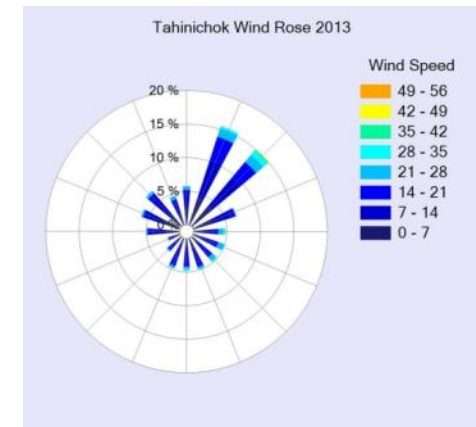
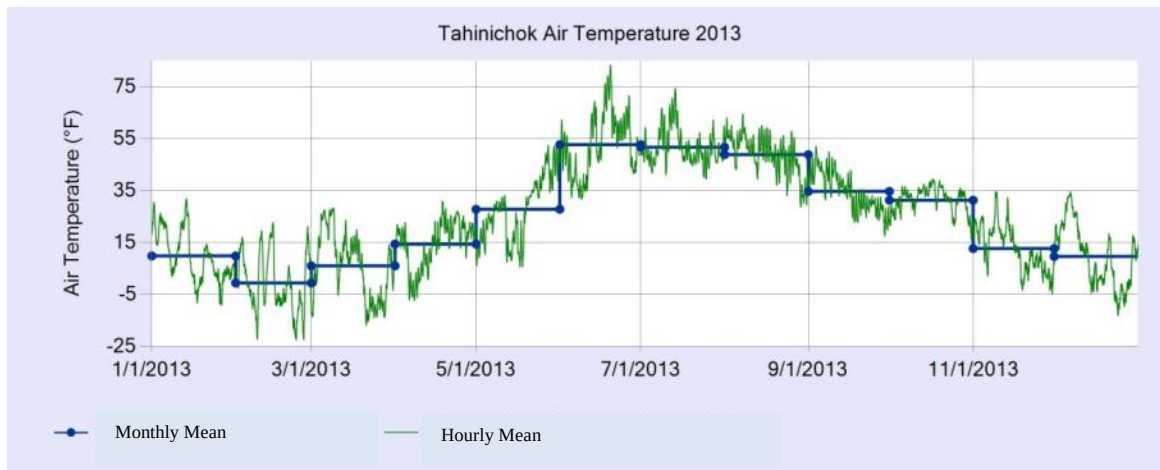
## Tahinichok – Cape Krusenstern National Preserve

### Period of Record: July 2011 - present



Tahinichok is located in CAKR, 60 miles north of Kotzebue at an elevation of 966 feet. The station is sited on broad sloping hills just north of the Rabbit Creek drainage. Vegetation near the site is composed of dwarf shrub tundra with hummocks (*Lupinus*, *Betula nana*, *Empetrum*, *Arctous alpine*, *Arternisia arctica*, *Ledum*, *Hierchloe alpine*). Temperatures ranged from  $-23.4^{\circ}\text{F}$  to  $85.1^{\circ}\text{F}$  in 2013 with a mean annual air temperature of  $25.1^{\circ}\text{F}$ . Fall and winter temperatures are mild compared to interior sites due to the influence of the Chukchi Sea which is about 10 miles west. Winds averaged 11.3 mph in 2013. Snow is likely redistributed by wind in winter months. See Table 8 for a data quality summary.

| Tahinichok<br>2013 | Rain     | Air Temperature        |             |                  | Wind Speed  |                  | Relative<br>Humidity | Solar<br>Radiation     | Snow<br>Depth | Soil Temperature       |          |          |          |
|--------------------|----------|------------------------|-------------|------------------|-------------|------------------|----------------------|------------------------|---------------|------------------------|----------|----------|----------|
|                    | (inches) | ( $^{\circ}\text{F}$ ) |             |                  | (mph)       |                  | (%)                  | ( $\text{KW m}^{-2}$ ) | (inches)      | ( $^{\circ}\text{F}$ ) |          |          |          |
| Month              | Total    | Absolute<br>Min.       | Mean        | Absolute<br>Max. | Mean        | Absolute<br>Max. | Mean                 | Total                  | Mean          | 10<br>cm               | 20<br>cm | 50<br>cm | 75<br>cm |
| Jan                | 0.00     | -9.9                   | 9.8         | 31.9             | 16.0        | 55.4             | 69                   | 2                      | 2.8           | M                      | M        | M        | X        |
| Feb                | 0.00     | -23.4                  | -0.6        | 22.7             | 12.5        | 43.9             | 70                   | 19                     | 1.6           | M                      | M        | M        | X        |
| Mar                | 0.00     | -17.6                  | 6.0         | 28.4             | 11.1        | 48.6             | 71                   | 72                     | 1.2           | M                      | M        | M        | X        |
| Apr                | 0.00     | -8.0                   | 14.4        | 33.9             | 10.5        | 39.7             | 61                   | 147                    | 0.9           | M                      | M        | M        | X        |
| May                | M        | 4.8                    | 27.8        | 53.9             | 14.0        | 42.3             | M                    | 180                    | M             | M                      | M        | M        | X        |
| Jun                | M        | 31.5                   | 52.7        | 85.1             | 9.0         | 28.9             | M                    | 176                    | M             | M                      | M        | M        | X        |
| Jul                | 2.21     | 38.9                   | 51.7        | 75.6             | 10.5        | 33.9             | 86                   | 121                    | 0.0           | 52.3                   | 50.7     | 48.1     | 42.0     |
| Aug                | 3.16     | 27.9                   | 48.9        | 65.3             | 8.2         | 27.4             | 80                   | 111                    | 0.1           | 49.3                   | 48.4     | 46.7     | 42.2     |
| Sep                | 2.01     | 16.3                   | 34.7        | 52.6             | 10.8        | 34.7             | 83                   | 65                     | 0.3           | 35.3                   | 35.6     | 35.4     | 35.0     |
| Oct                | 1.36     | 15.3                   | 31.3        | 39.8             | 10.8        | 34.8             | 94                   | 18                     | 0.8           | 30.6                   | 31.1     | 31.4     | 32.0     |
| Nov                | 0.04     | -6.3                   | 12.7        | 34.9             | 11.3        | 55.6             | 88                   | 3                      | 3.4           | 17.9                   | 18.9     | 20.7     | 26.4     |
| Dec                | 0.47     | -14.0                  | 9.6         | 34.8             | 11.6        | 41.4             | 80                   | 0                      | 5.1           | 11.9                   | 12.7     | 14.3     | 20.5     |
| <b>2013</b>        | <b>X</b> | <b>-23.4</b>           | <b>25.1</b> | <b>85.1</b>      | <b>11.3</b> | <b>55.6</b>      | <b>X</b>             | <b>916</b>             | <b>X</b>      | <b>X</b>               | <b>X</b> | <b>X</b> | <b>X</b> |



## Appendix B. AWOS Station Summaries

| Anaktuvuk<br>Pass 2013 | Air Temperature  |       |                  | Wind Speed |                  | Relative<br>Humidity |
|------------------------|------------------|-------|------------------|------------|------------------|----------------------|
|                        | (°F)             |       |                  | (mph)      |                  | (%)                  |
| Month                  | Absolute<br>Min. | Mean  | Absolute<br>Max. | Mean       | Absolute<br>Max. | Mean                 |
| Jan                    | -32.8            | -10.2 | 26.6             | 9.0        | 35.7             | 68                   |
| Feb                    | -45.4            | -18.4 | 10.4             | 9.8        | 31.1             | 60                   |
| Mar                    | -23.8            | -2.9  | 24.8             | 10.4       | 28.8             | 58                   |
| Apr                    | M                | M     | M                | M          | M                | M                    |
| May                    | M                | M     | M                | M          | M                | M                    |
| Jun                    | 23.0             | 53.6  | 80.6             | 8.0        | 33.4             | 55                   |
| Jul                    | 37.4             | 54.2  | 77.0             | 8.1        | 26.5             | 65                   |
| Aug                    | M                | M     | M                | M          | M                | M                    |
| Sep                    | 10.4             | 30.6  | 51.8             | 8.1        | 24.2             | 67                   |
| Oct                    | 6.8              | 26.5  | 42.8             | 7.8        | 29.9             | 70                   |
| Nov                    | -25.6            | 1.8   | 33.8             | 10.6       | 41.4             | 64                   |
| Dec                    | -29.2            | -5.1  | 39.2             | 11.0       | 33.4             | 63                   |
| <b>2013 Annual</b>     | -45.4            | X     | 80.6             | X          | X                | X                    |

## Appendix C. Fire RAWS Station Summaries

| Hoodoo Hill<br>2013 | Rain        | Air Temperature |          |               | Wind Speed |               | Relative Humidity | Solar Radiation       |
|---------------------|-------------|-----------------|----------|---------------|------------|---------------|-------------------|-----------------------|
|                     | (inches)    | (°F)            |          |               | (mph)      |               | (%)               | (KW m <sup>-2</sup> ) |
| Month               | Total       | Absolute Min.   | Mean     | Absolute Max. | Mean       | Absolute Max. | Mean              | Total                 |
| Jan                 | 0.00        | -17             | 2.8      | 31            | 8.2        | 54            | 75                | 4                     |
| Feb                 | 0.00        | -26             | -7.3     | 18            | 8.2        | 48            | 69                | 22                    |
| Mar                 | 0.00        | -24             | 3.2      | 37            | 11.8       | 44            | 72                | 73                    |
| Apr                 | 0.02        | M               | M        | M             | M          | M             | M                 | M                     |
| May                 | 0.01        | M               | M        | M             | M          | M             | M                 | M                     |
| Jun                 | 0.54        | M               | M        | M             | M          | M             | M                 | M                     |
| Jul                 | 1.19        | M               | M        | M             | M          | M             | M                 | M                     |
| Aug                 | 3.27        | 29              | 48.0     | 68            | 4.5        | 14            | 87                | 121                   |
| Sep                 | 1.42        | 19              | 33.1     | 52            | 4.9        | 18            | 91                | 67                    |
| Oct                 | 0.89        | 19              | 29.5     | 40            | 5.2        | 20            | 97                | 25                    |
| Nov                 | 0.24        | -12             | 12.3     | 36            | 5.8        | 33            | 87                | 4                     |
| Dec                 | 0.57        | -18             | 5.8      | 36            | 5.2        | 20            | 82                | 1                     |
| <b>2013 Annual</b>  | <b>8.15</b> | <b>X</b>        | <b>X</b> | <b>X</b>      | <b>X</b>   | <b>X</b>      | <b>X</b>          | <b>X</b>              |

| Norutak<br>Lake 2013 | Rain     | Air Temperature |             |               | Wind Speed |               | Relative Humidity | Solar Radiation       |
|----------------------|----------|-----------------|-------------|---------------|------------|---------------|-------------------|-----------------------|
|                      | (inches) | (°F)            |             |               | (mph)      |               | (%)               | (KW m <sup>-2</sup> ) |
| Month                | Total    | Absolute Min.   | Mean        | Absolute Max. | Mean       | Absolute Max. | Mean              | Total                 |
| Jan                  | X        | -44             | -6.8        | 25            | 0.7        | 12            | 82                | 0                     |
| Feb                  | X        | -46             | -8.4        | 20            | 1.1        | 12            | 79                | 3                     |
| Mar                  | X        | -33             | 1.8         | 37            | 2.5        | 27            | 69                | 32                    |
| Apr                  | 0.12     | -29             | 14.5        | 48            | 3.4        | 24            | 58                | 131                   |
| May                  | X        | -7              | 36.7        | 80            | 4.6        | 35            | 52                | 215                   |
| Jun                  | X        | 30              | 62.3        | 88            | 4.6        | 24            | 53                | 195                   |
| Jul                  | X        | 32              | 58.8        | 87            | 4.5        | 26            | 71                | 140                   |
| Aug                  | X        | 13              | 52.5        | 81            | 3.2        | 22            | 72                | 115                   |
| Sep                  | X        | 9               | 36.9        | 61            | 2.8        | 22            | 81                | 45                    |
| Oct                  | X        | 11              | 32.3        | 44            | 2.7        | 24            | 91                | 12                    |
| Nov                  | X        | -34             | -2.1        | 34            | 1.5        | 32            | 74                | 3                     |
| Dec                  | X        | -42             | -12.3       | 35            | 1.2        | 29            | 69                | 0                     |
| <b>2013 Annual</b>   | <b>X</b> | <b>-46</b>      | <b>22.6</b> | <b>88</b>     | <b>2.8</b> | <b>35</b>     | <b>71</b>         | <b>891</b>            |

| Noatak<br>RAWS 2013 | Rain        | Air Temperature |       |               | Wind Speed |               | Relative Humidity | Solar Radiation       |
|---------------------|-------------|-----------------|-------|---------------|------------|---------------|-------------------|-----------------------|
|                     | (inches)    | (°F)            |       |               | (mph)      |               | (%)               | (KW m <sup>-2</sup> ) |
| Month               | Total       | Absolute Min.   | Mean  | Absolute Max. | Mean       | Absolute Max. | Mean              | Total                 |
| Jan                 | 0.00        | -28             | -5.1  | 30            | 8.0        | 49            | 74                | M                     |
| Feb                 | 0.00        | -37             | -14.7 | 13            | 8.8        | 49            | 73                | M                     |
| Mar                 | 0.00        | -28             | -3.3  | 29            | 5.2        | 41            | 72                | M                     |
| Apr                 | 0.00        | -23             | 4.4   | 36            | 8.1        | 50            | 70                | M                     |
| May                 | 0.03        | -5              | 28.5  | 72            | 8.0        | 44            | 70                | M                     |
| Jun                 | 1.82        | 27              | 56.6  | 90            | 7.1        | 36            | 63                | M                     |
| Jul                 | 0.90        | 39              | 56.0  | 82            | 6.6        | 52            | 73                | M                     |
| Aug                 | 1.73        | 20              | 47.7  | 72            | 7.3        | 41            | 78                | 113                   |
| Sep                 | 1.21        | 14              | 33.4  | 55            | 9.4        | 40            | 80                | 61                    |
| Oct                 | 1.09        | 11              | 28.6  | 41            | 6.2        | 40            | 89                | 17                    |
| Nov                 | 0.03        | -31             | -1.1  | 33            | 6.0        | 45            | 75                | 4                     |
| Dec                 | 0.32        | -42             | -2.8  | 37            | 5.3        | 49            | 72                | 0                     |
| <b>2013 Annual</b>  | <b>7.13</b> | -42             | 19.5  | 90            | 7.2        | 52            | 74                | X                     |

| Kavet Creek<br>2013 | Rain         | Air Temperature |      |               | Wind Speed |               | Relative Humidity | Solar Radiation       |
|---------------------|--------------|-----------------|------|---------------|------------|---------------|-------------------|-----------------------|
|                     | (inches)     | (°F)            |      |               | (mph)      |               | (%)               | (KW m <sup>-2</sup> ) |
| Month               | Total        | Absolute Min.   | Mean | Absolute Max. | Mean       | Absolute Max. | Mean              | Total                 |
| Jan                 | 0.00         | -24             | 6.8  | 31            | 6.6        | 45            | 72                | 3                     |
| Feb                 | 0.05         | -30             | -3.1 | 24            | 3.8        | 29            | 71                | 13                    |
| Mar                 | 0.07         | -22             | 6.6  | 31            | 5.9        | 34            | 66                | 59                    |
| Apr                 | 0.18         | -17             | 16.7 | 45            | 4.6        | 37            | 56                | 156                   |
| May                 | 0.27         | 2               | 35.9 | 73            | 5.4        | 32            | 60                | 203                   |
| Jun                 | 1.04         | 33              | 62.7 | 94            | 4.7        | 25            | 57                | 194                   |
| Jul                 | 1.79         | 46              | 60.3 | 87            | 4.8        | 26            | 71                | 156                   |
| Aug                 | 2.67         | 23              | 53.1 | 71            | 2.0        | 13            | 76                | 122                   |
| Sep                 | 2.63         | 21              | 38.3 | 60            | 2.3        | 14            | 79                | 64                    |
| Oct                 | 3.98         | 9               | 32.7 | 45            | 3.0        | 15            | 91                | 15                    |
| Nov                 | 0.85         | -30             | 2.6  | 37            | 2.4        | 19            | 79                | 2                     |
| Dec                 | 0.29         | -41             | 0.3  | 39            | 3.4        | 43            | 72                | 0                     |
| <b>2013 Annual</b>  | <b>13.82</b> | -41             | 26.4 | 94            | 4.1        | 45            | 71                | 988                   |

| Quartz Creek 2013  | Rain        | Air Temperature |             |               | Wind Speed |               | Relative Humidity | Solar Radiation       |
|--------------------|-------------|-----------------|-------------|---------------|------------|---------------|-------------------|-----------------------|
|                    | (inches)    | (°F)            |             |               | (mph)      |               | (%)               | (KW m <sup>-2</sup> ) |
| Month              | Total       | Absolute Min.   | Mean        | Absolute Max. | Mean       | Absolute Max. | Mean              | Total                 |
| Jan                | 0.04        | -30             | 8.6         | 34            | 12.0       | 57            | 71                | 5                     |
| Feb                | 0.00        | -38             | -8.1        | 24            | 12.6       | 53            | 68                | 27                    |
| Mar                | 0.00        | -28             | 4.6         | 36            | 9.8        | 46            | 68                | 91                    |
| Apr                | 0.12        | -18             | 13.0        | 45            | 9.3        | 47            | 66                | 171                   |
| May                | 0.00        | -2              | 30.2        | 62            | 10.8       | 45            | 71                | 205                   |
| Jun                | 0.55        | 27              | 55.5        | 92            | 8.5        | 34            | 61                | 196                   |
| Jul                | 1.57        | 36              | 54.9        | 83            | 7.5        | 35            | 70                | M                     |
| Aug                | 3.02        | 29              | 51.6        | 74            | 7.8        | 34            | 81                | M                     |
| Sep                | 1.03        | 20              | 37.7        | 58            | 7.9        | 37            | 81                | M                     |
| Oct                | 1.38        | 17              | 34.2        | 44            | 8.9        | 41            | 89                | M                     |
| Nov                | 0.30        | -13             | 14.9        | 39            | 8.6        | 65            | 80                | M                     |
| Dec                | 0.38        | -27             | 7.7         | 41            | 8.2        | 51            | 78                | M                     |
| <b>2013 Annual</b> | <b>8.39</b> | <b>-38</b>      | <b>25.7</b> | <b>92</b>     | <b>9.3</b> | <b>65</b>     | <b>74</b>         | <b>X</b>              |

| Umiat 2013         | Rain        | Air Temperature |             |               | Wind Speed |               | Relative Humidity | Solar Radiation       |
|--------------------|-------------|-----------------|-------------|---------------|------------|---------------|-------------------|-----------------------|
|                    | (inches)    | (°F)            |             |               | (mph)      |               | (%)               | (KW m <sup>-2</sup> ) |
| Month              | Total       | Absolute Min.   | Mean        | Absolute Max. | Mean       | Absolute Max. | Mean              | Total                 |
| Jan                | 0.00        | -44             | -21.2       | 9             | 6.7        | 32            | 62                | 1                     |
| Feb                | 0.00        | -54             | -30.1       | -9            | 4.5        | 23            | 56                | 8                     |
| Mar                | 0.00        | -40             | -13.8       | 13            | 5.1        | 26            | 64                | 54                    |
| Apr                | 0.00        | -40             | -2.5        | 36            | 7.6        | 39            | 65                | 134                   |
| May                | 0.00        | -23             | 25.5        | 51            | 6.4        | 40            | 71                | 186                   |
| Jun                | 1.00        | 24              | 54.1        | 90            | 7.0        | 31            | 66                | 169                   |
| Jul                | 1.57        | 35              | 56.2        | 78            | 6.6        | 38            | 72                | 141                   |
| Aug                | 0.97        | 23              | 48.1        | 83            | 5.9        | 31            | 80                | 97                    |
| Sep                | 1.07        | 2               | 32.7        | 67            | 5.6        | 27            | 83                | 49                    |
| Oct                | 0.21        | 2               | 20.4        | 42            | 3.3        | 22            | 84                | 19                    |
| Nov                | 0.07        | -37             | -1.1        | 37            | 6.8        | 48            | 70                | 2                     |
| Dec                | 0.69        | -45             | -10.3       | 39            | 5.0        | 50            | 66                | 0                     |
| <b>2013 Annual</b> | <b>5.58</b> | <b>-54</b>      | <b>13.9</b> | <b>90</b>     | <b>5.9</b> | <b>50</b>     | <b>70</b>         | <b>860</b>            |

## Appendix D. 2013 Snotel Station Summaries

| Atigun Pass        | Precip.     | Air Temperature |             |               | Snow Depth |           |           |
|--------------------|-------------|-----------------|-------------|---------------|------------|-----------|-----------|
|                    | (inches)    | (°F)            |             |               | (inches)   |           |           |
| Month              | Total       | Absolute Min.   | Mean        | Absolute Max. | Min.       | Mean      | Max.      |
| Jan                | 0.8         | -39.6           | -4.5        | 24.6          | 32         | 36        | 39        |
| Feb                | 0.3         | -39.3           | -4.2        | 17.1          | 32         | 33        | 33        |
| Mar                | 0.9         | -27.9           | -0.5        | 22.3          | 33         | 34        | 35        |
| Apr                | 0.9         | -37.3           | 0.5         | 24.8          | 33         | 34        | 38        |
| May                | 1.6         | -16.2           | 19.7        | 59.4          | 23         | 38        | 45        |
| Jun                | 2.0         | 19.9            | 45.0        | 66.9          | 0          | 8         | 22        |
| Jul                | 1.9         | 33.4            | 46.8        | 64.4          | 0          | 0         | 0         |
| Aug                | 3.9         | 15.8            | 40.4        | 61.3          | 0          | 1         | 6         |
| Sep                | 2.5         | 9.1             | 24.7        | 41.5          | 3          | 7         | 13        |
| Oct                | 1.8         | 6.4             | 21.5        | 33.1          | 12         | 18        | 24        |
| Nov                | 0.3         | -24.9           | -1.7        | 21.9          | 22         | 30        | 37        |
| Dec                | 0.1         | -35.1           | -2.1        | 30.0          | 33         | 35        | 38        |
| <b>2013 Annual</b> | <b>17.0</b> | <b>-39.6</b>    | <b>15.6</b> | <b>66.9</b>   | <b>0</b>   | <b>23</b> | <b>45</b> |

| Coldfoot           | Precip.     | Air Temperature |             |               | Snow Depth |          |           |
|--------------------|-------------|-----------------|-------------|---------------|------------|----------|-----------|
|                    | (inches)    | (°F)            |             |               | (inches)   |          |           |
| Month              | Total       | Absolute Min.   | Mean        | Absolute Max. | Min.       | Mean     | Max.      |
| Jan                | 1.3         | -53.9           | -3.7        | 28.2          | 2          | 7        | 14        |
| Feb                | 0.3         | -32.4           | 0.9         | 28.4          | 11         | 12       | 13        |
| Mar                | 1.0         | -33.5           | 5.1         | 33.4          | 12         | 14       | 20        |
| Apr                | 0.4         | -25.2           | 16.2        | 42.3          | 17         | 18       | 21        |
| May                | 0.1         | 1.0             | 37.6        | 78.3          | 0          | 8        | 17        |
| Jun                | 0.7         | 36.0            | 60.5        | 87.4          | 0          | 0        | 0         |
| Jul                | 2.7         | 0.0             | 58.8        | 83.8          | 0          | 0        | 0         |
| Aug                | 1.4         | 25.3            | 52.4        | 82.6          | 0          | 0        | 0         |
| Sep                | 3.0         | 16.2            | 32.1        | 61.5          | 0          | 1        | 4         |
| Oct                | 3.4         | 10.9            | 31.8        | 48.7          | 2          | 4        | 7         |
| Nov                | 2.1         | -41.6           | -0.7        | 34.5          | 7          | 17       | 22        |
| Dec                | 1.4         | -47.9           | -10.8       | 36.1          | 20         | 22       | 24        |
| <b>2013 Annual</b> | <b>17.8</b> | <b>-53.9</b>    | <b>23.5</b> | <b>87.4</b>   | <b>0</b>   | <b>9</b> | <b>24</b> |

| Kelly Station      | Precip.     | Air Temperature |             |               | Snow Depth |          |           |
|--------------------|-------------|-----------------|-------------|---------------|------------|----------|-----------|
|                    | (inches)    | (°F)            |             |               | (inches)   |          |           |
| Month              | Total       | Absolute Min.   | Mean        | Absolute Max. | Min.       | Mean     | Max.      |
| Jan                | 0.5         | -24.2           | 9.2         | 36.1          | 4          | 7        | 10        |
| Feb                | 0.1         | -35.3           | -1.2        | 25.9          | 8          | 8        | 9         |
| Mar                | 0.4         | -24.0           | 6.6         | 36.5          | 9          | 10       | 12        |
| Apr                | 0.5         | -11.4           | 15.1        | 39.0          | 10         | 11       | 14        |
| May                | 2.2         | 1.2             | 30.9        | 63.9          | 0          | 11       | 18        |
| Jun                | 1.7         | 32.5            | 55.8        | 89.4          | 0          | 0        | 0         |
| Jul                | 2.3         | 34.2            | 55.2        | 81.7          | 0          | 0        | 0         |
| Aug                | 3.3         | 26.4            | 51.2        | 65.8          | 0          | 0        | 0         |
| Sep                | 2.4         | 16.2            | 36.9        | 59.7          | 0          | 0        | 0         |
| Oct                | 2.9         | 14.5            | 33.0        | 44.1          | 0          | 0        | 0         |
| Nov                | 2.2         | -25.6           | 9.1         | 38.1          | 0          | 6        | 12        |
| Dec                | 2.5         | -30.5           | 6.1         | 40.5          | 10         | 13       | 15        |
| <b>2013 Annual</b> | <b>21.0</b> | <b>-35.3</b>    | <b>25.9</b> | <b>89.4</b>   | <b>0</b>   | <b>6</b> | <b>18</b> |

| Pargon Creek       | Precip.     | Air Temperature |             |               | Snow Depth |          |           |
|--------------------|-------------|-----------------|-------------|---------------|------------|----------|-----------|
|                    | (inches)    | (°F)            |             |               | (inches)   |          |           |
| Month              | Total       | Absolute Min.   | Mean        | Absolute Max. | Min.       | Mean     | Max.      |
| Jan                | 1.1         | -33.3           | 11.8        | 38.5          | 3          | 5        | 9         |
| Feb                | 0.3         | -49.5           | -4.7        | 27.1          | 6          | 7        | 9         |
| Mar                | 0.4         | -37.1           | 5.0         | 37.2          | 7          | 8        | 10        |
| Apr                | 0.3         | -24.0           | 13.0        | 38.1          | 7          | 8        | 9         |
| May                | 0.4         | -3.6            | 32.0        | 69.3          | 0          | 3        | 7         |
| Jun                | 0.1         | 30.9            | 55.4        | 88.5          | 0          | 0        | 0         |
| Jul                | 1.5         | 35.4            | 54.4        | 77.5          | 0          | 0        | 0         |
| Aug                | 2.4         | 26.1            | 52.5        | 74.5          | -1         | 0        | 1         |
| Sep                | 0.5         | 19.6            | 40.0        | 59.5          | 0          | 0        | 1         |
| Oct                | 3.2         | 13.1            | 35.6        | 45.7          | 0          | 0        | 2         |
| Nov                | 2.0         | -23.6           | 16.1        | 40.8          | 0          | 1        | 2         |
| Dec                | 1.6         | -36.6           | 8.6         | 45.3          | 0          | 1        | 3         |
| <b>2013 Annual</b> | <b>13.8</b> | <b>-49.5</b>    | <b>26.9</b> | <b>88.5</b>   | <b>-1</b>  | <b>3</b> | <b>10</b> |

## Appendix E. 2013 Alaska Weather Highlights

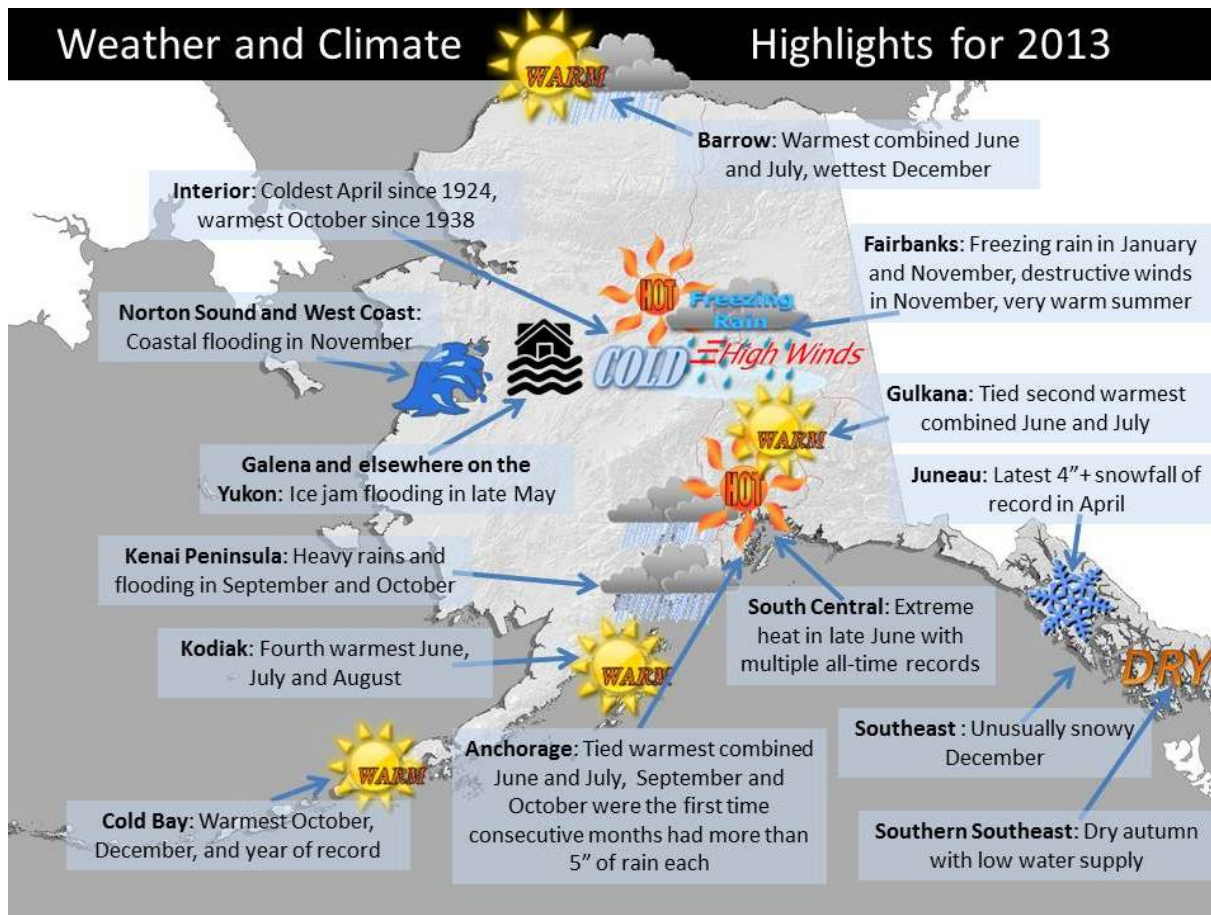
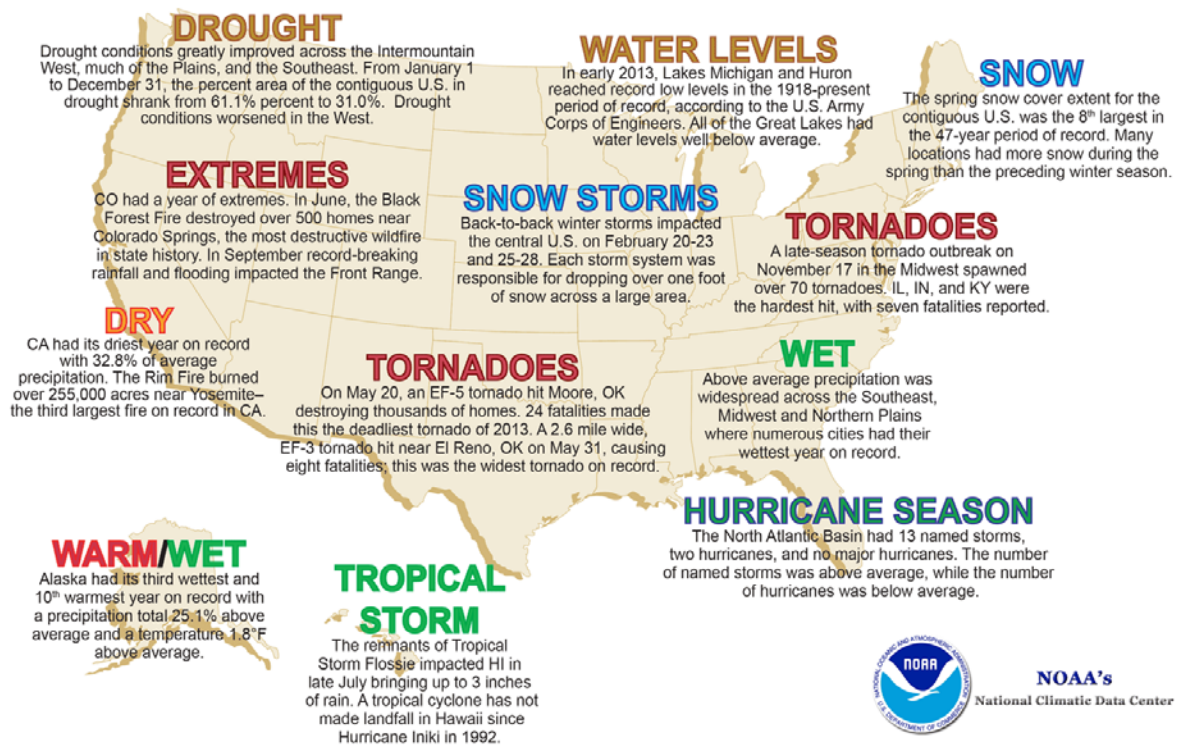


Image courtesy of NOAA (NOAA 2014a).

## Appendix F. 2013 U.S. Weather Highlights

# Preliminary Significant U.S. Weather and Climate Events for 2013



Graph courtesy of NOAA (NOAA 2014a).

## Appendix G. 2013 Worldwide Significant Climate Anomalies

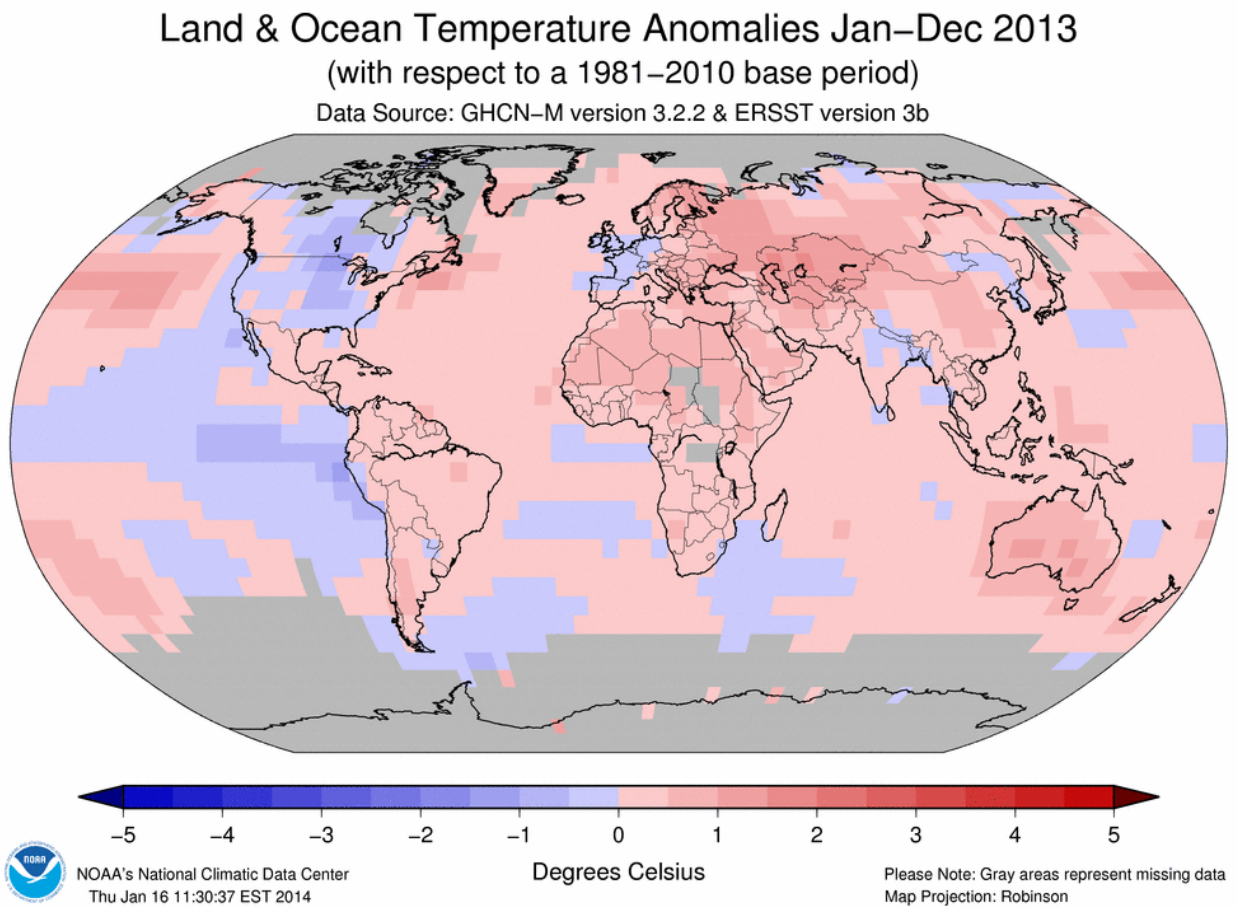


Figure courtesy of NOAA (NOAA 2014c).

# Land-Only Precipitation Percentiles Jan–Dec 2013

NOAA's National Climatic Data Center

Data Source: GHCN–M version 2

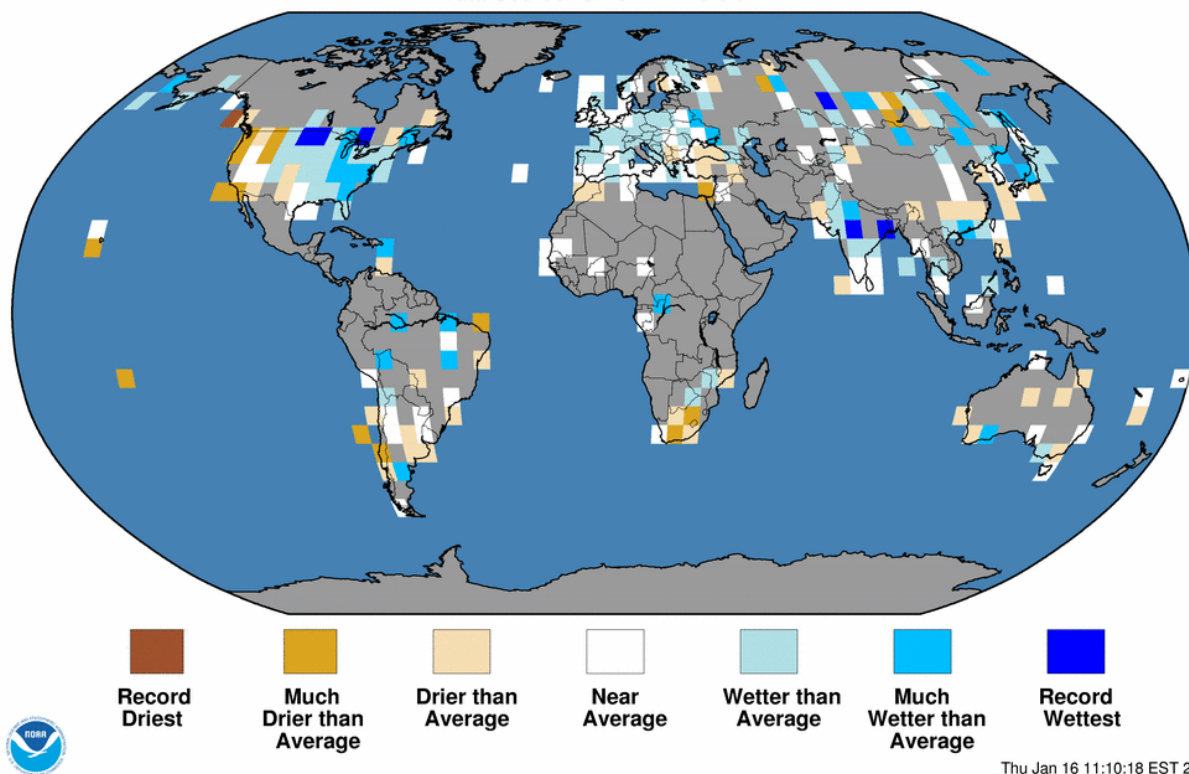
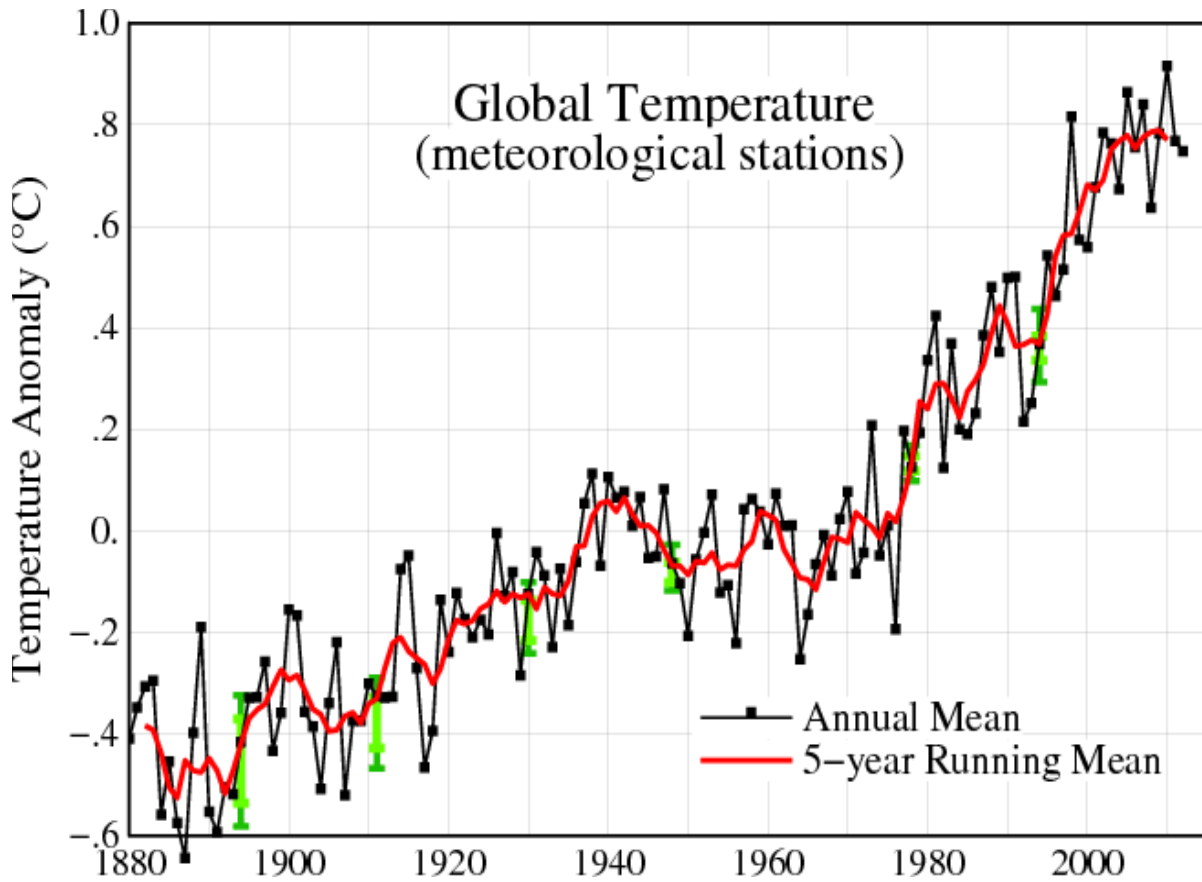


Figure courtesy of NOAA (NOAA 2014c).



Global mean annual temperature departure (°C) from the 1951-1980 normal (the reference period used by NASA Goddard Institute for Space Studies [GISS]). Graph courtesy of GISS (GISS 2014).

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**National Park Service**  
**U.S. Department of the Interior**



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