



# Climate Monitoring in the Southwest Alaska Network

## *Annual Report for the 2013 Hydrologic Year*

Natural Resource Technical Report NPS/SWAN/NRTR—2014/857



#### **ON THE COVER**

Kelvin-Helmholtz clouds over the Gulf of Alaska, Kenai Fjords National Park. The Kelvin-Helmholtz instability can occur when there is a difference in velocities across the interface between two fluids. In the cover photograph, the interface is between two layers of air with different densities that are moving at different speeds. Turbulent eddies are developing along the interface and the condensation and evaporation of water vapor in these eddies are making them visible as wave-shaped clouds. A more familiar example of the Kelvin-Helmholtz instability occurs when wind blows over water forming waves.

Photograph by: Chris Lauver

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Data in this report were collected and analyzed using methods based on established, peer-reviewed protocols and were analyzed and interpreted within the guidelines of the protocols. This report received informal peer review by subject-matter experts who were not directly involved in the collection, analysis, or reporting of the data.

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## Abstract

The Southwest Alaska Network Inventory and Monitoring program monitors climate across a region that includes five national park units: Alagnak Wild River, Aniakchak National Monument and Preserve, Katmai National Park and Preserve, Kenai Fjords National Park, and Lake Clark National Park and Preserve. Monitoring efforts are currently focused on operating and maintaining weather stations in three network parks. Weather observations are also obtained from an additional 30 stations across the region of interest and included along with weather observations from network weather stations in annual reports. This report summarizes weather observations from the recent hydrologic year and provides a regional and historical climatic context. The results provided in this report help identify natural variability in weather patterns and long-term climate trends. This report offers reliable climate data to researchers interpreting ecosystem changes and should also be interesting to a broad audience including land managers and park visitors.

The Southwest Alaska Network region experienced slightly colder than average temperatures and near average precipitation during the 2013 hydrologic year (October 2012 through September 2013). Compared to the climatological normal (the prevailing set of weather conditions calculated over a 30-year period, currently 1981-2010), mean annual temperatures for six long-term weather stations ranged from 2.3 °F below average to 0.5 °F above average. Total annual precipitation was 90 to 113 % of average. Two winter months (January, February) and two summer months (June, July) were warmer than average (with two-month mean temperatures 5.9 °F and 2.2 °F above average, respectively) but the remainder of the year was either colder than average or at near average temperatures. Above average precipitation fell across most of the region during January, May, and August but the remainder of the year was drier than normal or at near normal conditions. Above average precipitation also occurred during February in King Salmon (255 % of average) and during July in Seward (224 % of average), when drier than normal conditions were experienced across most of the rest of the region. When compared to the longer period of record (nominally 1931 to present), temperature and precipitation during the 2013 hydrologic year was slightly warmer than the conditions observed during the 2006-2009 and 2011-2012 hydrologic years and drier than the conditions generally observed during recent years. Negative (cool phase) Pacific Decadal Oscillation conditions and neutral to slightly negative (La Niña) ENSO conditions occurred during the 2013 hydrologic year.

Staff from the Southwest Alaska Network and parks maintained 10 weather stations, relocated one weather station, and set up a new weather station during the 2013 hydrologic year. The Contact Creek Remote Automated Weather Station in Katmai National Park and Preserve was removed in September 2013. It has been replaced by a Climate Reference Network station (named King Salmon 42 SE), which is operated and maintained by the National Oceanic and Atmospheric Administration. The Remote Automated Weather Station that was at Contact Creek was relocated to a location close to the Three Forks cabin near the Valley of Ten Thousand Smokes in Katmai National Park and Preserve. A new Remote Automated Weather Station was set up near Silver Salmon Lakes on the Cook Inlet coast of Lake Clark National Park and Preserve. This weather station will eventually replace the Hickerson Lake weather station after one year of simultaneous operation.



## **Acknowledgments**

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## Acronyms

|               |                                                                 |
|---------------|-----------------------------------------------------------------|
| <b>ACRC</b>   | Alaska Climate Research Center                                  |
| <b>ALAG</b>   | Alagnak Wild River                                              |
| <b>ANIA</b>   | Aniakchak National Monument and Preserve                        |
| <b>ASOS</b>   | Automated Surface Observing System                              |
| <b>AWOS</b>   | Automated Weather Observing System                              |
| <b>BLM</b>    | Bureau of Land Management                                       |
| <b>BUOY</b>   | Moored Buoy (NOMAD)                                             |
| <b>CMAN</b>   | Coastal Marine Automated Network                                |
| <b>COOP</b>   | Cooperative Observing Program                                   |
| <b>CRN</b>    | Climate Reference Network ( <b>CLRN</b> is also used)           |
| <b>ENSO</b>   | El Niño-Southern Oscillation                                    |
| <b>FAA</b>    | Federal Aviation Administration                                 |
| <b>GOES</b>   | Geostationary Operational Environmental Satellites              |
| <b>IPCC</b>   | Intergovernmental Panel on Climate Change                       |
| <b>KATM</b>   | Katmai National Park and Preserve                               |
| <b>KEFJ</b>   | Kenai Fjords National Park                                      |
| <b>LACL</b>   | Lake Clark National Park and Preserve                           |
| <b>NCDC</b>   | National Climatic Data Center                                   |
| <b>NDBC</b>   | National Data Buoy Center                                       |
| <b>NESDIS</b> | National Environmental Satellite, Data, and Information Service |
| <b>NIFC</b>   | National Interagency Fire Center                                |
| <b>NOAA</b>   | National Oceanic and Atmospheric Administration                 |
| <b>NOMAD</b>  | Navy Oceanographic Meteorological Automated Device              |
| <b>NPS</b>    | National Park Service                                           |
| <b>NRCS</b>   | Natural Resources Conservation Service                          |
| <b>NWS</b>    | National Weather Service                                        |
| <b>P</b>      | Precipitation                                                   |
| <b>PDO</b>    | Pacific Decadal Oscillation                                     |
| <b>RAWS</b>   | Remote Automated Weather Station                                |
| <b>SNCO</b>   | Snow Course                                                     |
| <b>SNOTEL</b> | Snowpack Telemetry                                              |
| <b>SST</b>    | Sea Surface Temperature                                         |
| <b>SWAN</b>   | Southwest Alaska Network                                        |
| <b>T</b>      | Temperature                                                     |
| <b>USFS</b>   | United States Forest Service                                    |
| <b>WBAN</b>   | Weather Bureau Army Navy                                        |
| <b>WRCC</b>   | Western Regional Climate Center                                 |



# Introduction

This report is the fifth in an annual series detailing the climate of the Southwest Alaska Network (SWAN). The purpose of these annual reports is to summarize observations from local weather stations for the previous hydrologic year and to provide regional and historical contexts for these observations.

## Climate Overview

The SWAN consists of five National Park Service units: Alagnak Wild River (ALAG), Aniakchak National Monument and Preserve (ANIA), Katmai National Park and Preserve (KATM), Kenai Fjords National Park (KEFJ), and Lake Clark National Park and Preserve (LACL). The climate of this region is largely influenced by the region's high latitude, proximity to oceans, complex topography, and interaction of those features with global atmospheric circulation (Simpson et al. 2002). The park units in the SWAN are aligned along the northern Gulf of Alaska and the maritime subarctic climate of the eastern, coastal areas of KATM, KEFJ, and LACL is characterized by moderate temperatures and abundant precipitation. Moist air masses are intercepted by the Kenai Mountains, the Aleutian and Alaska Ranges and heavy precipitation falls on their windward (east) sides. The western, more interior region of LACL is generally protected from maritime influence by large mountain ranges. The boreal climate here is more continental in nature and is characterized by a large annual range in temperature and small annual range in precipitation (Figure 1). The climate of the park units on the Alaska Peninsula (ALAG, ANIA, and KATM) is transitional between polar (tundra climate) and maritime (maritime subarctic) (Nowacki et al. 2001). In this region summer temperatures are moderated by the open waters of the Bering Sea (Bristol Bay), but winter temperatures are colder and more polar in nature due to the presence of sea ice in the coldest months. A more detailed discussion of the climate of the SWAN, including maps showing spatial and temporal patterns of temperature and precipitation, is provided by Redmond et al. (2005) and Davey et al. (2007).

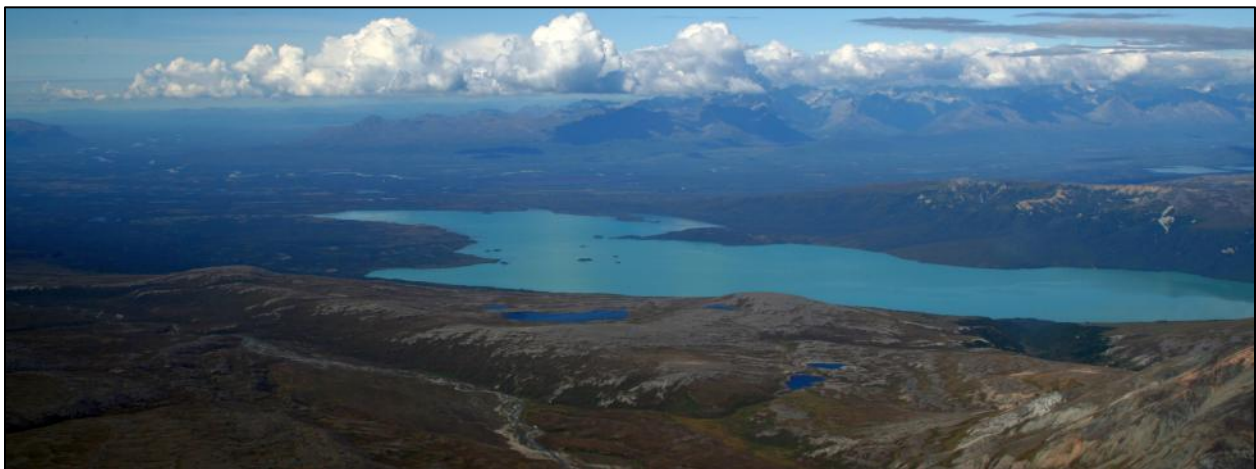


**Figure 1.** Interior regions of SWAN park units, like the landscape of the Trail Creek, Telaquana River, and Stony River drainages in Lake Clark National Park and Preserve, are protected from maritime influence by large mountain ranges. The boreal climate here is characterized by a large annual range in temperature and a small annual range in precipitation.

### ***Climate vs. Weather***

Although the terms climate and weather are sometimes used interchangeably, they differ in temporal perspective. Weather refers to the condition of the atmosphere at a specific point in time or during a short-lived atmospheric event. Climate refers to the aggregation of weather conditions for a location or region and can be defined with averages or representative values for weather elements.

### ***Average, Normal, and Period of Record***

*Average* conditions refer to the prevailing set of climatic conditions based on the most recent 30 year reference period, which is currently 1981-2010. This 30 year reference period is referred to as the climatic *normal*. The *period of record* refers to the prevailing set of climatic conditions during the entire history of observations at a particular weather station. *Average* (i.e. *normal*) and *period of record* values for a specific weather station may differ significantly. This year marks the third for which the new 30 year reference period (1981-2010) will be used for comparison. Climatological comparisons to the ‘new’ normal (1981-2010) conditions will differ slightly from those to the ‘old’ normal (1971-2000) conditions. The 30 year climatic normal is used exclusively for comparison in the Results section. The period of record is used exclusively as a basis for historical context in the Discussion section.

### ***Intrinsic Climate Patterns***

Fall and winter atmospheric circulation over the North Pacific Ocean is dominated by the Aleutian Low, which is important to the climatology of SWAN parks. Low pressure systems moving from west to east along the subpolar front usually reach maximum intensity in the area of the Aleutian Low, a semi-permanent low pressure center. Winter storm tracks generally follow the Aleutian Islands and move into the Gulf of Alaska with a frequency of about four to five storms a month where they affect SWAN parks with precipitation and strong winds. The Aleutian Low weakens in the summer season and summer storm tracks generally follow the Aleutian Islands and then turn northward into the eastern Bering Sea with a frequency of three to four storms per month (Simpson et al. 2002). The seasonal variability in the location and intensity of the Aleutian Low and associated storm tracks explains much of the seasonal variability in climate patterns and differences in the timing of maximum precipitation in SWAN parks (Bennett et al. 2006).

Annual to decadal climate variability in the SWAN is primarily influenced by large-scale changes in atmospheric and oceanic circulation, such as the El Niño Southern Oscillation (ENSO) and the Pacific Decadal Oscillation (PDO). The ENSO affects the strength and positioning of the Jet Stream and the PDO affects North Pacific sea level pressure and sea surface temperature. Although their origins are not completely understood, both climatic oscillations are recognized to have important climatic consequences to coastal Alaska, including the SWAN.

ENSO events are recognized to influence temperatures by  $\pm 2-4$  °F at a large spatial scale (Simpson et al. 2002, Papineau 2005). While the average El Niño event results in a modest increase in winter and summer temperatures across Alaska, the effect is both spatially and temporally (from one El Niño event to another) variable. The average La Niña event results in cooler than normal temperatures and drier conditions in both winter and summer.

An abrupt positive shift in mean annual temperatures during 1976-1977 is widely recognized and is well correlated with the shift from the negative to positive phase of the PDO (Simpson et al. 2002, Hartman and Wendler 2005). Although not as pronounced as the shift in temperature, a corresponding increase in winter precipitation has been observed north of 57°N, primarily affecting coastal areas (Papineau n.d.). The PDO also influences winter time storm tracks, diverting them northward into the Cook Inlet area (Simpson et al. 2002).

### ***Climate Change***

The global climate is changing and rates of change are dramatically accelerated at northern latitudes (IPCC 2013). Alaska has warmed substantially over the 20<sup>th</sup> century, annual precipitation has increased (Weller et al. 1999), and the growing season has lengthened (Keyser et al. 2000). Temperature data from two long-term climate stations in the SWAN region show a significant increase in both mean wintertime and mean annual temperatures for 1949-2013 (Alaska Climate Research Center, 2014). Mean winter temperatures at King Salmon have increased by 7.6 °F and mean annual temperatures have increased by 3.2 °F. Mean winter temperatures at Homer have increased by 6.0 °F and mean annual temperatures have increased by 3.3 °F.

These temperature trends span the 1976-1977 Pacific Climate Shift (Hartman and Wendler 2005); however, the observed warming trend is supported by independent observations of sea ice, glaciers, permafrost, vegetation, and snow cover. Climate projections derived from five General Circulation Models based on an intermediate climate change scenario (IPCC-A1B) suggest that average annual temperatures for SWAN parks will increase by 0.9-1.1 °F per decade (Scenarios Network for Alaska Planning 2009). Precipitation is also generally projected to increase with 11-26% more snowfall in winter and 10-12% more rain in summer.

### **Other Resources**

Additional climate-related information for the SWAN and surrounding areas include:

- Alaska Center for Climate Assessment & Policy (<http://www.uaf.edu/accap/>)
- Alaska Climate Research Center (<http://climate.gi.alaska.edu/>)
- Alaska Ocean Observing System (<http://www.aos.org/>)
- Alaska Snow Water and Climate Services (<http://ambcs.org/>)
- Alaska State Climate Center (<http://climate.uaa.alaska.edu/>)
- National Climatic Data Center (<http://www.ncdc.noaa.gov/oa/>)
- NOAA Climate Services (<http://www.climate.gov>)
- National Data Buoy Center (<http://ndbc.noaa.gov>)
- National Weather Service – Alaska Region (<http://www.arh.noaa.gov/>)
- Pacific River Forecast Center (<http://aprfc.arh.noaa.gov/>)
- Western Regional Climate Center (<http://www.wrcc.dri.edu/>)



## Methods

### Stations

Few weather stations in Alaska have long-term reliable records. A complete inventory of land-based weather stations in the SWAN was completed by Davey and others (2007). Climate conditions have been monitored at a few locations near SWAN park units since the late 1930s and 1940s (one station record extends discontinuously to 1908). This report includes climate data from 42 stations operated by six different climate monitoring programs that are currently monitored by the SWAN (Figure 2). General descriptions of those climate monitoring programs are provided in Table 1 and station metadata are documented in Table 2. Collectively, those programs provide consistent monitoring of weather conditions and in some cases, provide a long-term climate record. However, the stations used for analysis in this summary report are the six weather stations with the longest, most complete records located near three SWAN parks.

### Data Acquisition, Quality Control, and Data Processing

Six different climate monitoring programs, described in Table 1, maintain official repositories for climate data monitored by the SWAN. Acquisition of climate data and data processing details are provided in the Methods for Monitoring Climate in SWAN Parks (Lindsay et al. 2012). In short, Remote Automated Weather Station (RAWS) data are obtained from the Western Regional Climate Center (WRCC). Data for National Oceanic and Atmospheric (NOAA) National Weather Service Cooperative Observing Program (COOP), Automated Surface Observing System (ASOS), Automated Weather Observing System (AWOS), and Climate Reference Network (CRN) stations are obtained from the NOAA National Climatic Data Center (NCDC). Snow Course and Snowpack Telemetry (SNOTEL) data are obtained from the National Resources Conservation Service (NRCS). Coastal-Marine Automated Network (CMAN) and moored buoy data (BUOY) data are obtained from the NOAA National Data Buoy Center (NDBC). Data from ancillary stations (e.g. seasonal ranger stations, temporary field data loggers) are not included in this report.

Data quality control procedures are implemented by external agencies that manage the six different climate monitoring programs. Data-quality flags indicate missing or suspect data and the use of estimation procedures. RAWS data are subjected to additional data quality control measures that use range checking that follows MesoWest, or more conservative, specifications (Lindsay et al. 2012). After acquisition, climate data (excluding Snow Course data) are processed using routines that convert data to standardized formats in both metric and U.S. customary units. Climate variables are summarized to daily and monthly measures. Maximum, minimum, and arithmetic means are derived for temperature. Arithmetic means are derived for relative humidity and snow depth. Cumulative values are calculated for precipitation and solar radiation. Scalar and unit vector averaging are used to derive average wind speed and wind direction, respectively. Missing, suspect, or otherwise flagged data are not used for summary purposes. For derived measures, the percentage of valid observations is reported as a measure of the reliability of the derived mean and cumulative values. Monthly measures are not considered representative of actual climatic conditions if more than 10% (three days) of observations are missing or suspect. Yearly measures are not considered representative if more than 17% (five days) are missing from any month (modified from WMO 1989).

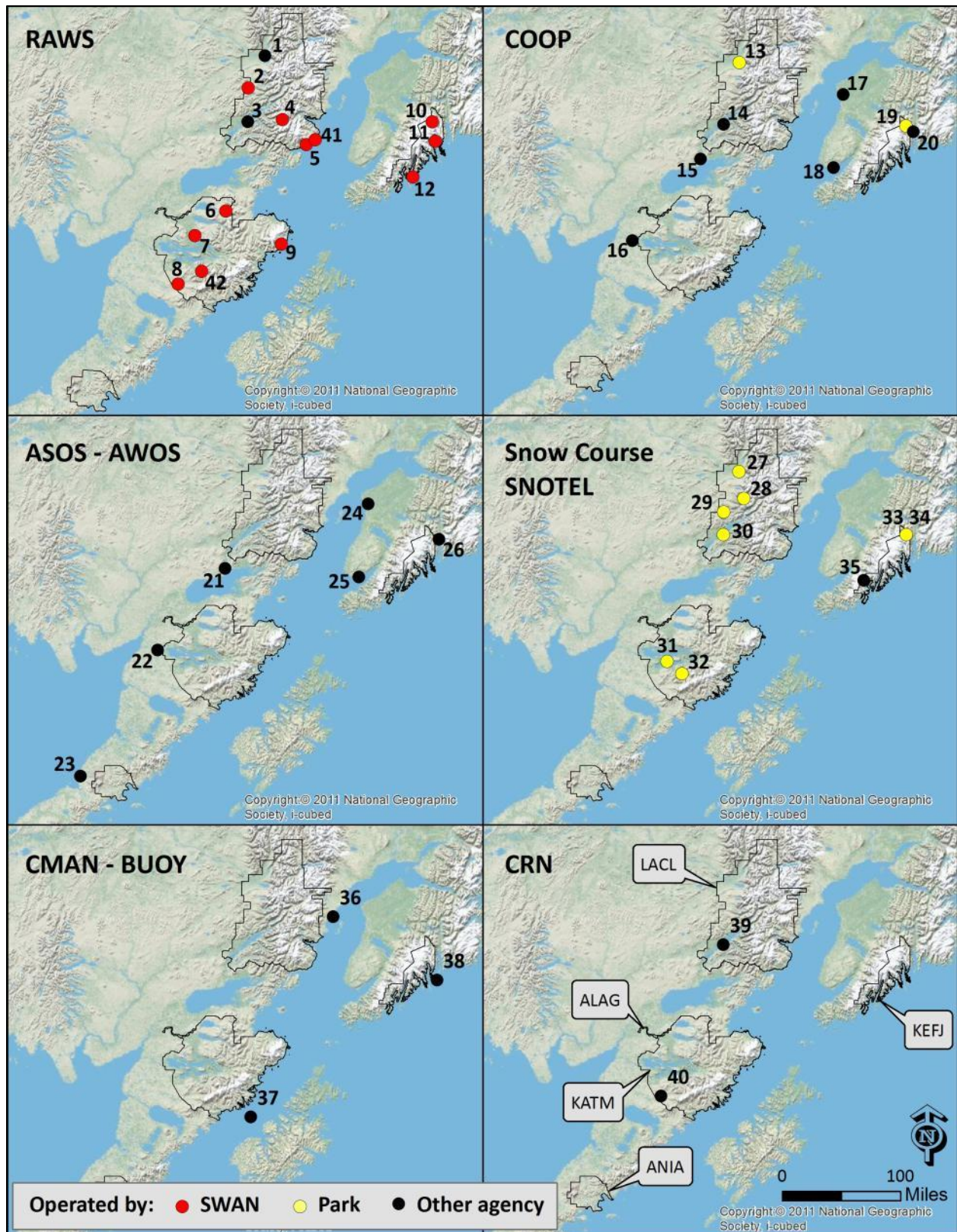


**Figure 2.** Locations of weather stations included in this report. Station acronyms, identifying numbers, and park acronyms are described in Table 1, Table 2, and the introduction section, respectively.

**Table 1.** Climate monitoring programs used within SWAN.

| Climate monitoring program (Acronym in bold)                                                                              | Responsible agency                                                                     | Program synopsis                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|---------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>RAWS</b> ( <i>Remote Automated Weather Stations</i> )                                                                  | National Interagency Fire Center (NIFC), NPS, BLM, USFS, etc.                          | Interagency network of weather stations mostly used by fire-personnel to estimate a fire-danger rating in support of preventative measures, and to forecast the behavior of wildland fires. Automated sensors record hourly air temperature, relative humidity, precipitation, wind speed and direction, solar radiation, and snow depth.                                                                                                           |
| <b>COOP</b> (National Weather Service Cooperative Observing Program)                                                      | National Oceanic and Atmospheric Administration (NOAA)-National Weather Service (NWS)  | Observer-based program created in 1890 to define the climate of the United States and help measure extreme weather events, climate variability, and long-term climatic changes. Manual observations include daily maximum and minimum air temperature, precipitation, and snowfall.                                                                                                                                                                 |
| <b>ASOS</b> (Automated Surface Observing System);<br><br>AWOS (Automated Weather Observing System)                        | NOAA-NWS, Federal Aviation Administration (FAA)                                        | Weather stations installed at airports and military bases mostly used to support aviation needs and weather forecasting. Automated sensors record sub-hourly air temperature, relative humidity, precipitation, wind speed and direction, barometric pressure and other elements.                                                                                                                                                                   |
| <b>SNCO</b> ( <i>Snow Course</i> );<br><br><b>SNOTEL</b> ( <i>SNOWpack TELEmetry</i> )                                    | National Resources Conservation Service (NRCS)                                         | Observer-based program that manually measures snow depth and snow-water equivalent along permanent transects;<br><br>Automated stations that provide hourly measurements of air temperature, precipitation, snow depth, snow-water equivalent and other elements.                                                                                                                                                                                   |
| CMAN (Coastal-Marine Automated Network);<br><br>Moored BUOY (Navy Oceanographic Meteorological Automated Device or NOMAD) | NOAA-National Data Bouy Center (NDBC)                                                  | Weather stations installed at lighthouses, capes, beaches, nearshore islands, and offshore platforms. Automated sensors record hourly air temperature, wind speed, gust, and direction, barometric pressure. Some stations also measure sea water temperature, and wave direction and intensity. Moored buoys equipped with automated sensors that record hourly air temperature, wind speed and direction, barometric pressure and other elements. |
| <b>CRN</b> ( <i>Climate Reference Network</i> )                                                                           | NOAA-National Climatic Data Center, NOAA-Atmospheric Turbulence and Diffusion Division | Network of weather stations being developed to provide long-term observations of temperature and precipitation that can be coupled to long-term, historical observations for the detection and attribution of present and future climate change. Automated sensors record hourly air temperature and precipitation. Other elements include ground surface temperature, solar radiation, and wind speed.                                             |

**Table 2.** Weather stations included in this report. Map numbers identify locations in Figure 2. ID number is from the climate monitoring network (e.g. NESDIS ID, COOP Station No., WBAN ID, NRCS ID, NDBC No.). Station start is the earliest date listed in the NCDC Multi-network Metadata System.

| Station name         | Acronym | Station type | Map no. | ID no.      | Lat. N  | Lon. W   | Elev ft. | Station start |
|----------------------|---------|--------------|---------|-------------|---------|----------|----------|---------------|
| Brooks Camp          | BRCA    | SNCO         | 31      | 55J01       | 58.533  | 155.767  | 150      | 1995          |
| Chigmit Mountains    | CHMO    | RAWS         | 4       | FA6544FC    | 60.2249 | 153.4675 | 4658     | 7/2009        |
| Contact Creek*       | COCR    | RAWS         | 8       | 32803738*   | 58.2076 | 155.9225 | 657      | 6/2008*       |
| Coville              | COVI    | RAWS         | 7       | 3280B12C    | 58.8025 | 155.5629 | 1567     | 6/2008        |
| Drift River Terminal | DRRI    | CMAN         | 36      | DRFA2       | 60.5533 | 152.1367 | 53       | 9/1999        |
| Exit Glacier         | EXGL    | SNCO         | 33      | 49L18       | 60.1903 | 149.6212 | 400      | 9/1988        |
| Exit Glacier         | EXGL    | SNTE         | 34      | 49L18       | 60.1903 | 149.6212 | 400      | 7/2011        |
| Fishtrap Lake        | FILA    | SNCO         | 29      | 54L02       | 60.4913 | 154.3296 | 1800     | 8/1991        |
| Fourpeaked           | FOUR    | RAWS         | 9       | 328135C2    | 58.7057 | 153.5179 | 1074     | 6/2009        |
| Harding Icefield     | HAIC    | RAWS         | 10      | FA656210    | 60.1325 | 149.7820 | 4335     | 7/2004        |
| Hickerson Lake       | HILA    | RAWS         | 5       | 3280C7BC    | 59.9148 | 152.8925 | 1048     | 6/2008        |
| Homer Airport        | HOAI    | COOP         | 18      | 503665      | 59.6428 | 151.4872 | 64       | 9/1949        |
| Homer Airport        | HOAI    | ASOS         | 25      | 25507       | 59.6428 | 151.4872 | 64       | 12/1997       |
| Iliamna Airport      | ILAI    | COOP         | 15      | 503905      | 59.7539 | 154.9069 | 183      | 9/1949        |
| Iliamna Airport      | ILAI    | ASOS         | 21      | 25506       | 59.7539 | 154.9069 | 183      | 12/1997       |
| Kenai Airport        | KEAI    | COOP         | 17      | 504546      | 60.5797 | 151.2391 | 91       | 9/1949        |
| Kenai Airport        | KEAI    | ASOS         | 24      | 26523       | 60.5797 | 151.2391 | 91       | 5/1999        |
| King Salmon Airport  | KISA    | COOP         | 16      | 504766      | 58.6829 | 156.6563 | 47       | 7/1955        |
| King Salmon Airport  | KISA    | ASOS         | 22      | 25503       | 58.6829 | 156.6563 | 47       | 6/1998        |
| King Salmon 42 SE    | KS42    | CLRN         | 40      | USW00025522 | 58.2076 | 155.9225 | 657      | 8/2012        |
| McArthur Pass        | MCPA    | RAWS         | 12      | 3280244E    | 59.4726 | 150.3337 | 1266     | 6/2008        |
| Nuka Glacier         | NUGL    | SNTE         | 35      | 50K06S      | 59.6943 | 150.7110 | 1250     | 10/1990       |
| Pedersen Lagoon      | PELA    | RAWS         | 11      | 326AD012    | 59.8944 | 149.7308 | 624      | 8/2011        |
| Pfaff Mine           | PFMI    | RAWS         | 6       | FA65578A    | 59.1109 | 154.8367 | 2018     | 6/2008        |
| Pilot Rock           | PIRO    | CMAN         | 38      | PILA2       | 59.7417 | 149.4700 | 79       | 12/1999       |
| Port Alsworth        | POAL    | COOP         | 14      | 507570      | 60.2033 | 154.3164 | 260      | 6/1960        |
| Port Alsworth        | POAL    | SNCO         | 30      | 54L01       | 60.1921 | 154.3272 | 270      | 10/1991       |
| Port Alsworth        | POAL    | RAWS         | 3       | FA6102CC    | 60.1958 | 154.3200 | 321      | 6/1992        |
| Port Alsworth 1 SW   | P1SW    | CRN          | 39      | USW00026562 | 60.1958 | 154.3198 | 315      | 9/2009        |
| Port Heiden          | POHE    | AWOS         | 23      | 25508       | 56.9500 | 158.6167 | 95       | 10/2007       |
| Seward               | SEWA    | COOP         | 20      | 508371      | 60.1039 | 149.4439 | 110      | 9/1949        |
| Seward Airport       | SEAI    | ASOS         | 26      | 26438       | 60.1283 | 149.4167 | 22       | 4/1997        |
| Seward 8NW           | S8NW    | COOP         | 19      | 508375      | 60.1883 | 149.6275 | 410      | 6/1983        |
| Shelikof Strait      | SHST    | BUOY         | 37      | 46077       | 57.9200 | 154.2542 | 37       | 10/2005       |
| Silver Salmon Lakes  | SISA    | RAWS         | 41      | 32352246    | 59.9754 | 152.6713 | 23       | 7/2013        |
| Snipe Lake           | SNLA    | RAWS         | 2       | 328041A8    | 60.6103 | 154.3199 | 2315     | 6/2008        |
| Stoney               | STON    | RAWS         | 1       | FA600036    | 61.0008 | 153.8958 | 1250     | 6/1992        |
| Telaquana Lake       | TELA    | COOP         | 13      | T.B.D.      | 60.984  | 153.924  | 1250     | 6/1997        |
| Telaquana Lake       | TELA    | SNCO         | 27      | 53L01       | 60.983  | 153.917  | 1550     | 8/1991        |

Continued on next page.

**Table 2.** Weather stations included in this report (continued).

| Station name     | Acronym | Station type | Map no. | ID no.    | Lat. N  | Lon. W   | Elev ft. | Station start |
|------------------|---------|--------------|---------|-----------|---------|----------|----------|---------------|
| Three Forks      | THFO    | SNCO         | 32      | 55J02     | 58.36   | 155.383  | 900      | 1995          |
| Three Forks      | THFO    | RAWS         | 42      | 32803738* | 58.3678 | 155.3839 | 1358     | 9/2013        |
| Upper Twin Lakes | UTLA    | SNCO         | 28      | 53L02     | 60.650  | 153.800  | 2000     | 8/1991        |

\*Contact Creek RAWS was removed in September 2013 and moved to Three Forks. The NESDIS ID is the same.

## Reporting Interval

Reporting based on the hydrologic year (October 1 to September 30) is more relevant, complete, and timely than reporting would be if it were based on the calendar year. The timing and seasonality of many physical processes that are driven by climate (e.g. onset and breakup of lake ice, glacial accumulation and ablation dynamics, and the magnitude and timing of streamflow) more closely follow the hydrologic year. Considerable data are not transmitted from many remote weather stations (i.e. RAWS operated and maintained by the SWAN) during winter months because of antenna icing (e.g. interference with GOES telemetry); however, these data are stored on-site, are retrieved during subsequent summer months, and climate databases are updated with the complete record in September.

## Summary Reports and Graphs

Summary reports and graphs for the most consistently measured climate variables from 42 weather stations monitored by the SWAN are included in the Appendices and are organized alphabetically by park, climate monitoring program, and station name. Daily measures are used for generating graphs (with the exception of NRCS Snow Courses) and monthly measures are used for generating summary reports. Mean temperature, total precipitation, mean snow depth, mean wind speed and direction, and maximum wind speed are presented in graphs. Minimum, maximum, and mean temperature data, the number of frost days (where the minimum temperature is below freezing), and the number of ice days (where the maximum temperature is below freezing) are included in the summary reports. Total precipitation, average snow depth, mean and maximum wind speed, maximum wind direction, and cumulative solar radiation are also presented in the summary reports. The percentage of valid observations is reported as a measure of the reliability of the derived mean and cumulative values for all reported climate variables. Climatic normal values (arithmetic mean over a 30-year interval) from the NCDC for the 1981-2010 period and period of record mean values from the WRCC are included for stations with a long enough observational record.

## Stations Used in Analyses

The stations used for analysis in this summary report are six weather stations with the longest, most complete records located near three SWAN parks. These stations are Homer Airport, Iliamna Airport, Kenai Airport, King Salmon Airport, Port Alsworth, and Seward (Table 2).



# Results

## Regional Overview

### *Temperature*

The Southwest Alaska Network region experienced slightly colder than average temperatures and near average precipitation during the 2013 hydrologic year. Compared to the climatological normal (the prevailing set of weather conditions calculated over a 30-year period, currently 1981-2010), mean annual temperatures for long-term weather stations in the SWAN region were 2.3 °F below average to 0.5°F above average (Table 3). There were four stations with colder than average conditions (a negative deviation) and one station with slightly warmer than average conditions (a positive deviation; Table 3). One station, Port Alsworth, lacked climate data for September, so annual measures are not valid for this location. However, temperature reported at a nearby weather station (Port Alsworth 1 SW) indicates colder than average (1.6 °F below average) temperature. Maps showing monthly temperature departures from average, which are calculated by subtracting the 30-year average monthly temperature from the observed average monthly temperature, are depicted in Figure 3.

The hydrologic year began with cooler than average temperatures during October. Temperatures were warm for the first third of the month and then swung to the cold side. Temperatures during November were significantly colder than average with temperatures ranging from 2.5 °F below average in Seward to 7.9 °F in Iliamna. These cold conditions continued into December with temperatures ranging from 3.8 °F below average in Homer to 8.0 °F below average in Kenai – significant negative deviations from average temperatures (ACRC 2014a). In stark contrast, the New Year ushered in warm conditions across the SWAN region. The most significant deviation from average temperatures occurred in Port Alsworth where January was 9.9 °F above average and February was 8.0 °F above average. Temperatures returned to more normal conditions in March with a mean deviation from normal of 0.9 °F below average. Of interest in March, sea ice extent in the Bering Sea reached its maximum extent for the winter – an area 3 % below the 1981-2010, but typical of the past decade (Perovich et al. 2013).

Alaska had its seventh coldest April on record (NCDC 2013). Frigid temperatures across the SWAN region ranged from 4.2 °F below average in Iliamna to 10.4 °F below average in Kenai. May provided some relief, but remained colder than average at all long term station except for Pt. Alsworth. Temperatures quickly rose during summer and, statewide, Alaska saw its third warmest June, fifth warmest July, and 11<sup>th</sup> warmest August (NCDC 2013). However, summer temperatures were somewhat moderated in southwest Alaska. June saw temperatures ranging from 1.6 °F below average in King Salmon to 4.6 °F above average in Pt. Alsworth. Several daily temperature records were broken in Seward during the month of June with a new daily high temperature record being set on June 17 (88 °F; ACIS 2014). July saw temperatures that ranged from 0.5 °F below average to 2.9 °F above average. King Salmon reported a minimum temperature of 31 °F on the 5<sup>th</sup> of July, replacing the old record low temperature for this day set in 1981 (ACRC 2014a). In general, slightly

warmer than average conditions continued across the SWAN region until September 2013, which brought a return to average temperatures at most locations across the region.

### ***Precipitation***

The SWAN region received near average precipitation during the 2013 hydrologic year. Compared to the climatological normal, total annual precipitation for long-term weather stations in the SWAN region was 90 to 113 % of average (Table 4). In contrast to some previous years, there was no obvious spatial pattern of monthly departure from average precipitation across the SWAN region. Kenai and King Salmon received slightly above average precipitation (112 and 113 % of average, respectively) whereas Iliamna, Seward, and Homer received slightly below average precipitation (90 to 93 % of average). Precipitation was not reported for Pt. Alsworth during the month of September, so annual measures are not valid. However, precipitation reported at a nearby weather station (Port Alsworth 1 SW) indicates near average (102 % of average) precipitation. Maps showing monthly precipitation percent of average, which is calculated by dividing the observed monthly precipitation by the 30-year average monthly precipitation, are shown for long-term weather stations in Figure 4.

In general, mid-winter (December and January), spring (May), and summer (July and August) were characterized by wetter than average conditions whereas fall (October and November), late winter (February), and spring (April) saw drier than average conditions in the SWAN region. October 2012 was characterized by below average precipitation across the SWAN region with 22 to 89 % of average precipitation. Despite the low monthly totals, King Salmon received several significant snow falls, including 7.2 inches on October 14, which set a new daily record for snowfall on that day (ACRC 2014). November was very dry with total monthly precipitation ranging from 8 % of average in Seward to 39 % of average in Iliamna. December, January, and March brought above average precipitation to most of the SWAN region with long term stations receiving a mean three-month precipitation total that was 124% of the 1981-2010 average.

King Salmon received an unusual amount of precipitation in February with 255 % of average precipitation while the other long term stations all received less than average precipitation. The cold conditions experienced in April were coupled with extremely dry conditions with precipitation ranging from 14 % of average in Iliamna to 64 % of average in Kenai. May was slightly wetter than average, a departure from the typical seasonal climate pattern where spring is usually the driest time of year in the SWAN region. With the exception of September, the remainder of the hydrologic year was characterized by above average precipitation. Notably, July 25 was the wettest day (1.86 inches) ever recorded for this month in Kenai (ACIS 2014).

**Table 3.** Average daily temperatures during hydrologic year 2013 (Oct. 1, 2012 to Sep. 30, 2013) and departures from 1981-2010 averages for long-term weather stations in southwest Alaska.

| Station name        | Station ID | Oct            | Nov            | Dec            | Jan           | Feb           | Mar            | Apr             | May            | Jun            | Jul            | Aug            | Sep            | Annual         |
|---------------------|------------|----------------|----------------|----------------|---------------|---------------|----------------|-----------------|----------------|----------------|----------------|----------------|----------------|----------------|
| Homer Airport       | 503665     | 36.7<br>(-1.4) | 25.5<br>(-4.0) | 23.3<br>(-3.8) | 30.7<br>(5.9) | 31.3<br>(5.1) | 30.3<br>(0.4)  | 31.9<br>(-5.1)  | 43.1<br>(-1.4) | 53.2<br>(2.7)  | 57.3<br>(2.7)  | 56.8<br>(2.9)  | 50.8<br>(2.7)  | 39.2<br>(0.5)  |
| Iliamna Airport     | 503905     | 33.3<br>(-1.8) | 16.8<br>(-7.9) | 14.7<br>(-6.1) | 25.7<br>(8.2) | 24.0<br>(4.3) | 23.0<br>(-0.5) | 28.9<br>(-4.2)  | 42.9<br>(-1.1) | 55.9<br>(4.2)  | 59.2<br>(3.1)  | 56.1<br>(1.3)  | 47.2<br>(-0.8) | 35.7<br>(-0.1) |
| Kenai Airport       | 504546     | 33.1<br>(-2.1) | 15.8<br>(-7.4) | 11.0<br>(-8.0) | 22.0<br>(5.6) | 23.4<br>(3.7) | 22.0<br>(-3.7) | 25.8<br>(-10.4) | 42.1<br>(-3.9) | 53.1<br>(0.6)  | 55.8<br>(-0.5) | 54.6<br>(-0.4) | 46.8<br>(-1.3) | 33.9<br>(-2.3) |
| King Salmon Airport | 504766     | 31.3<br>(-2.2) | 15.2<br>(-7.7) | 12.4<br>(-6.2) | 25.4<br>(9.2) | 23.1<br>(4.3) | 21.3<br>(-2.8) | 28.6<br>(-5.1)  | 42.6<br>(-1.6) | 55.4<br>(-1.6) | 57.8<br>(2.3)  | 55.8<br>(1.2)  | 47.0<br>(-0.6) | 34.7<br>(-0.5) |
| Port Alsworth       | 507570     | 31.5<br>(-3.0) | 16.7<br>(-7.1) | 14.4<br>(-5.0) | 25.4<br>(9.9) | 26.6<br>(8.0) | 27.3<br>(3.0)  | 30.7<br>(-4.5)  | 46.3<br>(0.3)  | 58.9<br>(4.6)  | 60.8<br>(2.9)  | 57.7<br>(2.2)  | --<br>(--)     | --<br>(--)     |
| Seward              | 508371     | 38.1<br>(-1.5) | 28.4<br>(-2.5) | 24.1<br>(-4.8) | 30.3<br>(3.2) | 31.6<br>(3.3) | 30.4<br>(-1.7) | 33.7<br>(-5.0)  | 44.4<br>(-2.0) | 55.7<br>(3.5)  | 58.7<br>(2.7)  | 55.8<br>(0.1)  | 50.2<br>(0.7)  | 40.2<br>(-0.3) |

Temperatures are given in degrees Fahrenheit. Departures from 1981-2010 averages are given in parenthesis. Station IDs are from National Weather Service COOP stations. Monthly statistics are not reported if more than 10% of observations (three days) are missing. Annual statistics are not reported if more than 17% of observations (five days) are missing from any month. The percentage of valid observations are reported in the Appendices.

**Table 4.** Total monthly precipitation during hydrologic year 2013 (Oct. 1, 2012 to Sep. 30, 2013) and percentage versus 1981-2010 averages for long-term weather stations in southwest Alaska.

| Station name        | Station ID | Oct          | Nov           | Dec           | Jan           | Feb           | Mar           | Apr          | May           | Jun           | Jul           | Aug            | Sep            | Annual         |
|---------------------|------------|--------------|---------------|---------------|---------------|---------------|---------------|--------------|---------------|---------------|---------------|----------------|----------------|----------------|
| Homer Airport       | 503665     | 2.06<br>(80) | 0.53<br>(19)  | 4.61<br>(150) | 4.34<br>(165) | 1.23<br>(72)  | 0.94<br>(57)  | 0.53<br>(50) | 1.15<br>(140) | 0.49<br>(60)  | 0.86<br>(55)  | 3.39<br>(145)  | 2.39<br>(72)   | 22.51<br>(93)  |
| Iliamna Airport     | 503905     | 0.84<br>(26) | 0.83<br>(39)  | 1.61<br>(106) | 2.03<br>(160) | 1.06<br>(100) | 0.91<br>(117) | 0.12<br>(14) | 0.23<br>(20)  | 1.42<br>(107) | 3.36<br>(117) | 5.83<br>(140)  | 4.22<br>(93)   | 22.45<br>(90)  |
| Kenai Airport       | 504546     | 1.74<br>(66) | 0.15<br>(11)  | 0.92<br>(68)  | 2.04<br>(213) | 0.62<br>(70)  | 0.45<br>(70)  | 0.38<br>(64) | 1.74<br>(191) | 0.41<br>(38)  | 2.96<br>(161) | 4.88<br>(181)  | 4.32<br>(132)  | 20.63<br>(113) |
| King Salmon Airport | 504766     | 1.86<br>(89) | 1.60<br>(115) | 2.06<br>(167) | 2.41<br>(236) | 1.94<br>(255) | 1.51<br>(216) | 0.19<br>(20) | 0.33<br>(26)  | 1.06<br>(64)  | 1.31<br>(57)  | 5.39<br>(183)  | 2.08<br>(65)   | 21.75<br>(112) |
| Port Alsworth       | 507570     | 0.33<br>(22) | 0.22<br>(15)  | 0.51<br>(56)  | 0.60<br>(74)  | 0.74<br>(90)  | 0.36<br>(55)  | 0.02<br>(49) | 0.56<br>(137) | 0.84<br>(114) | 1.24<br>(93)  | 1.43<br>(76)   | --<br>(--)     | --<br>(--)     |
| Seward              | 508371     | 2.84<br>(30) | 0.55<br>(8)   | 7.09<br>(74)  | 8.88<br>(110) | 5.67<br>(94)  | 6.15<br>(139) | 0.69<br>(15) | 5.74<br>(170) | 1.02<br>(42)  | 6.28<br>(224) | 10.72<br>(191) | 11.22<br>(114) | 66.85<br>(91)  |

Percentages of monthly average precipitation versus 1981-2010 given in parentheses. Station IDs are from National Weather Service COOP stations. Monthly statistics are not reported if more than 10% of observations (three days) are missing. Annual statistics are not reported if more than 17% of observations (five days) are missing from any month. The percentage of valid observations are reported in the Appendices.

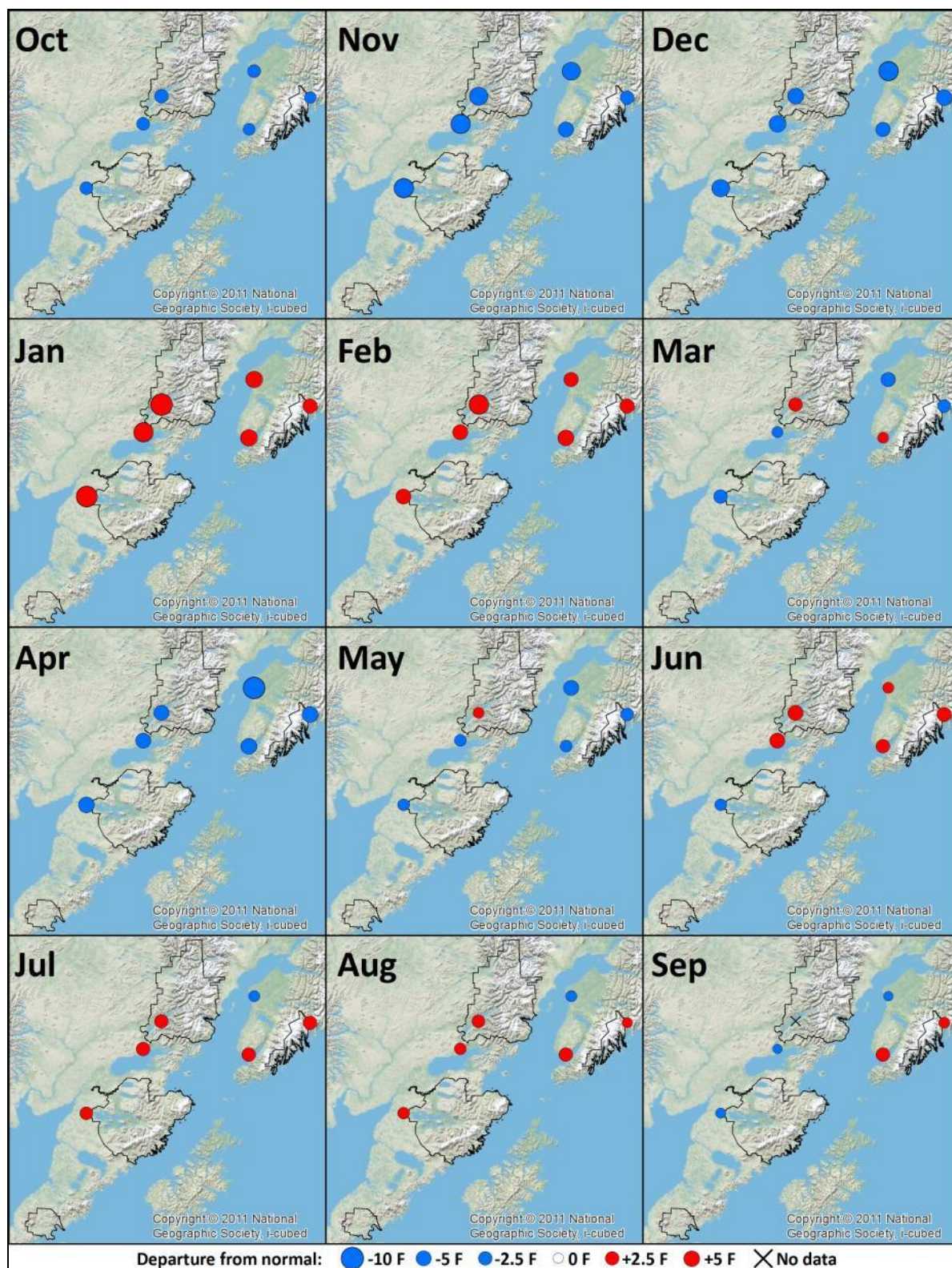


**Figure 3.** Monthly temperature anomalies (departure from 1981-2010 averages) for long-term weather stations in southwest Alaska during the 2013 hydrologic year. Red symbols indicate warmer than average conditions and blue symbols indicate cooler than average conditions.

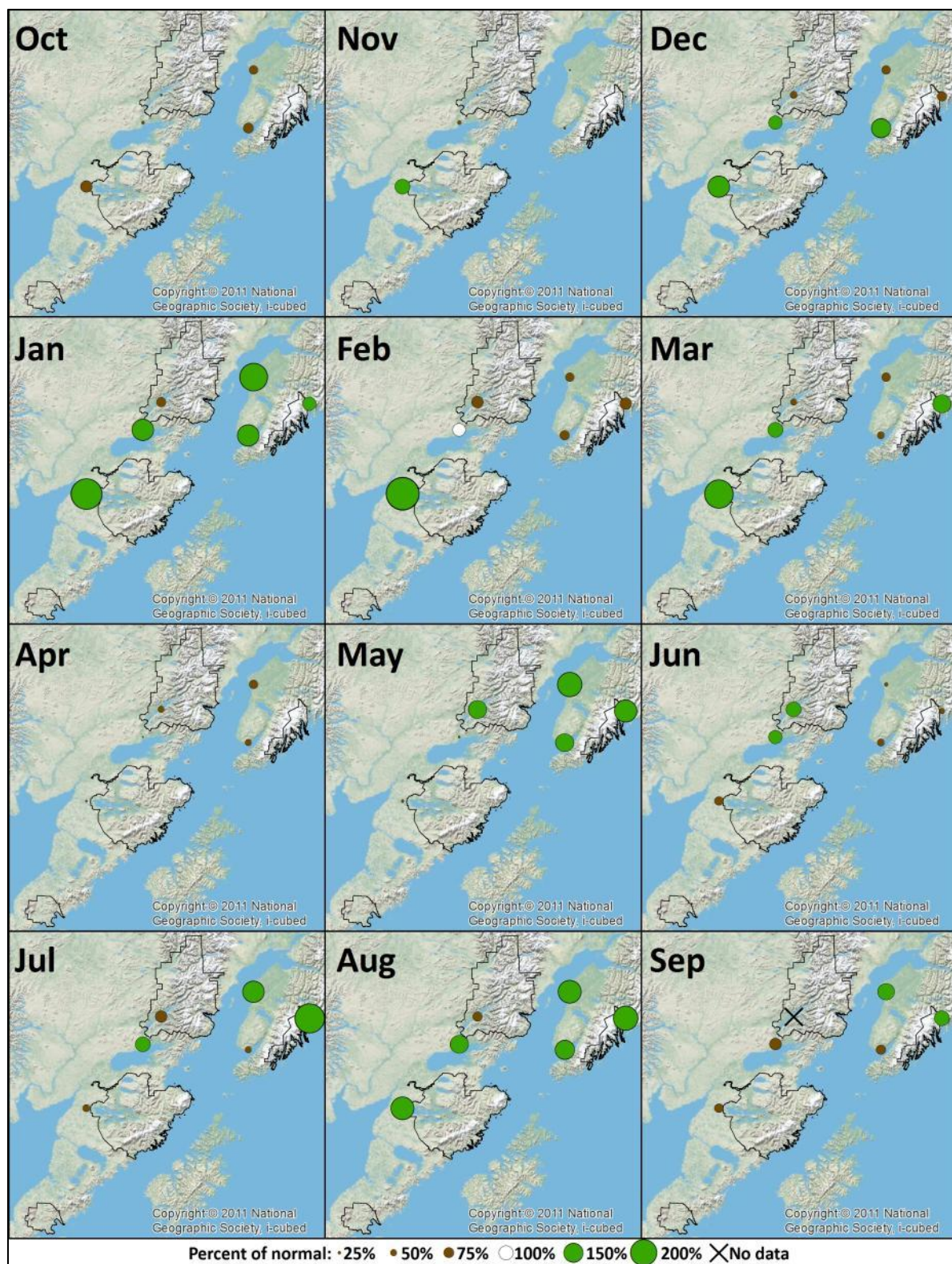


**Figure 4.** Monthly precipitation anomalies (percentages of 1981-2010 averages) for long-term weather stations in southwest Alaska during the 2013 hydrologic year. Green symbols indicate wetter than average conditions, brown symbols indicate drier than average conditions.

## **Location of Summary Reports and Graphs for Individual Stations**

Summary reports and graphs for consistently measured climate variables from 42 weather stations monitored by the SWAN (shown in Figure 2 and listed in Table 2) are included in the Appendices and are organized alphabetically by park, climate monitoring program, and station name.

## **Limitations**

Measuring winter-time precipitation (i.e. snowfall, snow depth, and snow water equivalent) is difficult to accomplish across the SWAN region. Snow surveys are relatively accurate, but they are only measured once a month (at best) and at a few key locations. Most remote weather stations have limited (photovoltaic) power supplies and therefore rely on unheated tipping buckets, which are only capable of accurately measuring liquid precipitation (e.g. rain). Although sonic snow depth sensors are used at many of these stations (e.g. RAWs), snow water equivalent is not measured. A few remote weather stations utilize storage or displacement precipitation gauges or snow pillows (Harding Icefield, Nuka Glacier). The logistical challenges and costs associated with maintaining those gauges or pillows (which are filled with an antifreeze solution) and protecting them from wildlife are significant and make them impractical to operate at more than a few key locations. Undercatch (the difference between the actual amount of precipitation and the amount measured by a precipitation gauge) is a problem at the Harding Icefield because of the windy nature of the site.

Currently, accurate year-round precipitation is only measured at a few locations within the SWAN, including all of the long term stations (Table 3) discussed above. Summarized precipitation values reported in the tables in the Appendices for individual stations that are only capable of measuring liquid precipitation are indicated with notes. Precipitation values reported for these stations are not considered valid if the maximum air temperature is below 31.1 °F and this is reflected in the percentage of valid observations that are reported as a measure of the reliability of cumulative values. False precipitation may also be recorded at RAWs during strong wind events. Vibrations from strong winds shaking the station can cause tipping buckets to tip excessively, artificially exaggerating any precipitation that may (or may not) be occurring. Precipitation values reported for these stations are not considered valid when maximum wind speeds exceed 70 mph and this is reflected in the percentage of valid observations.

# Discussion

## Historical Context

### *Limitations*

Assessments of the historical context of trends and average conditions for SWAN region weather stations should be viewed in the context of the available record and quality of data. Although the 50 to 80 year observational period for the long-term stations discussed above provides an adequate basis for evaluating the historical context of the recent climate with respect to climatological normal or the period of record, it is possible that this period may be too short for discerning long-term changes in climate. The climate data for the long-term stations discussed above has been subjected to a suite of quality assurance checks (NCDC 2011), but it has not been adjusted for bias resulting from historical changes in instrumentation and observing practices and no detrending has been done. In some cases (e.g. Port Alsworth), the record is not complete. Period of record means are used exclusively as a basis for historical context in this discussion. Trends are presented with respect to PDO phase (1952-1976 and 1977-2001) and to the entire period of record.

### ***Temperature and Precipitation at Long-Term Stations – Data Presentation Methods***

Relatively complete daily records of maximum temperature, minimum temperature, and precipitation are available for the last 50 to 80 years from six long-term stations (Homer Airport, Iliamna Airport, Kenai Airport, King Salmon Airport, Port Alsworth, and Seward) located across the SWAN region. Temperature and precipitation data are summarized by hydrologic year for each of the long-term stations in Figures 5 – 10. Mean daily maximum temperatures are plotted in box A. Values for years where no month is missing more than five values are shown with colored symbols. Values for years where one or more months have more than five missing values (sometimes an entire month of data is missing) are not be considered representative and are only shown for reference (these data are shown with white symbols). Mean daily maximum temperature anomalies are plotted in box B. These anomalies were calculated by subtracting the period of record mean daily maximum temperature from the observed mean daily maximum temperature for that year. Mean daily minimum temperatures are plotted in box C. Mean daily minimum temperature anomalies are plotted in box D. Total precipitation (for the hydrologic year) is plotted in box E. Precipitation anomalies are plotted in box F. The sample standard deviation ( $\pm 1\sigma$ ) is provided for reference and helps to identify which anomalies are significant. Both the period of record means and anomalies were calculated only for years where no month is missing more than five daily values. Mean annual temperature anomalies for each of the long-term stations for years where no month is missing more than five daily values are shown in Figure 11.

Trend lines are presented for two discrete PDO phases (1952-1976 and 1977-2001 using solid lines) and for the entire period of record (using dotted lines). The simple statistical technique that was used to identify linear trend was least squares linear regression (observed time series against time) and the estimated slope coefficient of the regression equation was then tested for significance (Haan 2002). A  $t$  statistic test was applied to the estimated slope coefficient and the  $p$ -value for  $t$  was used to estimate the probability of significance of trends. Numeric values for period of record means, standard deviations, and all regression results are presented in the discussion text and tables.

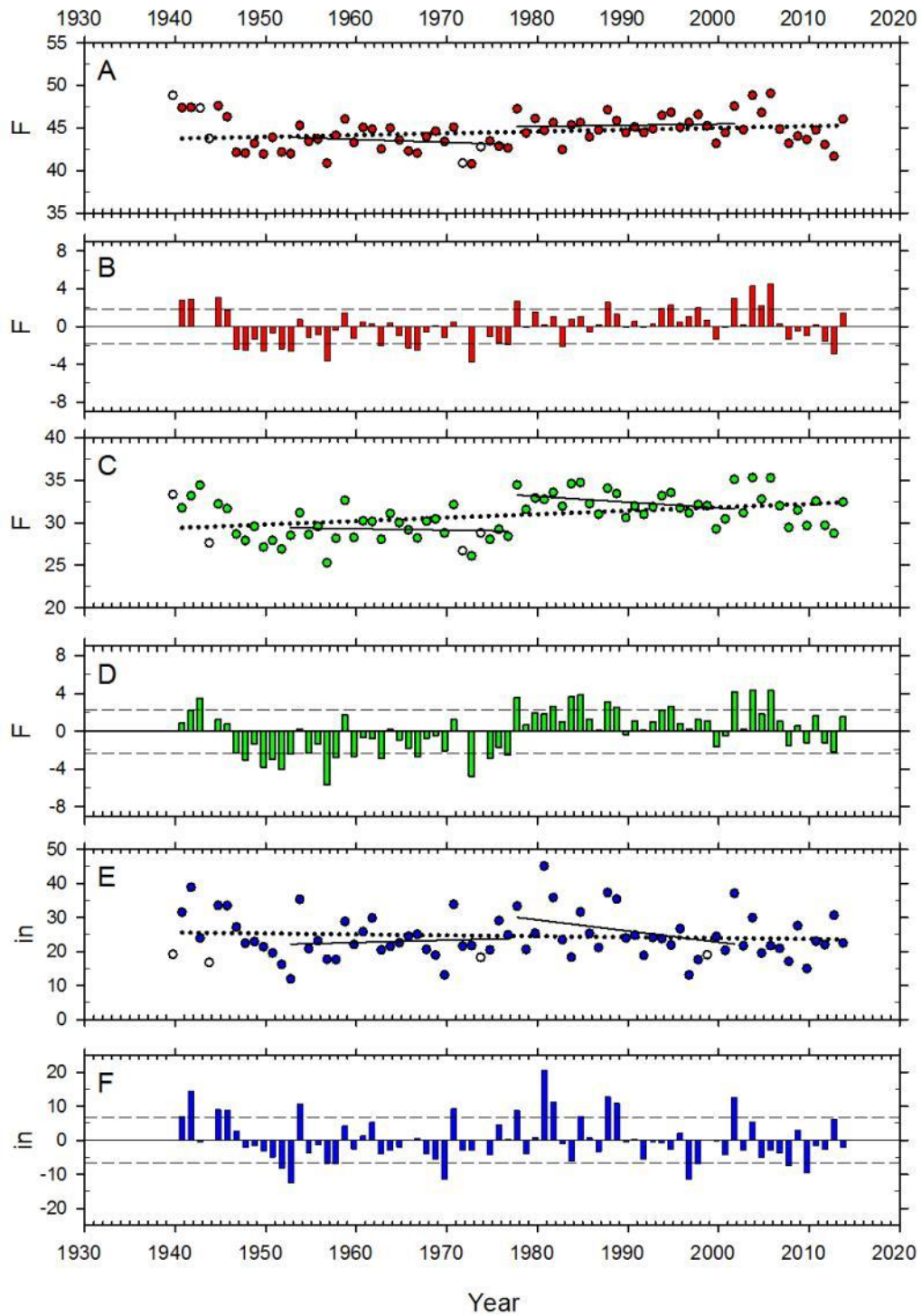


**Figure 5.** Temperature (T) and precipitation (P) at Homer Airport for 1939-2013 hydrologic years. A) Mean maximum T, B) maximum T anomalies, C) mean minimum T, D) minimum T anomalies, E) total annual P, F) annual P anomalies. Colored symbols represent years where no month is missing >5 values, white symbols represent years where  $\geq 1$  month is missing >5 values. Trend lines are for PDO phases (solid line) and period of record (dotted line). Anomalies and standard deviations (dashed lines) calculated using years where no month is missing >5 values.

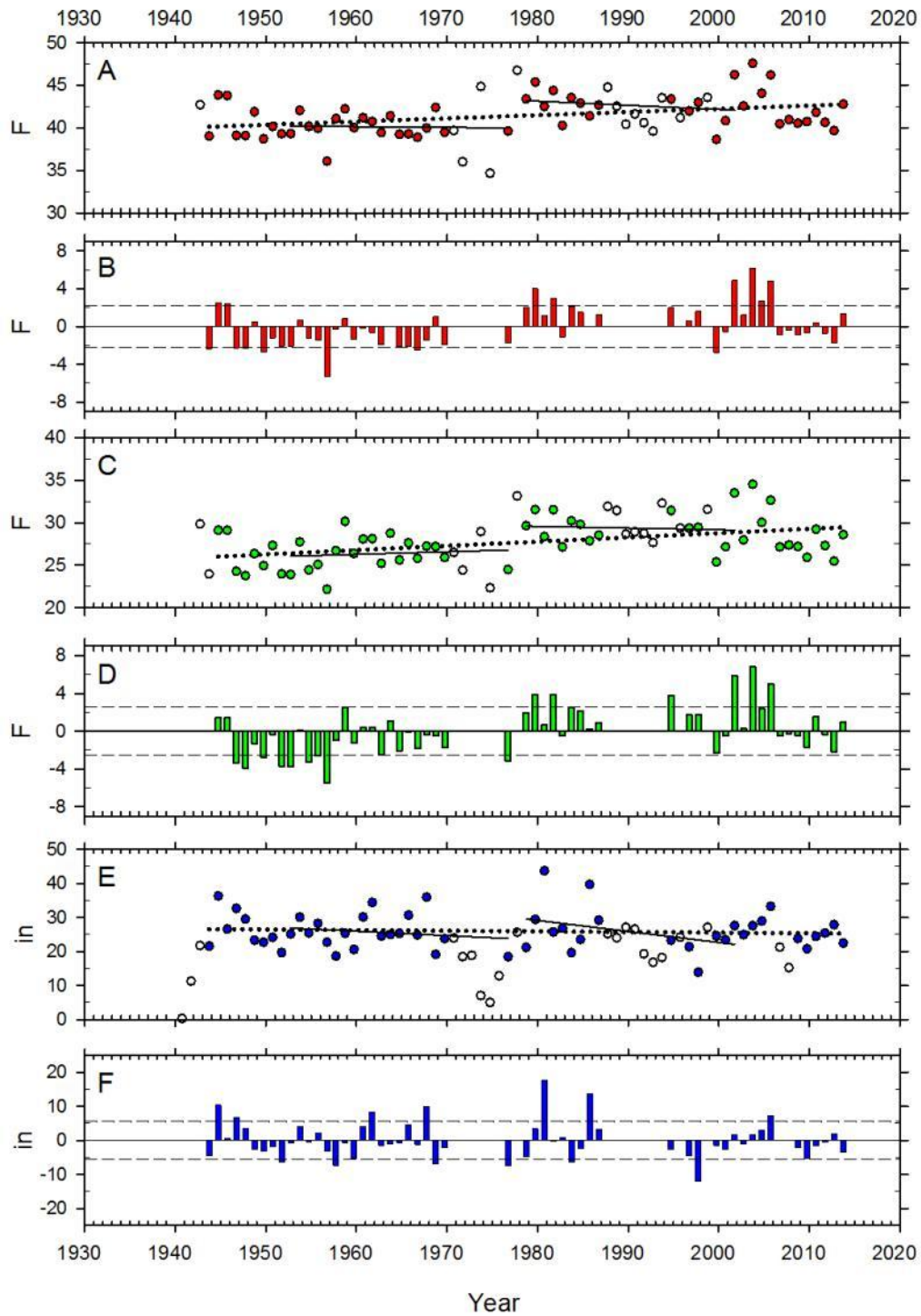


**Figure 6.** Temperature (T) and precipitation (P) at Iliamna Airport for 1943-2013 hydrologic years. A) Mean maximum T, B) maximum T anomalies, C) mean minimum T, D) minimum T anomalies, E) total annual P, F) annual P anomalies. Colored symbols represent years where no month is missing >5 values, white symbols represent years where  $\geq 1$  month is missing >5 values. Anomalies and standard deviations (dashed lines) calculated using years where no month is missing >5 values.

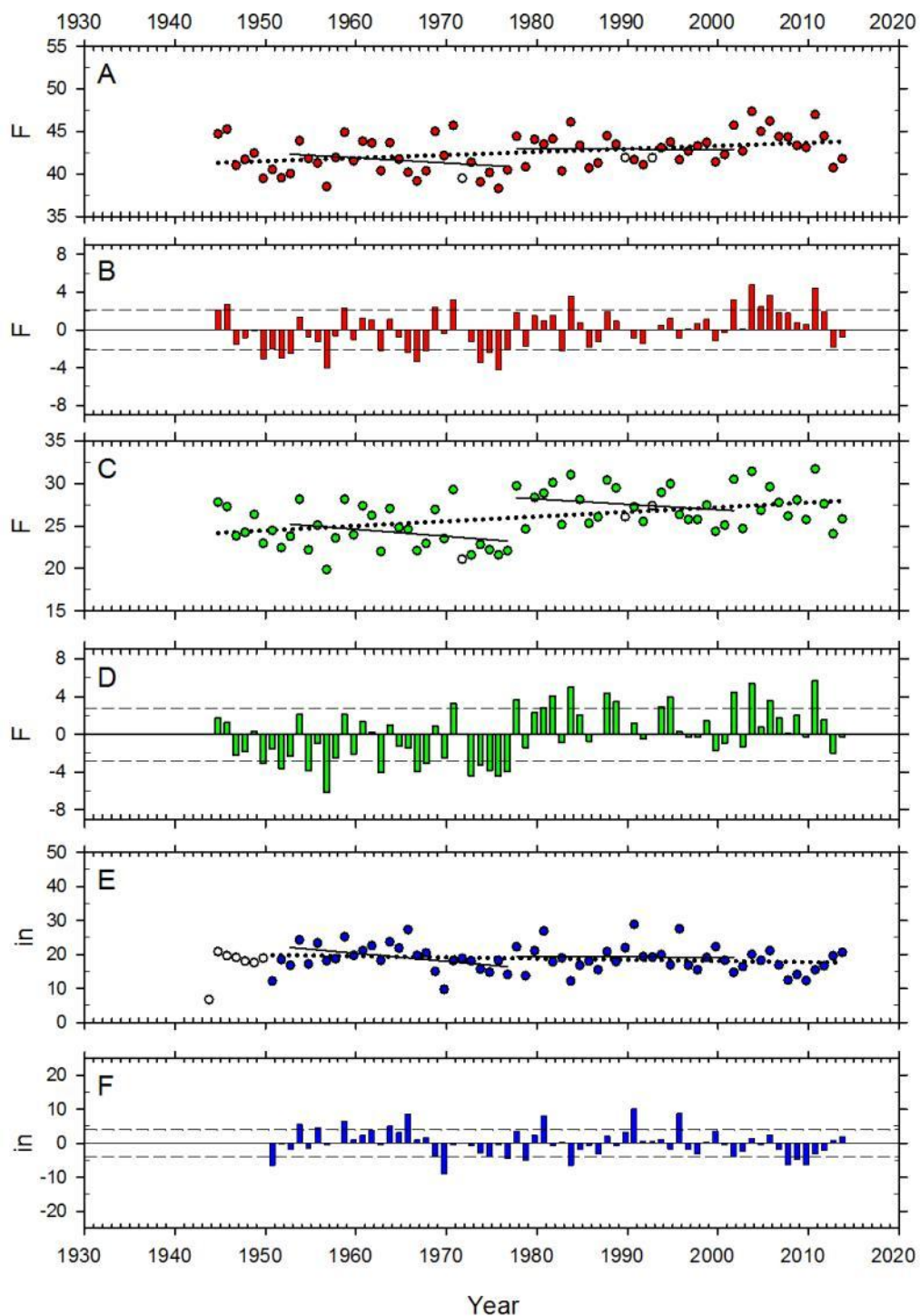


**Figure 7.** Temperature (T) and precipitation (P) at Kenai Airport for 1944-2013 hydrologic years. A) Mean maximum T, B) maximum T anomalies, C) mean minimum T, D) minimum T anomalies, E) total annual P, F) annual P anomalies. Colored symbols represent years where no month is missing >5 values, white symbols represent years where  $\geq 1$  month is missing >5 values. Anomalies and standard deviations (dashed lines) calculated using years where no month is missing >5 values.

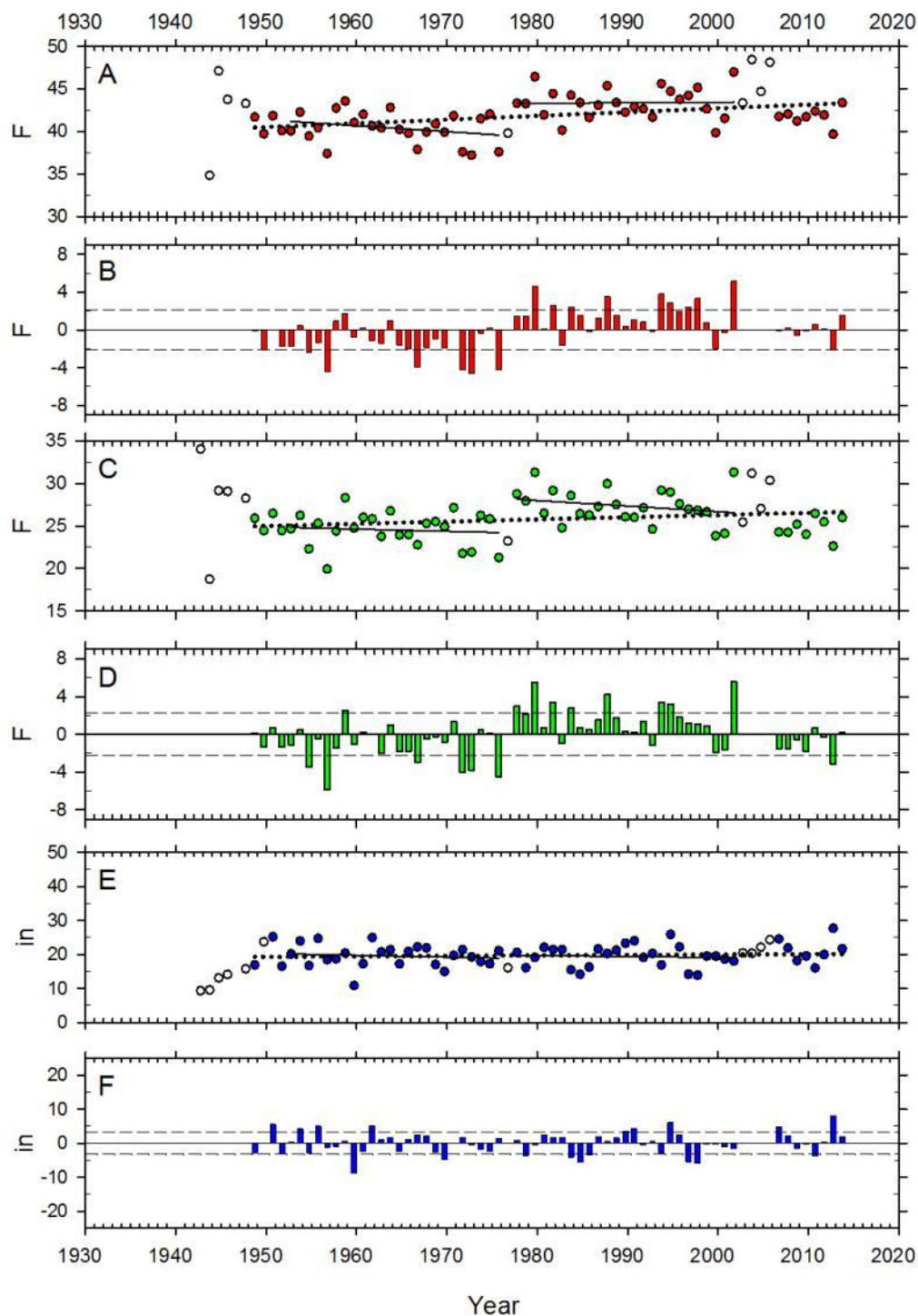


**Figure 8.** Temperature (T) and precipitation (P) at King Salmon Airport for 1942-2013 hydrologic years. A) Mean maximum T, B) maximum T anomalies, C) mean minimum T, D) minimum T anomalies, E) total annual P, F) annual P anomalies. Colored symbols represent years where no month is missing >5 values, white symbols represent years where  $\geq 1$  month is missing >5 values. Anomalies and standard deviations (dashed lines) calculated using years where no month is missing >5 values.

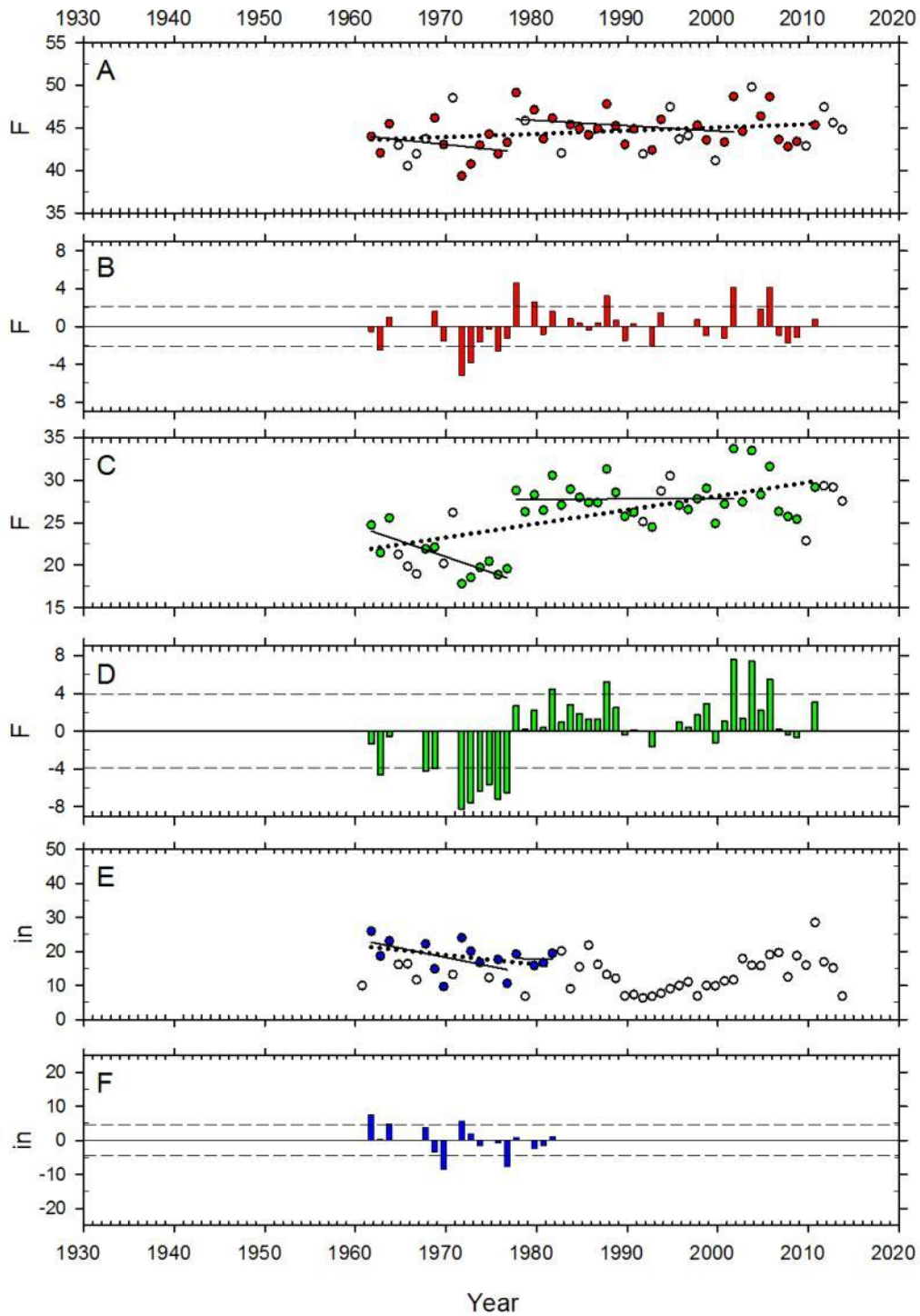


**Figure 9.** Temperature ( $T$ ) and precipitation ( $P$ ) at Port Alsworth for 1960-2013 hydrologic years. **A)** Mean maximum  $T$ , **B)** maximum  $T$  anomalies, **C)** mean minimum  $T$ , **D)** minimum  $T$  anomalies, **E)** total annual  $P$ , **F)** annual  $P$  anomalies. Colored symbols represent years where no month is missing  $>5$  values, white symbols represent years where  $\geq 1$  month is missing  $>5$  values. Anomalies and standard deviations (dashed lines) calculated using years where no month is missing  $>5$  values.

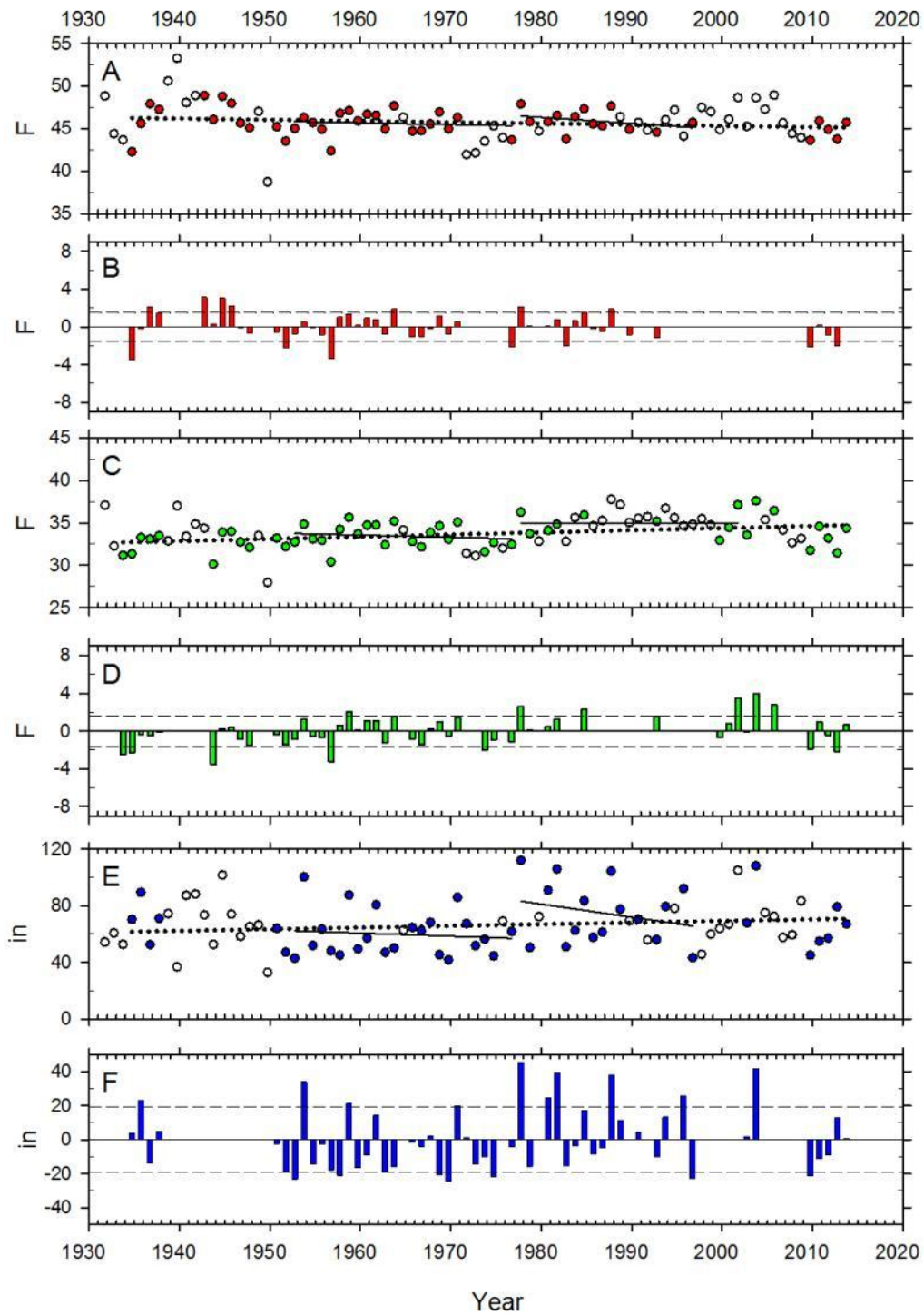


**Figure 10.** Temperature ( $T$ ) and precipitation ( $P$ ) at Seward for 1931-2013 hydrologic years. **A)** Mean maximum  $T$ , **B)** maximum  $T$  anomalies, **C)** mean minimum  $T$ , **D)** minimum  $T$  anomalies, **E)** total annual  $P$ , **F)** annual  $P$  anomalies. Colored symbols represent years where no month is missing  $>5$  values, white symbols represent years where  $\geq 1$  month is missing  $>5$  values. Anomalies and standard deviations (dashed lines) calculated using years where no month is missing  $>5$  values.

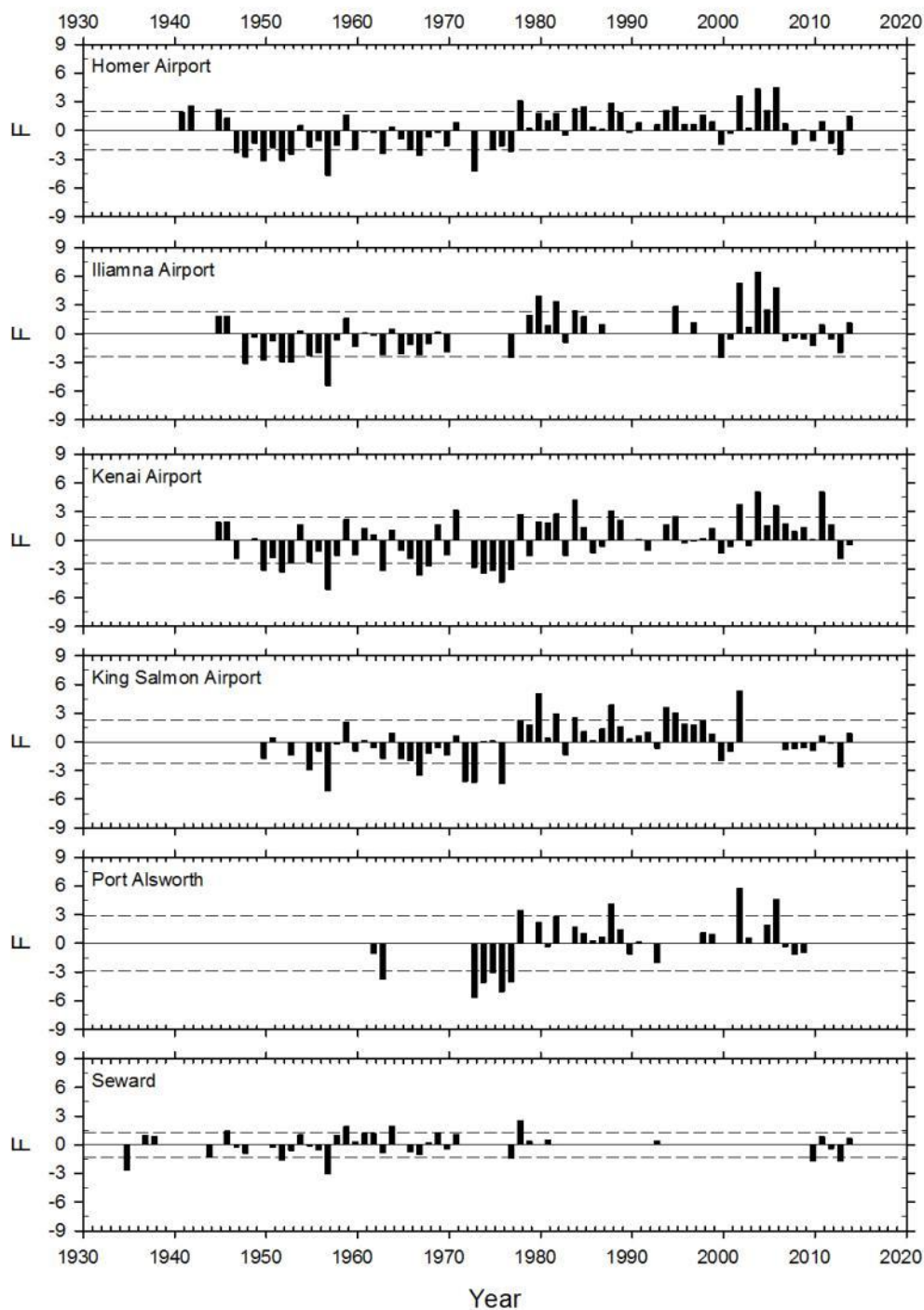


**Figure 11.** Mean annual temperature anomalies at the Homer Airport, Iliamna Airport, Kenai Airport, King Salmon Airport, Port Alsworth and Seward for the 1931-2013 hydrologic years. Only years where no month is missing more than five daily values are shown. Anomalies and sample deviations (dashed lines) calculated only for years where no month is missing more than five daily values.

### ***Temperature and Precipitation Changes during 1952-1976 and 1977-2001***

The abrupt positive shift in temperature beginning during the 1977 hydrologic year is evident at five of the long-term stations. This shift is not as noticeable at Iliamna, because it is obscured by the poor observational record during the 1971-1977 hydrologic years. The increase (spanning the 1976-1977 shift) in minimum temperatures is greater than the increase in maximum temperatures (boxes A and C in Figures 5 – 10). This shift reflects generally warmer winter conditions beginning in the late 1970s, and has been well correlated with the shift from negative (cool phase) to positive (warm phase) PDO conditions (e.g. Simpson et al. 2002; Hartman and Wendler 2005) although the cause of this shift is not well understood.

The period 1952-2001 (hydrologic years) was used to separate two equal periods of 25 years that are representative of climatic conditions during a cool (1952-1976) and warm phase (1977-2001) of the PDO (after Hartman and Wendler 2005). Station temperature and precipitation trends for cool and warm phase PDO conditions are presented in Figures 5 – 10 (with solid trend lines) and in Table 5. Trends significant at probability greater than 90% are identified with italic font and trends that are significant at a probability greater than 95% are identified with bold font (Table 5).

Mean annual maximum and minimum temperatures generally show a small, but statistically insignificant cooling trend (a decrease of 2.8 °F to an increase of 0.8 °F over 25 years) within both cool and warm PDO phases (Table 5). The prominent cooling trend (a decrease of 9.2 °F over 25 years) observed during 1952-1976 at Port Alsworth likely results from a shorter period of record (the station started in 1960) and fewer years of complete observations (n=11). The cooling trends described here starkly contrast the overall warming trends observed at all stations over the whole period of record, which are discussed below, but are also documented elsewhere (Hartman and Wendler 2005).

Precipitation generally shows a considerable, but statistically insignificant drying trend (a decrease in precipitation of 23.1 inches to an increase of 1.7 inches over 25 years). These individual PDO phase observations are generally consistent with the overall drying trends observed at four long term stations over the whole period of record, which are discussed next. Most of these temperature and precipitation trends during cool and warm PDO phases are not statistically significant (only three are significant at a probability >90%, Table 5); however, these results highlight the importance of the time period chosen for analysis and the significance of the PDO to local climatology.

**Table 5.** Trends for temperature and precipitation during cool (1952-1976) and warm (1977-2001) PDO phase. Trend lines are solid in Figures 5 – 10. Trends calculated using only years where no month is missing >5 values. *Italic font indicates significance at a probability >90%, bold font indicates >95%.*

| Station             | Trend cool PDO phase    |         | Trend warm PDO phase    |         |
|---------------------|-------------------------|---------|-------------------------|---------|
|                     | ( $\Delta$ over 25 yrs) | p-value | ( $\Delta$ over 25 yrs) | p-value |
| Homer Airport       |                         |         |                         |         |
| Maximum temperature | -0.8 °F                 | 0.44    | +0.3 °F                 | 0.70    |
| Minimum temperature | -0.4 °F                 | 0.76    | -1.7 °F                 | 0.10    |
| Precipitation       | +1.7 in                 | 0.68    | -8.2 in                 | 0.14    |
| Iliamna Airport     |                         |         |                         |         |
| Maximum temperature | -0.2 °F                 | 0.88    | -1.2 °F                 | 0.45    |
| Minimum temperature | +0.8 °F                 | 0.68    | -0.5 °F                 | 0.78    |
| Precipitation       | -3.2 in                 | 0.50    | -8.1 in                 | 0.18    |
| Kenai Airport       |                         |         |                         |         |
| Maximum temperature | -1.5 °F                 | 0.32    | -0.0 °F                 | 0.97    |
| Minimum temperature | -2.1 °F                 | 0.26    | -1.6 °F                 | 0.31    |
| Precipitation       | <b>-5.9 in</b>          | 0.026   | -0.2 in                 | 0.93    |
| King Salmon Airport |                         |         |                         |         |
| Maximum temperature | -1.7 °F                 | 0.20    | +0.2 °F                 | 0.89    |
| Minimum temperature | -0.7 °F                 | 0.67    | -1.6 °F                 | 0.25    |
| Precipitation       | -1.3 in                 | 0.59    | -0.7 in                 | 0.76    |
| Port Alsworth       |                         |         |                         |         |
| Maximum temperature | -2.8 °F                 | 0.37    | -1.6 °F                 | 0.33    |
| Minimum temperature | <b>-9.2 °F</b>          | 0.003   | +0.1                    | 0.96    |
| Precipitation       | <b>-13.4 in</b>         | 0.098   | -1.8 in                 | 0.93    |
| Seward              |                         |         |                         |         |
| Maximum temperature | -0.5 °F                 | 0.69    | -1.8 °F                 | 0.28    |
| Minimum temperature | -0.7 °F                 | 0.54    | +0.1 °F                 | 0.95    |
| Precipitation       | -5.6 in                 | 0.65    | -23.1 in                | 0.35    |

### ***Temperature and Precipitation Changes over the Period of Record***

When temperature is examined over the period of record, trends in annual mean maximum and minimum temperature contrast those for the individual PDO phases. Station temperature and precipitation trends over the period of record are presented in Figures 5 – 10 (with dotted trend lines) and in Table 6. Mean annual temperatures show a sizeable (increase of 1.7 to 5.1 °F over 50 years) and statistically significant warming trend at all long term stations, with the exception of Seward where mean annual temperatures show no change (an increase of 0.04 °F over 50 years). Mean annual minimum temperatures show a greater increase in temperature over time when compared to mean annual maximum temperatures at all long term stations except for King Salmon. Precipitation shows a statistically insignificant drying trend (with a decrease in total precipitation of 1.0 to 13.9 inches over 50 years) at Homer, Iliamna, Kenai, and Port Alsworth whereas precipitation shows a statistically insignificant increase (of 0.7 inches and 5.8 inches over 50 years) at King Salmon and Seward, respectively. The majority of the temperature changes described are significant at probabilities greater than 95% (values in bold font in Table 6) and the existence and relevance of these trends are well documented elsewhere (IPCC 2013, Klein et al. 2005, Weller et al. 1999). The precipitation trends are not statistically significant, owing in part to a large interannual variability in precipitation and, in some cases, an inferior observational record.

**Table 6.** Trends for temperature and precipitation over the period of record. Trend lines are dotted in Figures 5 – 10. Trends calculated using only years where no month is missing >5 values. *Italic font* indicates significance at a probability >90%, **bold font** indicates >95%.

| <b>Station</b>      | <b>Trend<br/>period of record<br/>(<math>\Delta</math> over 50 yrs)</b> | <b>p-value</b> |
|---------------------|-------------------------------------------------------------------------|----------------|
| Homer Airport       |                                                                         |                |
| Mean temperature    | <b>+1.7 °F</b>                                                          | 0.003          |
| Maximum temperature | <b>+1.0 °F</b>                                                          | 0.045          |
| Minimum temperature | <b>+2.0 °F</b>                                                          | 0.001          |
| Precipitation       | -1.4 in                                                                 | 0.46           |
| Iliamna Airport     |                                                                         |                |
| Mean temperature    | <b>+2.0 °F</b>                                                          | 0.005          |
| Maximum temperature | <b>+1.9 °F</b>                                                          | 0.004          |
| Minimum temperature | <b>+2.5 °F</b>                                                          | 0.001          |
| Precipitation       | -1.0 in                                                                 | 0.58           |
| Kenai Airport       |                                                                         |                |
| Mean temperature    | <b>+2.3 °F</b>                                                          | 0.001          |
| Maximum temperature | <b>+1.8 °F</b>                                                          | 0.003          |
| Minimum temperature | <b>+2.7 °F</b>                                                          | 0.001          |
| Precipitation       | -1.8 in                                                                 | 0.19           |
| King Salmon Airport |                                                                         |                |
| Mean temperature    | <b>+1.9 °F</b>                                                          | 0.017          |
| Maximum temperature | <b>+2.2 °F</b>                                                          | 0.002          |
| Minimum temperature | <b>+1.3 °F</b>                                                          | 0.099          |
| Precipitation       | +0.7 in                                                                 | 0.57           |
| Port Alsworth       |                                                                         |                |
| Mean temperature    | <b>+5.1 °F</b>                                                          | 0.011          |
| Maximum temperature | +1.9 °F                                                                 | 0.14           |
| Minimum temperature | <b>+8.1 °F</b>                                                          | 0.001          |
| Precipitation       | -13.9 in                                                                | 0.14           |
| Seward              |                                                                         |                |
| Mean temperature    | +0.0 °F                                                                 | 0.94           |
| Maximum temperature | -0.7 °F                                                                 | 0.14           |
| Minimum temperature | <b>+1.3 °F</b>                                                          | 0.008          |
| Precipitation       | +5.8 in                                                                 | 0.37           |

### ***Recent Temperature and Precipitation Anomalies***

In this study, the standard deviation is used as a measure of what constitutes a significant temperature or precipitation anomaly (after Papineau no date). Standard deviations for long term stations for the sample population (i.e. only years where no month is missing >5 values) are presented in Table 7. The first half of the first decade of the 21<sup>st</sup> century was significantly warmer than the period of record at long term stations in the SWAN region (Figure 11) with 1 – 4 years exceeding one, and sometimes two, standard deviations of sample population. In contrast, the last eight hydrologic years (2006-2013) have been generally slightly colder than average (for 6 of 8 years) and have not exhibited significant temperature anomalies (with the exception of 2010 at Kenai Airport). The warm temperature anomalies at Kenai during recent hydrologic years are inconsistent with conditions observed at the other long-term stations. The cause of these anomalies isn't clear and presents an opportunity for investigation by the NWS.

The generally colder than average temperatures experienced in southwest Alaska since the 2006 hydrologic year starkly contrast with the warmer than average conditions observed across the rest of the high latitudes, the contiguous United States (Figure 12), and globally. For example, the contiguous U.S. average annual temperature for the 2012 calendar year was the warmest year in the 1895-2012 period of record (NCDC 2012). Notably, the 2013 calendar year was the coolest for the nation since 2009, but ranked as the 37<sup>th</sup> warmest year in the 119-year period of record (NCDC 2013). The apparent cooling trend observed in Alaska during the first decade of the 21<sup>st</sup> century is described in a recent paper (Wendler and Chen 2012) and discussed in relation to the Pacific Decadal Oscillation (PDO).

The historical context for precipitation is less clear. The 2013 hydrologic year was characterized by near average precipitation (box D in Figures 5-10; the precipitation record at Port Alsworth in recent years is not complete enough for evaluation). Near average annual precipitation during the 2013 hydrologic year represent a slight departure from the generally drier than normal conditions observed during recent years (except for 2012). Seward is characterized by wide interannual variability in precipitation over the entire period of record ( $1\sigma = 19.1$  inches, Table 7, Figure 10).

**Table 7.** Standard deviations for temperature and precipitation over the period of record and period of record mean air temperature. The sample population only includes years where no month is missing >5 values.

| Station             | 1 $\sigma$ | Period of record mean |
|---------------------|------------|-----------------------|
| Homer Airport       |            |                       |
| Mean temperature    | 2.0 °F     | 37.73 °F              |
| Maximum temperature | 1.8 °F     | 44.55 °F              |
| Minimum temperature | 2.3 °F     | 30.91 °F              |
| Precipitation       | 6.6 in     | 24.50 in              |
| Iliamna Airport     |            |                       |
| Mean temperature    | 2.4 °F     | 34.59 °F              |
| Maximum temperature | 2.2 °F     | 41.37 °F              |
| Minimum temperature | 2.6 °F     | 27.65 °F              |
| Precipitation       | 5.5 in     | 25.94 in              |
| Kenai Airport       |            |                       |
| Mean temperature    | 2.4 °F     | 34.35 °F              |
| Maximum temperature | 2.1 °F     | 42.55 °F              |
| Minimum temperature | 2.8 °F     | 26.03 °F              |
| Precipitation       | 3.9 in     | 18.68 in              |
| King Salmon Airport |            |                       |
| Mean temperature    | 2.2 °F     | 33.83 °F              |
| Maximum temperature | 2.2 °F     | 41.81 °F              |
| Minimum temperature | 2.3 °F     | 25.76 °F              |
| Precipitation       | 3.3 in     | 19.67 in              |
| Port Alsworth       |            |                       |
| Mean temperature    | 2.9 °F     | 35.49 °F              |
| Maximum temperature | 2.2 °F     | 44.54 °F              |
| Minimum temperature | 3.9 °F     | 26.08 °F              |
| Precipitation       | 4.6 in     | 18.29 in              |
| Seward              |            |                       |
| Mean temperature    | 1.3 °F     | 39.52 °F              |
| Maximum temperature | 1.5 °F     | 45.75 °F              |
| Minimum temperature | 1.6 °F     | 33.61 °F              |
| Precipitation       | 19.1 in    | 66.13 in              |

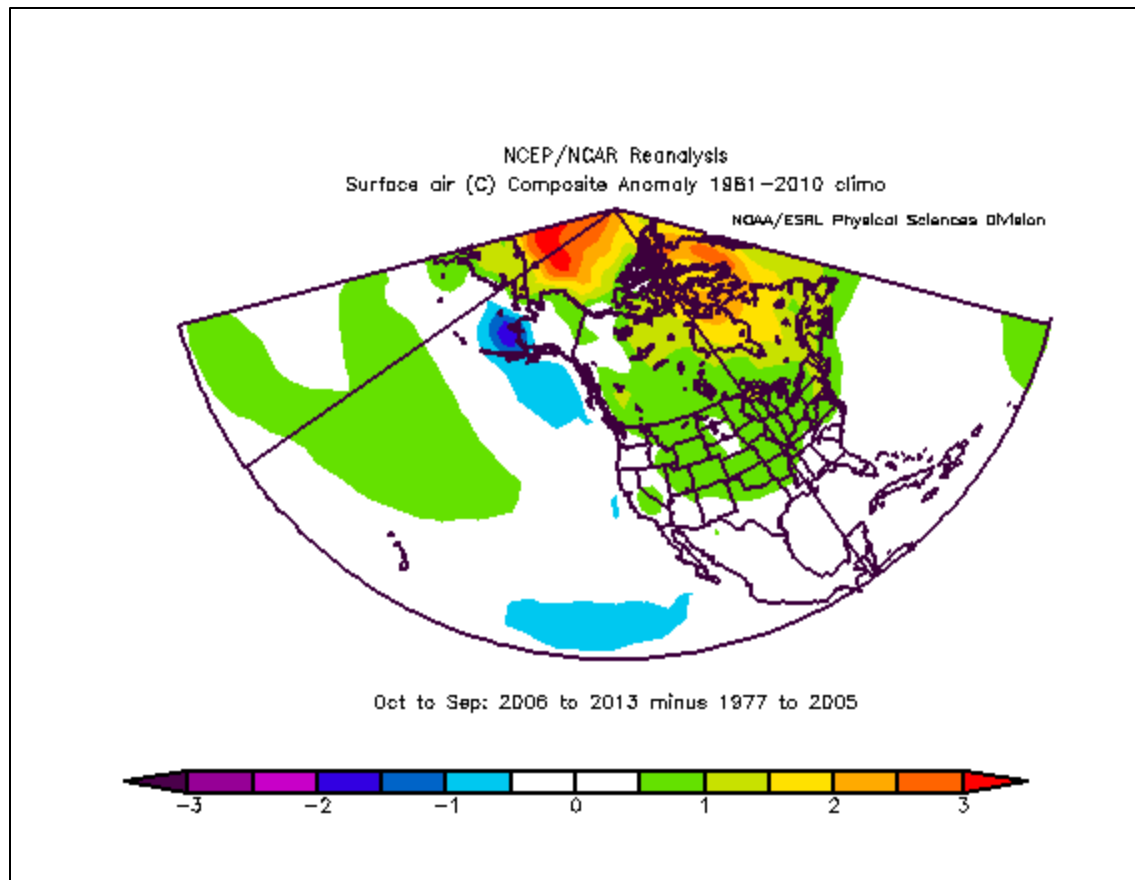


**Figure 12.** Surface air temperature composite anomaly for part of the northern hemisphere (recent seven-year composite anomaly {October to September 2006 to 2013} minus 1977 to 2005 composite anomaly). Figure was generated using the NOAA/ESRL Physical Sciences Division website (<http://www.esrl.noaa.gov/psd/>) using NCEP reanalysis data (Kalnay et al. 1996). Anomalies are based on the 1981-2010 climatological normal.

### ***PDO Conditions***

The 2013 hydrologic year was characterized by negative (cool phase) or slightly-negative PDO conditions (JISAO 2014). These negative PDO conditions are reflected by cold sea surface temperature (SST) anomalies in the Gulf of Alaska and Bering Sea (within a few hundred miles of shore) and warm SST anomalies in the central North Pacific (Figure 13). Negative (cool phase) PDO conditions have prevailed since August 2006 with the notable exception of much of the 2010 hydrologic year, which was characterized by neutral to slightly positive PDO conditions.

PDO conditions are moderately correlated to temperature. Temperatures in and near the Gulf of Alaska are often cooler than normal when negative PDO conditions exist (Zhang et al. 1996; Mantua et al. 1997). It has also been suggested that drier than normal conditions occur in the Gulf of Alaska region north of about 57° N latitude and on the Alaska Peninsula when negative PDO conditions exist (Mantua et al. 1997; Papineau no date). Other studies, however, found no relationship between PDO and precipitation in this region (L'Heureux et al. 2004).

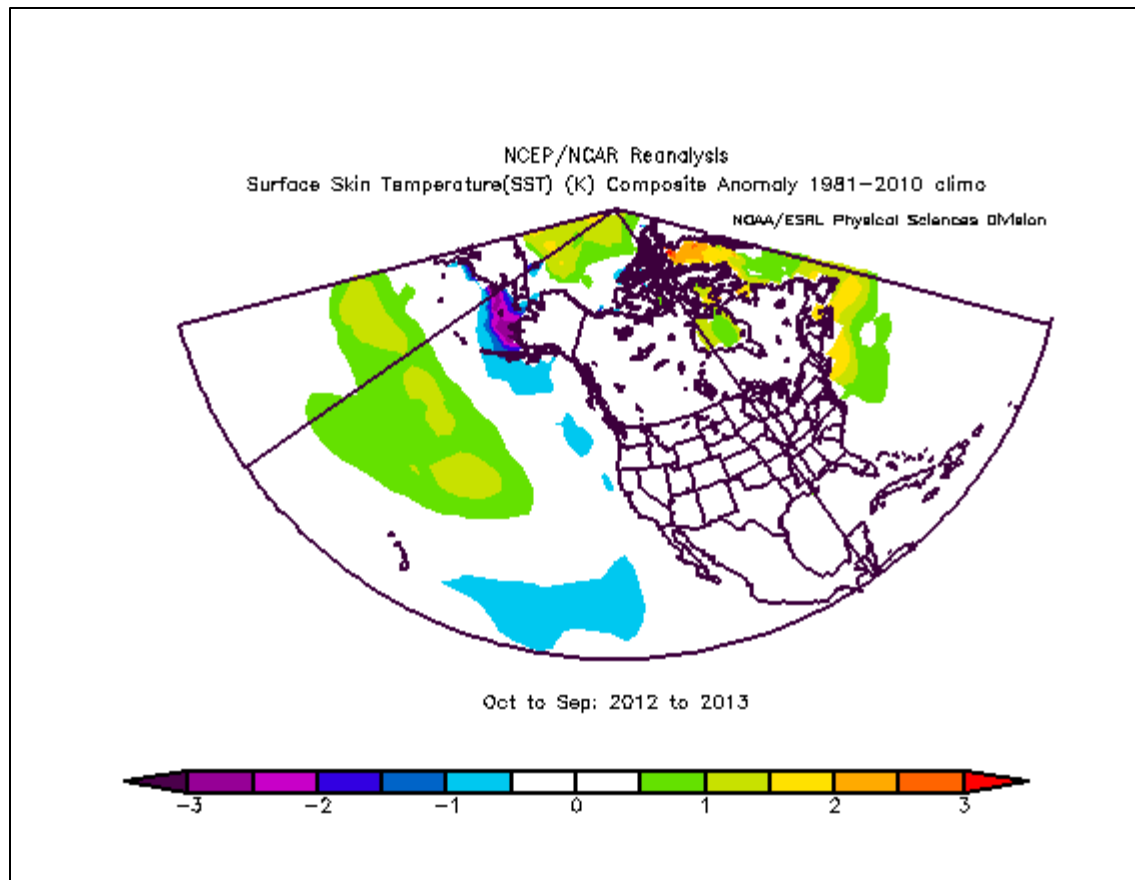


**Figure 13.** Sea surface temperature composite anomaly for the North Pacific area (October 2012 - September 2013). Figure was generated using the NOAA/ESRL Physical Sciences Division website (<http://www.esrl.noaa.gov/psd/>) using NCEP reanalysis data (Kalnay et al. 1996). Climate means are based on 1981-2010.

### ***ENSO Conditions***

The 2013 hydrologic year was generally characterized by neutral to slightly-negative (La Niña) ENSO conditions (NWS Climate Prediction Center 2014). The weak La Niña event that developed in the fall of 2011 ended by spring 2012.

A rigorous comparison of temperature and precipitation data from long-term stations in the SWAN region to recent ENSO events (listed in Table 8) has not been done. However, a cursory analysis indicates that temperature data from the long-term stations are better correlated to El Niño events than La Niña events. Warm annual temperature anomalies occurred during all but two recent El Niño events (1992 and 2007) during the last 30 years, whereas an approximately equal number of both warm and cold annual temperature anomalies occurred during recent La Niña events. This quick comparison did not consider the importance of seasonal temperature anomalies nor the duration and intensity of individual ENSO events.

**Table 8.** El Niño and La Niña events (since 1950) of varying intensity listed by hydrologic year (NWS Climate Prediction Center, 2014). An event is defined as exceeding  $\pm 0.5$  °C Oceanic Niño Index for five consecutive overlapping three-month running (e.g. June-August-September) seasons.

| El Niño events | La Niña events |
|----------------|----------------|
| 1958           | 1950           |
| 1964           | 1951           |
| 1966           | 1955           |
| 1969           | 1956           |
| 1970           | 1957           |
| 1973           | 1963           |
| 1977           | 1965           |
| 1978           | 1968           |
| 1983           | 1971           |
| 1987           | 1972           |
| 1988           | 1974           |
| 1992           | 1975           |
| 1995           | 1976           |
| 1998           | 1985           |
| 2003           | 1989           |
| 2005           | 1996           |
| 2007           | 1999           |
| 2010           | 2000           |
|                | 2001           |
|                | 2008           |
|                | 2011           |
|                | 2012           |

## Weather Extremes

Maximum and minimum temperatures, maximum wind gusts, and the number of frost and days ice days during the 2013 hydrologic year are listed in Table 9. Maximum temperatures recorded across the SWAN region range from 63.1 °F (Shelikof Strait BUOY) to 86.9 °F (Port Alsworth CLRN). Minimum temperatures recorded across the SWAN region range from -47 °F (Stoney RAWS) to 8.2 °F (Pilot Rock CMAN). The maximum wind speed (instantaneous gust) documented was northwest at 112 mph at the Pedersen Lagoon RAWS. The number of frost days (a day on which the minimum air temperature falls below 32 °F) range from 80 days (Shelikof Strait BUOY) to 262 days (Chigmit Mountain RAWS). The number of ice days (a day on which the maximum air temperature does not rise above 32 °F) range from 22 days (Shelikof Strait BUOY) to 216 days (Chigmit Mountain RAWS).

**Table 9.** Weather extremes, frost days, and ice days during the 2013 hydrologic year at weather stations across southwest Alaska.

| Station name         | Station type | Max temp | Min temp | Max wind speed | Max wind direction | Frost days | Ice days |
|----------------------|--------------|----------|----------|----------------|--------------------|------------|----------|
| Chigmit Mountains    | RAWS         | 71.1     | -20.6    | 84.8           | 271                | 262        | 216      |
| Contact Creek        | RAWS         | --       | --       | --             | --                 | --         | --       |
| Coville              | RAWS         | 77.5     | -16.2    | 78.1           | 110                | 218        | 107      |
| Drift River Terminal | CMAN         | 71.2     | -0.6     | 51.0           |                    | 169        | 87       |
| Exit Glacier         | SNTE         | --       | -17.0    |                |                    | 196        | --       |
| Fourpeaked           | RAWS         | --       | --       | --             | --                 | --         | --       |
| Harding Icefield     | RAWS         | 72.9     | -21.3    | 100.9          | 117                | 251        | 207      |
| Hickerson Lake       | RAWS         | 83.3     | 0.1      | 87.2           | 358                | 198        | 90       |
| Homer Airport        | COOP         | 76       | -1       |                |                    | 181        | 58       |
| Homer Airport        | ASOS         | 76       | 2        |                |                    | 173        | 60       |
| Iliamna Airport      | COOP         | 85       | -15      |                |                    | 183        | 93       |
| Iliamna Airport      | ASOS         | 85       | -14      |                |                    | 180        | 96       |
| Kenai Airport        | COOP         | 76       | -28      |                |                    | 211        | 103      |
| Kenai Airport        | ASOS         | 75       | -27      |                |                    | 209        | 107      |
| King Salmon Airport  | COOP         | 82       | -22      |                |                    | 204        | 94       |
| King Salmon Airport  | ASOS         | 81       | -21      |                |                    | 198        | 97       |
| King Salmon 42 SE    | CLRN         | 79.7     | -21.6    |                |                    | 199        | 95       |
| McArthur Pass        | RAWS         | --       | --       | --             | --                 | --         | --       |
| Nuka Glacier         | SNTE         | 80.0     | -10.5    |                |                    | 207        | 95       |
| Pedersen Lagoon      | RAWS         | 84.9     | 2.1      | 112.3          | 333                | 145        | 27       |
| Pfaff Mine           | RAWS         | --       | --       | --             | --                 | --         | --       |
| Pilot Rock           | CMAN         | 74.5     | 8.2      | --             | --                 | 72         | 26       |
| Port Alsworth        | COOP         | --       | --       | --             | --                 | --         | --       |
| Port Alsworth        | RAWS         | --       | --       | --             | --                 | --         | --       |
| Port Alsworth 1 SW   | CRN          | 86.9     | -24.0    |                |                    | 225        | 99       |
| Port Heiden          | AWOS         | 73       | -9       |                |                    | 181        | 78       |
| Seward               | COOP         | 88       | 1        |                |                    | 158        | 53       |
| Seward Airport       | ASOS         | 88       | 2        |                |                    | 149        | 54       |
| Seward 8NW           | COOP         | --       | --       |                |                    | --         | --       |
| Shelikof Strait      | BUOY         | 63.1     | 12.9     | 62.9           |                    | 80         | 22       |
| Silver Salmon Lakes  | RAWS         | --       | --       | --             | --                 | --         | --       |
| Snipe Lake           | RAWS         | 84.0     | -27.0    | 72.7           | 119                | 228        | 143      |
| Stoney               | RAWS         | 94       | -47      | 34             | 158                | 248        | 119      |
| Telaquana Lake       | COOP         | 87       | -46      |                |                    | 219        | 130      |
| Three Forks          | RAWS         | --       | --       |                |                    | --         | --       |

Temperatures are degrees Fahrenheit. Wind speed is miles per hour. Wind direction is degrees (true) from north. Frost days are defined as a day on which the minimum air temperature falls below 32 °F. Ice days are defined as a day on which the maximum air temperature does not rise above 32 °F. Annual statistics are not reported if more than 17% of observations (five days) are missing from any month and are identified with double dashes (--). Elements that are not reported by a particular station are blank. Percentages of valid observations, along with all summary data, are reported in the Appendices.

## **Status of Climate Monitoring in Network Parks**

The SWAN maintained 10 weather stations, relocated one weather station, and set up a new weather station during the 2013 hydrologic year. Five weather stations (Chigmit Mountains, Contact Creek Fourpeaked, Harding Icefield, and McArthur Pass) were accessed by helicopter (two separate helicopter trips were made to Fourpeaked). The other stations were accessed by fixed-wing aircraft, boat, and foot. Both the Fourpeaked and Pfaff Mine RAWS experienced data acquisition and transmission problems due to faulty data loggers and these stations each required two maintenance trips during the 2013 hydrologic year. The Contact Creek RAWS was relocated to a location near the Three Forks cabin in Katmai National Park and Preserve. An additional station was set up near Silver Salmon Lakes in Lake Clark National Park and Preserve. A summary of all maintenance work at SWAN operated and maintained weather stations is summarized in Table 10 and described in detail in a complementary report specific to weather station maintenance (Lindsay 2013).

### ***Measuring Snow and Winter-time Precipitation***

Accurately measuring winter-time precipitation (i.e. snowfall, snow depth, and snow water equivalent) continues to prove difficult to accomplish. Network RAWS rely on unheated tipping buckets, which are only capable of accurately measuring liquid precipitation (e.g. rain). Although sonic snow depth sensors are used at these stations, snow water equivalent is not measured. Sonic snow depth sensors have been removed from coastal weather stations (Fourpeaked and McArthur Pass). Judd Communications snow depth sensors have now operated successfully for two full years at the Harding Icefield and Pedersen Lagoon RAWS. These sensors are also ultrasonic, but they seem to perform better in humid environments than those made by another manufacturer. The Silver Salmon Lakes RAWS is also equipped with a Judd sensor.

A total precipitation gauge (Sutron Corporation) was purchased during the 2013 hydrologic year (Figure 14). It is a weighing type gauge filled with two gallons of propylene glycol and one quart of hydraulic oil. It is capable of measuring both liquid and solid precipitation. Observations can be logged hourly using a built-in data logger. This gauge can measure up to 27 inches of precipitation while accommodating a temperature range down to -54 °F. This gauge is currently being tested at the Homer Field Office. It is intended for installation at Telaquana Lake during summer 2014; however Lake Clark National Park and Preserve is alternatively discussing the installation of a SNOTEL at Telaquana Lake. The SWAN fully supports the installation of a SNOTEL at Telaquana Lake, knowing that climatic data collected by this station would be both more useful and more readily available than precipitation data collected by a stand-alone, non-telemetered gauge.



**Figure 14.** Sutron total precipitation gauge slated for future installation at Telaquana Lake.

**Table 10.** Maintenance summary for RAWs operated and maintained by the SWAN during the 2013 hydrologic year. Acronyms are as follows: air temperature - relative humidity (AT/RH), wind speed (WS), wind direction (WD), solar radiation (SR), snow depth (SD), Global Positioning System (GPS) antenna, geostationary operational environmental satellite (GOES) antenna, data logger program (DLP), rain gauge-tipping bucket (RG-TB), soil temperature (ST), photo-voltaic (PV) panel, and serial digital interface (SDI).

| Station             | Date       | Maintenance                                                                                                                                                 |
|---------------------|------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Chigmit Mountains   | 06/12/2013 | Scheduled and additional maintenance. Replaced AT/RH, WS, WD, and SD sensors. Reinforced 20-ft mast. Replaced wind-sensor support arm and guy-wires.        |
| Contact Creek       | 06/24/2013 | Scheduled maintenance. Replaced AT/RH and SD sensors. Maintained time-lapse cameras.                                                                        |
| Contact Creek       | 09/03/2013 | Removed station. Relocated time-lapse camera to CRN station.                                                                                                |
| Coville             | 06/25/2013 | Scheduled maintenance. Replaced AT/RH, SR, and SD sensors. Replaced SDI expansion port. Maintained time-lapse cameras.                                      |
| Fourpeaked          | 10/22/2012 | Unscheduled maintenance. Replaced data logger, GOES transmitter and antenna, power manager, GPS antenna, and SR sensor.                                     |
| Fourpeaked          | 06/12/2013 | Scheduled maintenance. Tower side panels, data logger, GOES transmitter, AT/RH, WS, and WD sensors.                                                         |
| Harding Icefield    | 04/19/2013 | Scheduled maintenance. Replaced AT/RH, WS, WD, and SD sensors. Serviced all-season precipitation gauge and replaced associated RG-TB. Replaced 2 batteries. |
| Hickerson Lake      | 08/27/2013 | Scheduled maintenance. Replaced AT/RH and SD sensors.                                                                                                       |
| McArthur Pass       | 06/10/2013 | Scheduled and additional maintenance. Replaced AT/RH, WS, WD sensors and RG-TB. Reinforced 20-ft mast and replaced wind-sensor support arm and guy-wires.   |
| Pedersen Lagoon     | 08/07/2013 | Scheduled maintenance. Replaced AT/RH, WS, WD, and SD sensors.                                                                                              |
| Pfaff Mine          | 06/26/2013 | Scheduled and additional maintenance. Replaced AT/RH, SD, and ST sensors. Replaced digital-analog module for ST sensors.                                    |
| Pfaff Mine          | 07/22/2013 | Unscheduled maintenance. Replaced data logger, GOES transmitter, and AT/RH sensor.                                                                          |
| Silver Salmon Lakes | 07/09/2013 | Initial station setup.                                                                                                                                      |
| Snipe Lake          | 06/20/2013 | Scheduled maintenance. Replaced AT/RH and SD sensors. Maintained time-lapse cameras.                                                                        |
| Three Forks         | 09/05/2013 | Initial station setup.                                                                                                                                      |

### ***New Weather Stations – Silver Salmon Lakes and Three Forks RAWS***

A new weather station was installed on the west side of Cook Inlet near Silver Salmon Lakes in Lake Clark and another weather station in Katmai was moved from Contact Creek to the Three Forks cabin near the Valley of Ten Thousand Smokes. Both weather stations are fully automated and powered by solar panels and large capacity deep-cycle batteries. Weather observations are transmitted every hour to a weather satellite and are publicly available on the internet at [www.raws.dri.edu/cgi-bin/wea\\_daysum.pl?akASSL](http://www.raws.dri.edu/cgi-bin/wea_daysum.pl?akASSL) (Silver Salmon Lakes) and [www.raws.dri.edu/cgi-bin/wea\\_daysum.pl?akATHF](http://www.raws.dri.edu/cgi-bin/wea_daysum.pl?akATHF) (Three Forks). Weather observations include: temperature, relative humidity, wind speed and direction, precipitation, snow depth, and solar radiation. A time lapse camera is also present at Silver Salmon Lakes, taking daily photographs that document vegetation and snow pack conditions. These photographs are logged, but not transmitted.

The Silver Salmon Lakes weather station will eventually replace a weather station that was installed in 2008 at Hickerson Lake (located nearby at a higher elevation). This weather station has proven difficult to access and will be removed in 2014 after both stations have operated for one year. The Three Forks weather station was moved from a location at Contact Creek (located in southwestern Katmai) where a weather station was installed in 2008. This original weather station was replaced with a CRN Station that was installed by the NOAA in September 2012.

These new weather stations, along with others, are operated and maintained by the SWAN. Their primary purpose is to collect and archive weather observations at representative locations in order to document natural weather variability and long-term climate trends. They also support real-time needs for aviation and park operations.

### ***Possible Relocation of the Fourpeaked RAWS***

SWAN and park staffs are planning to possibly relocate the Fourpeaked RAWS. A few locations on the coast of Katmai National Park and Preserve are being evaluated as possible locations for relocating the weather station. Infrastructure and sensor damage due to winter storms has been problematic at the Fourpeaked weather station, where tower components and sensors have broken two years in a row. This type of damage is costly to repair (requiring a costly two-hour round-trip helicopter ride from Homer for access) and is resulting in a low percentage of valid weather observations. Locations at Cape Gull, Swikshak Lagoon, Kukak Bay, Geographic Harbor, and some privately owned lands will be considered. The NPS cabin at Swikshak Lagoon is a favored location because of accessibility and proximity to the current location. It is expected that an Environmental Assessment will need to be completed to assess potential impacts from installing a weather station at any newly proposed location in Katmai.

### Reinforcing the McArthur Pass RAWS

Wind speed and direction sensors are currently mounted on 20 ft (6 m) aluminum masts at network operated RAWS. Experience has shown that these sensors need to be replaced at a higher frequency (every year) than recommended by the manufacturer or the National Interagency Fire Program, which provides standards for the calibration and replacement of sensors. Ice build-up on the anemometer is a common problem at the McArthur Pass RAWS during winter months with false zero wind speeds often reported for two-week intervals (anemometer icing also occurs at the high elevation Chigmit Mountain RAWS). A combination of heavy icing and strong winds has snapped the 20 ft aluminum masts on five occasions and also destroyed other sensors. This has occurred three times at McArthur Pass, once at the Harding Icefield RAWS, and once at the Chigmit Mountains RAWS. Funding for maintaining the McArthur Pass weather station was increased by an additional \$5,000 per year to cover additional aviation and equipment costs in support of increased maintenance. In 2013, SWAN staff and a local welder modified the 20 ft aluminum mast (Figure 15). Three reinforced masts were assembled and were put into use at both McArthur Pass and the Chigmit Mountains RAWS. A reassessment of the effectiveness of these changes and long-term sustainability of operating the McArthur Pass RAWS will be made in approximately two years.

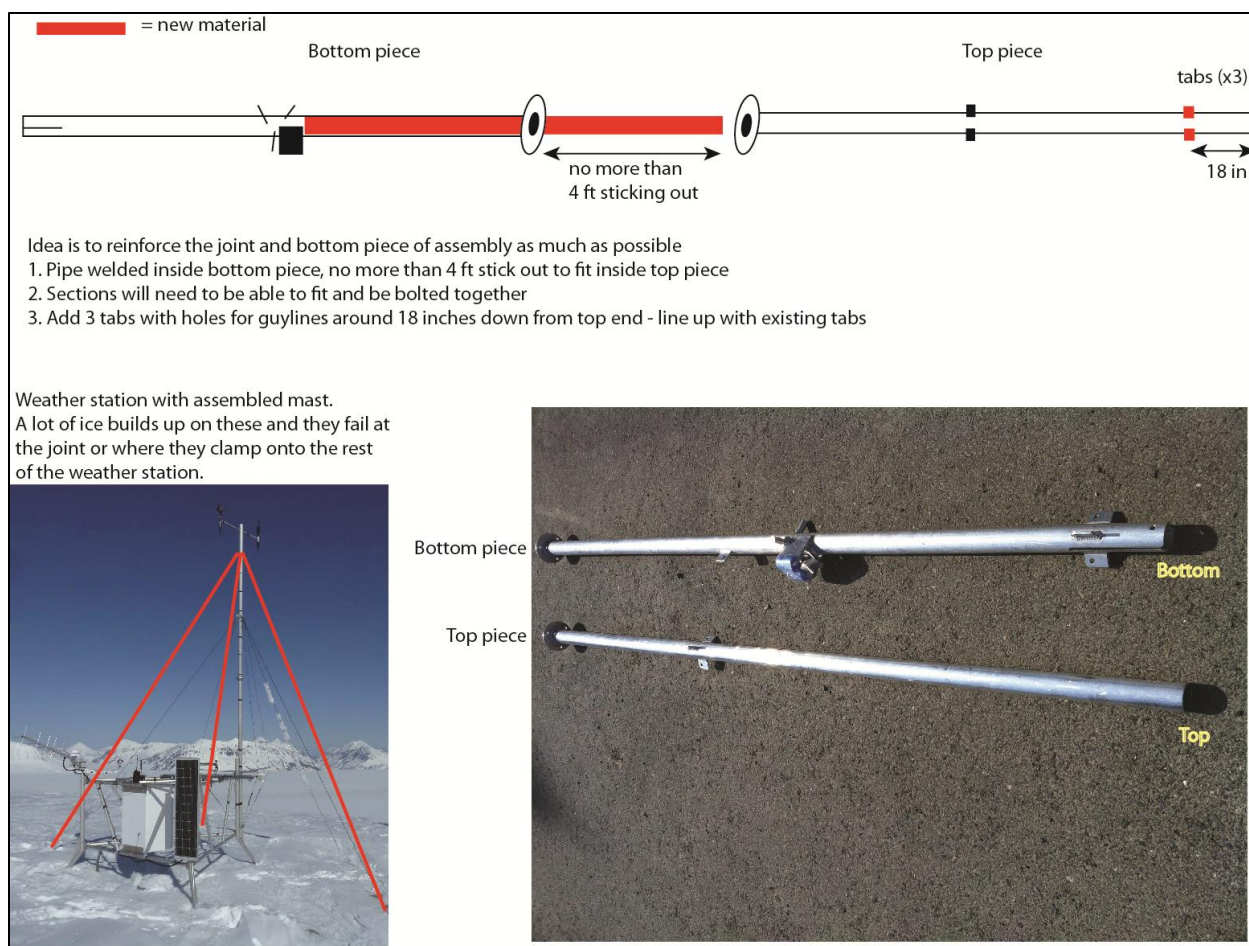


**Figure 15.** Description of modifications made to the 20 ft mast used on network RAWS.

### **Summary of Issues Affecting Performance and Data Quality During 2013**

A summary of all known issues affecting the performance and data quality of weather stations maintained and operated by the SWAN during the 2013 hydrologic year is provided in Table 11.

**Table 11.** Issues affecting performance and data quality of RAWs operated and maintained by the SWAN during the 2013 hydrologic year. Acronyms are as follows: air temperature (AT), relative humidity (RH), wind speed (WS), wind direction (WD), snow depth (SD), solar radiation (SR), soil temperature (ST), and rain gauge-tipping bucket (RG-TB).

| <b>Station</b>      | <b>Date begin</b> | <b>Date end</b> | <b>Issue</b>                                   |
|---------------------|-------------------|-----------------|------------------------------------------------|
| Chigmit Mountains   | 10/01/2012        | 09/30/2013      | Some artificial spikes in SD data              |
| Chigmit Mountains   | 10/01/2012        | 09/30/2013      | SD values over 35 inches not considered valid  |
| Chigmit Mountains   | 12/27/2012        | 06/13/2013      | WD/WS sensors not working (mast broke)         |
| Chigmit Mountains   | 06/22/2013        | 06/27/2013      | Anomalous high AT values                       |
| Contact Creek       | 09/03/2013        | 09/03/2013      | Last day of operation for station              |
| Coville             | 10/01/2012        | 09/30/2013      | Some artificial spikes in SD data              |
| Coville             | 10/01/2012        | 09/30/2013      | SD values over 40 inches not considered valid  |
| Fourpeaked          | 10/01/2012        | 10/22/2013      | No data available – bad data logger            |
| Fourpeaked          | 08/02/2013        | 08/11/2013      | RH sensor not working                          |
| Fourpeaked          | 10/01/2012        | 09/30/2013      | No SD sensor present                           |
| Harding Icefield    | 10/01/2012        | 09/30/2013      | Some artificial spikes in SD data              |
| Harding Icefield    | 10/01/2012        | 09/30/2013      | SD values over 28 inches not considered valid  |
| Harding Icefield    | 09/01/2013        | 09/30/2013      | SR sensor not working                          |
| Hickerson Lake      | 10/01/2012        | 09/30/2013      | SD values over 40 inches not considered valid  |
| McArthur Pass       | 10/01/2012        | 09/30/2013      | No SD sensor present                           |
| McArthur Pass       | 12/12/2012        | 06/10/2013      | No precipitation data – RG-TB broken           |
| McArthur Pass       | 03/07/2013        | 06/10/2013      | No WS data – WS not working, bearings seized   |
| McArthur Pass       | 03/07/2013        | 06/10/2013      | Some anomalous RH data                         |
| McArthur Pass       | 08/06/2013        | 08/09/2013      | No RH data                                     |
| McArthur Pass       | 09/13/2013        | 09/30/2013      | No AT/RH data – sensor blew away               |
| Pedersen Lagoon     | 10/01/2012        | 09/30/2013      | SD values over 60 inches not considered valid  |
| Pedersen Lagoon     | 12/30/2012        | 12/31/2012      | Anomalous AT data                              |
| Pedersen Lagoon     | 06/19/2013        | 08/07/2013      | WS data anomalously high – escalation problem  |
| Pedersen Lagoon     | 06/19/2013        | 08/07/2013      | Anomalous SD data – plant growth               |
| Pfaff Mine          | 10/01/2012        | 06/26/2013      | No ST#2 data – sensor stopped working          |
| Pfaff Mine          | 10/01/2012        | 09/30/2013      | SD values over 60 inches not considered valid  |
| Pfaff Mine          | 05/30/2013        | 07/22/2013      | Anomalous AT/RH data – data logger malfunction |
| Pfaff Mine          | 05/30/2013        | 07/22/2013      | Anomalous SD values – data logger malfunction  |
| Silver Salmon Lakes | 07/09/2013        | 07/09/2013      | First day of operation for station             |
| Silver Salmon Lakes | 07/09/2013        | 09/30/2013      | Few anomalous SD values – reading high         |
| Snipe Lake          | 10/01/2012        | 09/30/2013      | SD values over 60 inches not considered valid  |
| Snipe Lake          | 10/01/2012        | 06/20/2013      | RH data bad –low values – sensor malfunction   |
| Three Forks         | 09/06/2013        | 09/06/2013      | First day of operation for station             |

***Common Reporting and Technical Review***

Although the SWAN's monitoring objectives and reporting requirements are constrained by the monitoring protocol (Lindsay et al. 2012), significant adjustments to reporting methods and delivery formats are expected over time. Climate is monitored by all four of the NPS Inventory and Monitoring Networks in Alaska and these networks will consider using a common reporting format in the future. These networks will also be participating in a technical review of their collective climate monitoring efforts within the next few years.

## Conclusion

The results provided in this report help identify natural variability in weather patterns and long-term climate trends. This report offers reliable climate data to researchers interpreting ecosystem changes and should also be interesting to a broad audience including land managers and park visitors.

The Southwest Alaska Network region experienced slightly colder than average temperatures and near average precipitation during the 2013 hydrologic year (October 2012 through September 2013). Compared to the climatological normal (the prevailing set of weather conditions calculated over a 30-year period, currently 1981-2010), mean annual temperatures for six long-term weather stations ranged from 2.3 °F below average to 0.5 °F above average. Total annual precipitation was 90 to 113 % of average. Two winter months (January, February) and two summer months (June, July) were warmer than average (with two-month mean temperatures 5.9 °F and 2.2 °F above average, respectively) but the remainder of the year was either colder than average or at near average temperatures. Above average precipitation fell across most of the region during January, May, and August but the remainder of the year was drier than normal or at near normal conditions. Above average precipitation also occurred during February in King Salmon (255 % of average) and during July in Seward (224 % of average), when drier than normal conditions were experienced across most of the rest of the region. When compared to the longer period of record (nominally 1931 to present), temperature and precipitation during the 2013 hydrologic year was slightly warmer than the conditions observed during the 2006-2009 and 2011-2012 hydrologic years and drier than the conditions generally observed during recent years. Negative (cool phase) Pacific Decadal Oscillation conditions and neutral to slightly negative (La Niña) ENSO conditions occurred during the 2013 hydrologic year.



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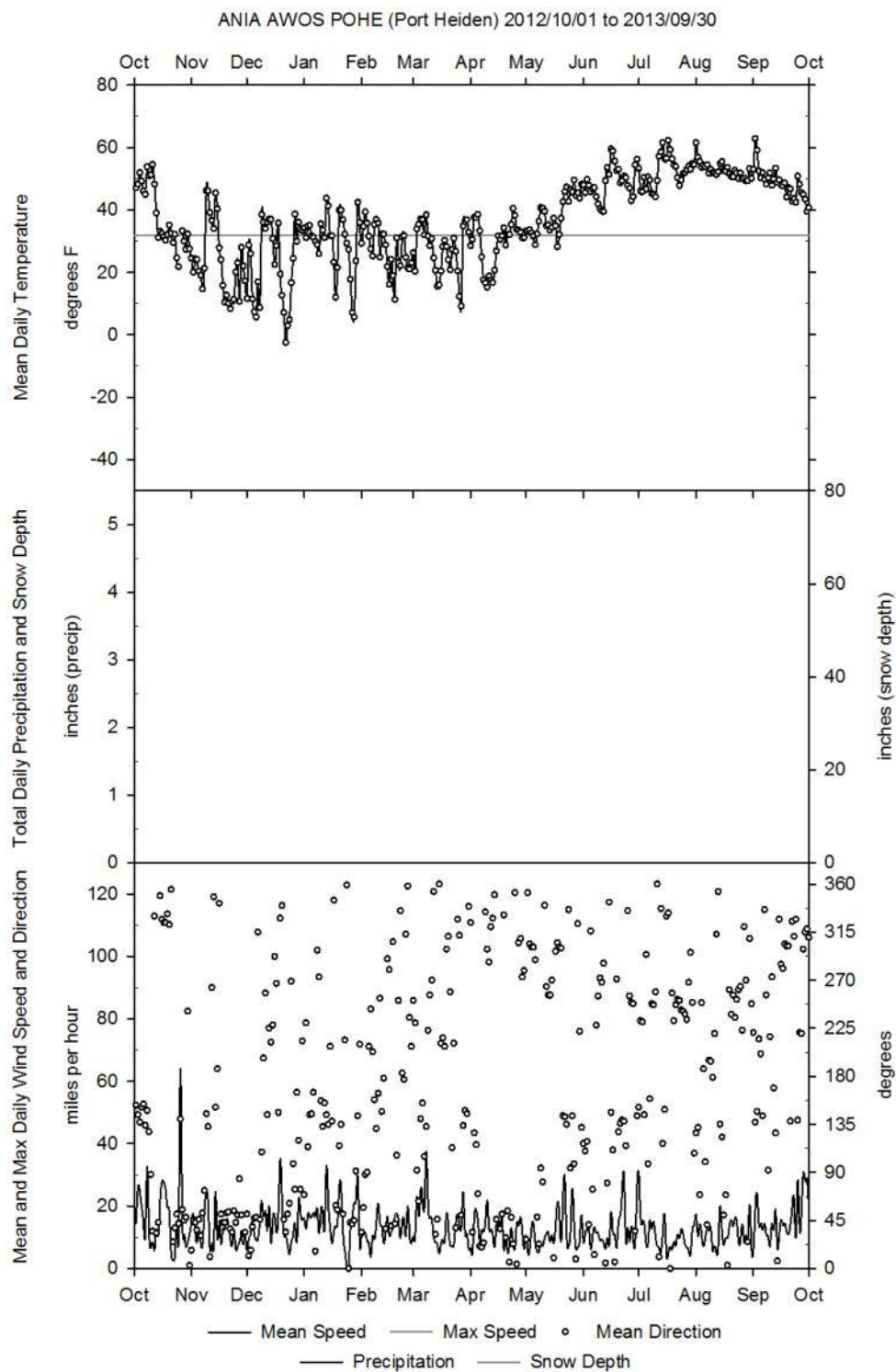
## Appendices - Annual Climate Summaries for 42 Weather Stations

Summary tables and graphs for the most consistently measured climate variables from all weather stations monitored by the SWAN are included in the appendices and are organized by park, climate monitoring program, and station name. Daily measures are used for generating graphs (with the exception of NRCS Snow Courses) and monthly measures are used for generating summary reports. Mean temperature, total precipitation, mean snow depth, mean wind speed and direction, and maximum wind speed are presented in graphs. Minimum, maximum, and mean temperature data, the number of frost days (number of days where the minimum temperature is below freezing), and the number of ice days (number of days where the maximum temperature is below freezing) are included in the summary reports. Total precipitation, average snow depth, mean and maximum wind speed, maximum wind direction, and cumulative solar radiation are also presented in the summary reports. The percentage of valid observations is reported as a measure of the reliability of the derived mean and cumulative values for all reported climate variables. Climatic normal values (arithmetic mean over a 30-year interval) from the NCDC for the 1981-2010 period and period of record (POR) values from the WRCC are included for stations with a long enough observational record

For all derived measures, the percentage of valid observations is reported as a measure of the reliability of the derived mean and cumulative values. Monthly measures should not be considered representative of actual climatic conditions if more than 10% (three days) of observations are missing or suspect. Yearly measures should not be considered representative if more than 17% (five days) are missing from any month.

All data used in this report are available upon request from the SWAN or from the SWAN website <http://science.nature.nps.gov/im/units/swan/monitor/weather.cfm>. Station data is available in a standardized format - summarized at hourly (where available), daily, and monthly intervals in both metric and U.S. customary units.

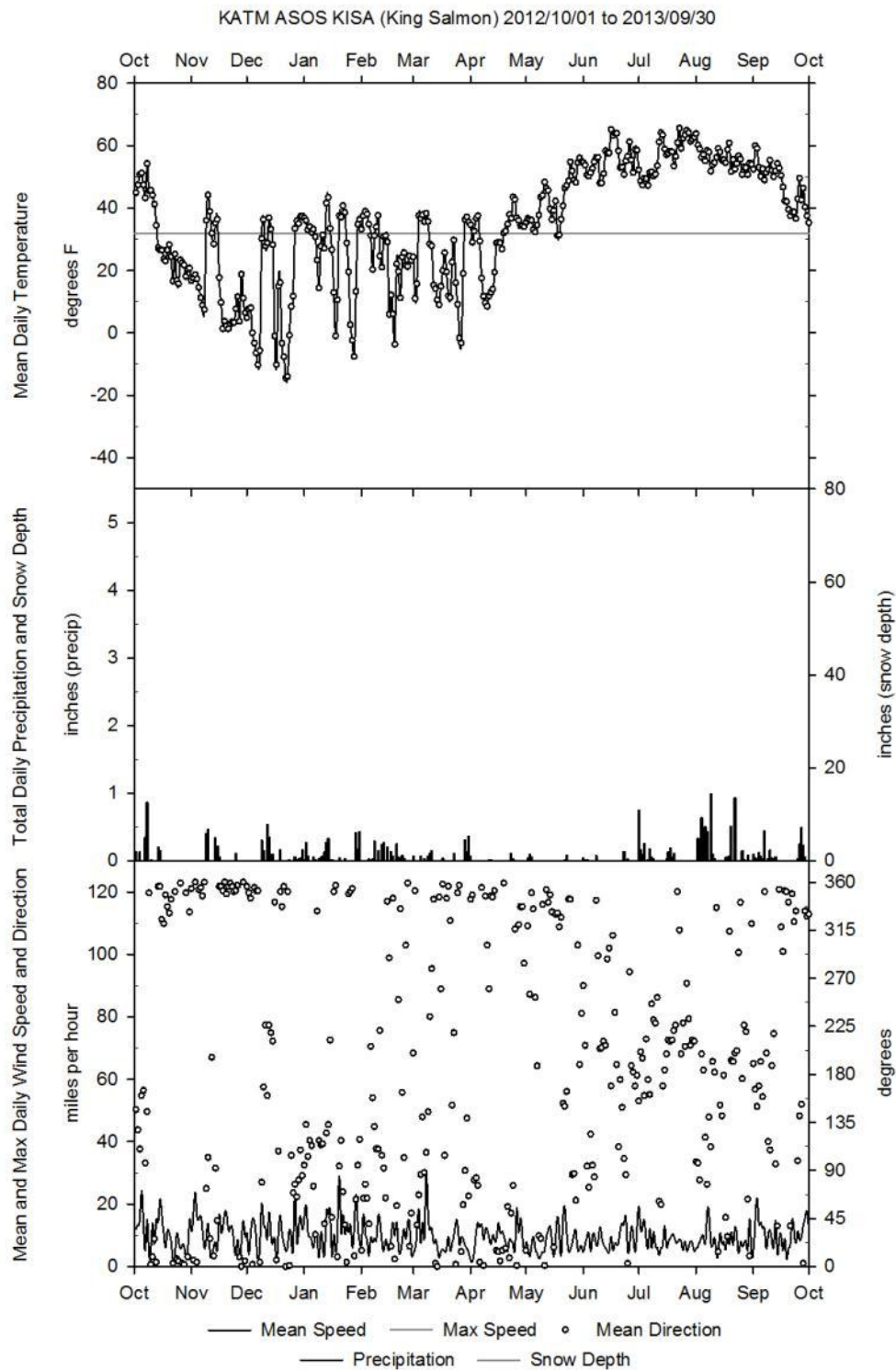
## Appendix 1-A Climate Graph for Port Heiden



## Appendix 1-B Climate Table for Port Heiden AWOS

| 2013 Hydrologic Year - ANIA AWOS POHE (Port Heiden) |      |      |      |      |      |      |      |      |      |      |      |      |      |
|-----------------------------------------------------|------|------|------|------|------|------|------|------|------|------|------|------|------|
|                                                     | Oct  | Nov  | Dec  | Jan  | Feb  | Mar  | Apr  | May  | Jun  | Jul  | Aug  | Sep  | Year |
| <b>Minimum air temperature (F)</b>                  |      |      |      |      |      |      |      |      |      |      |      |      |      |
| Min.                                                | 12   | 0    | -9   | -2   | 6    | 5    | 8    | 25   | 32   | 37   | 40   | 32   | -9   |
| Max.                                                | 52   | 45   | 37   | 39   | 36   | 36   | 36   | 43   | 51   | 56   | 55   | 54   | 56   |
| Mean                                                | 31.4 | 19.1 | 19.0 | 24.0 | 21.7 | 21.4 | 23.3 | 33.0 | 41.4 | 47.7 | 49.2 | 43.5 | 31.3 |
| # days <32 F                                        | 18   | 24   | 24   | 25   | 26   | 26   | 26   | 12   | 0    | 0    | 0    | 0    | 181  |
| % valid obs                                         | 93   | 56   | 63   | 95   | 100  | 100  | 100  | 97   | 96   | 96   | 97   | 99   | 91   |
| <b>Maximum air temperature (F)</b>                  |      |      |      |      |      |      |      |      |      |      |      |      |      |
| Min                                                 | 28   | 12   | 2    | 10   | 18   | 13   | 18   | 32   | 44   | 47   | 52   | 43   | 2    |
| Max                                                 | 67   | 49   | 43   | 46   | 43   | 43   | 48   | 59   | 70   | 73   | 62   | 72   | 73   |
| Mean                                                | 43.2 | 28.0 | 28.1 | 34.5 | 32.6 | 32.1 | 35.6 | 44.4 | 56.0 | 58.1 | 55.8 | 52.2 | 41.8 |
| # days <32 F                                        | 1    | 21   | 14   | 9    | 12   | 13   | 8    | 0    | 0    | 0    | 0    | 0    | 78   |
| % valid obs                                         | 93   | 56   | 63   | 95   | 100  | 100  | 100  | 97   | 96   | 96   | 97   | 99   | 91   |
| <b>Mean air temperature (F)</b>                     |      |      |      |      |      |      |      |      |      |      |      |      |      |
| Observed                                            | 37.2 | 24.9 | 19.8 | 29.2 | 27.4 | 27.4 | 29.4 | 38.9 | 48.9 | 52.5 | 52.3 | 48.2 | 37.3 |
| % valid obs                                         | 93   | 56   | 63   | 95   | 100  | 100  | 100  | 97   | 96   | 96   | 97   | 99   | 91   |
| POR mean                                            |      |      |      |      |      |      |      |      |      |      |      |      |      |
| 1981-2010                                           |      |      |      |      |      |      |      |      |      |      |      |      |      |
| <b>Precipitation</b>                                |      |      |      |      |      |      |      |      |      |      |      |      |      |
| Total                                               |      |      |      |      |      |      |      |      |      |      |      |      |      |
| % valid obs                                         |      |      |      |      |      |      |      |      |      |      |      |      |      |
| POR mean                                            |      |      |      |      |      |      |      |      |      |      |      |      |      |
| 1981-2010                                           |      |      |      |      |      |      |      |      |      |      |      |      |      |
| <b>Snow depth (in)</b>                              |      |      |      |      |      |      |      |      |      |      |      |      |      |
| Average                                             |      |      |      |      |      |      |      |      |      |      |      |      |      |
| % valid obs                                         |      |      |      |      |      |      |      |      |      |      |      |      |      |
| POR mean                                            |      |      |      |      |      |      |      |      |      |      |      |      |      |
| <b>Wind (mph, degrees)</b>                          |      |      |      |      |      |      |      |      |      |      |      |      |      |
| Mean speed                                          | 15.2 | 11.7 | 14.3 | 15.6 | 12.4 | 14.1 | 11.9 | 11.7 | 13.0 | 10.1 | 11.0 | 16.3 |      |
| % valid obs                                         | 96   | 100  | 100  | 98   | 100  | 100  | 100  | 99   | 99   | 97   | 97   | 100  |      |
| Max speed                                           |      |      |      |      |      |      |      |      |      |      |      |      |      |
| Max direction                                       |      |      |      |      |      |      |      |      |      |      |      |      |      |
| <b>Solar radiation (KWh/m2)</b>                     |      |      |      |      |      |      |      |      |      |      |      |      |      |
| Total                                               |      |      |      |      |      |      |      |      |      |      |      |      |      |
| % valid obs                                         |      |      |      |      |      |      |      |      |      |      |      |      |      |

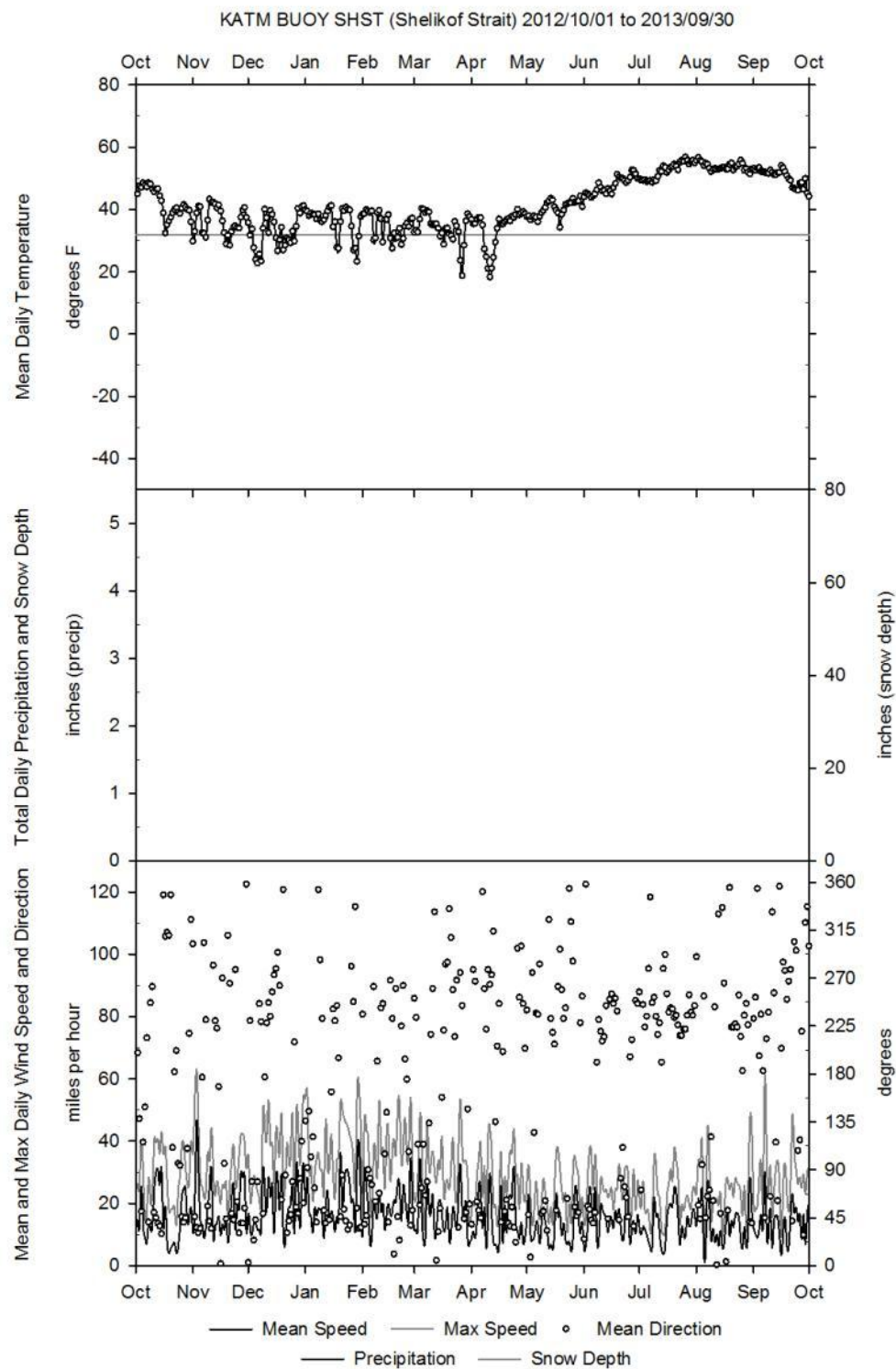
## Appendix 2-A Climate Graph for King Salmon Airport ASOS



## Appendix 2-B Climate Table for King Salmon Airport ASOS

| 2013 Hydrologic Year - KATM ASOS KISA (King Salmon Airport) |      |      |      |      |      |      |      |      |      |      |      |      |       |
|-------------------------------------------------------------|------|------|------|------|------|------|------|------|------|------|------|------|-------|
|                                                             | Oct  | Nov  | Dec  | Jan  | Feb  | Mar  | Apr  | May  | Jun  | Jul  | Aug  | Sep  | Year  |
| <b>Minimum air temperature (F)</b>                          |      |      |      |      |      |      |      |      |      |      |      |      |       |
| Min.                                                        | 4    | -3   | -21  | -11  | -11  | -18  | 1    | 17   | 35   | 31   | 42   | 24   | -21   |
| Max.                                                        | 48   | 41   | 34   | 39   | 37   | 36   | 37   | 46   | 50   | 57   | 58   | 52   | 58    |
| Mean                                                        | 24.1 | 9.6  | 4.9  | 19.2 | 15.9 | 13.1 | 18.8 | 31.6 | 44.0 | 48.3 | 49.8 | 39.5 | 26.6  |
| # days <32 F                                                | 20   | 28   | 26   | 24   | 26   | 24   | 27   | 14   | 0    | 1    | 0    | 8    | 198   |
| % valid obs                                                 | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100   |
| <b>Maximum air temperature (F)</b>                          |      |      |      |      |      |      |      |      |      |      |      |      |       |
| Min                                                         | 21   | 4    | -8   | -3   | 6    | 3    | 16   | 36   | 54   | 51   | 54   | 41   | -8    |
| Max                                                         | 60   | 50   | 43   | 48   | 42   | 42   | 51   | 77   | 80   | 81   | 70   | 70   | 81    |
| Mean                                                        | 39.1 | 21.0 | 20.4 | 32.1 | 30.5 | 29.5 | 37.7 | 53.3 | 66.5 | 66.8 | 61.3 | 54.3 | 42.8  |
| # days <32 F                                                | 11   | 23   | 17   | 10   | 13   | 15   | 8    | 0    | 0    | 0    | 0    | 0    | 97    |
| % valid obs                                                 | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100   |
| <b>Mean air temperature (F)</b>                             |      |      |      |      |      |      |      |      |      |      |      |      |       |
| Observed                                                    | 31.4 | 15.2 | 13.8 | 25.9 | 24.2 | 22.3 | 28.5 | 43.1 | 55.5 | 57.3 | 55.4 | 47.0 | 35.0  |
| % valid obs                                                 | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100   |
| POR mean                                                    |      |      |      |      |      |      |      |      |      |      |      |      |       |
| 1981-2010                                                   |      |      |      |      |      |      |      |      |      |      |      |      |       |
| <b>Precipitation</b>                                        |      |      |      |      |      |      |      |      |      |      |      |      |       |
| Total                                                       | 1.86 | 1.60 | 2.05 | 2.40 | 1.93 | 1.50 | 0.18 | 0.33 | 1.05 | 1.30 | 5.30 | 2.08 | 21.58 |
| % valid obs                                                 | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100   |
| POR mean                                                    |      |      |      |      |      |      |      |      |      |      |      |      |       |
| 1981-2010                                                   |      |      |      |      |      |      |      |      |      |      |      |      |       |
| <b>Snow depth (in)</b>                                      |      |      |      |      |      |      |      |      |      |      |      |      |       |
| Average                                                     |      |      |      |      |      |      |      |      |      |      |      |      |       |
| % valid obs                                                 |      |      |      |      |      |      |      |      |      |      |      |      |       |
| POR mean                                                    |      |      |      |      |      |      |      |      |      |      |      |      |       |
| <b>Wind (mph, degrees)</b>                                  |      |      |      |      |      |      |      |      |      |      |      |      |       |
| Mean speed                                                  | 10.4 | 11.0 | 10.7 | 11.5 | 9.3  | 9.3  | 9.6  | 7.8  | 9.1  | 8.1  | 8.5  | 10.7 |       |
| % valid obs                                                 | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  |       |
| Max speed                                                   |      |      |      |      |      |      |      |      |      |      |      |      |       |
| Max direction                                               |      |      |      |      |      |      |      |      |      |      |      |      |       |
| <b>Solar radiation (KWh/m2)</b>                             |      |      |      |      |      |      |      |      |      |      |      |      |       |
| Total                                                       |      |      |      |      |      |      |      |      |      |      |      |      |       |
| % valid obs                                                 |      |      |      |      |      |      |      |      |      |      |      |      |       |

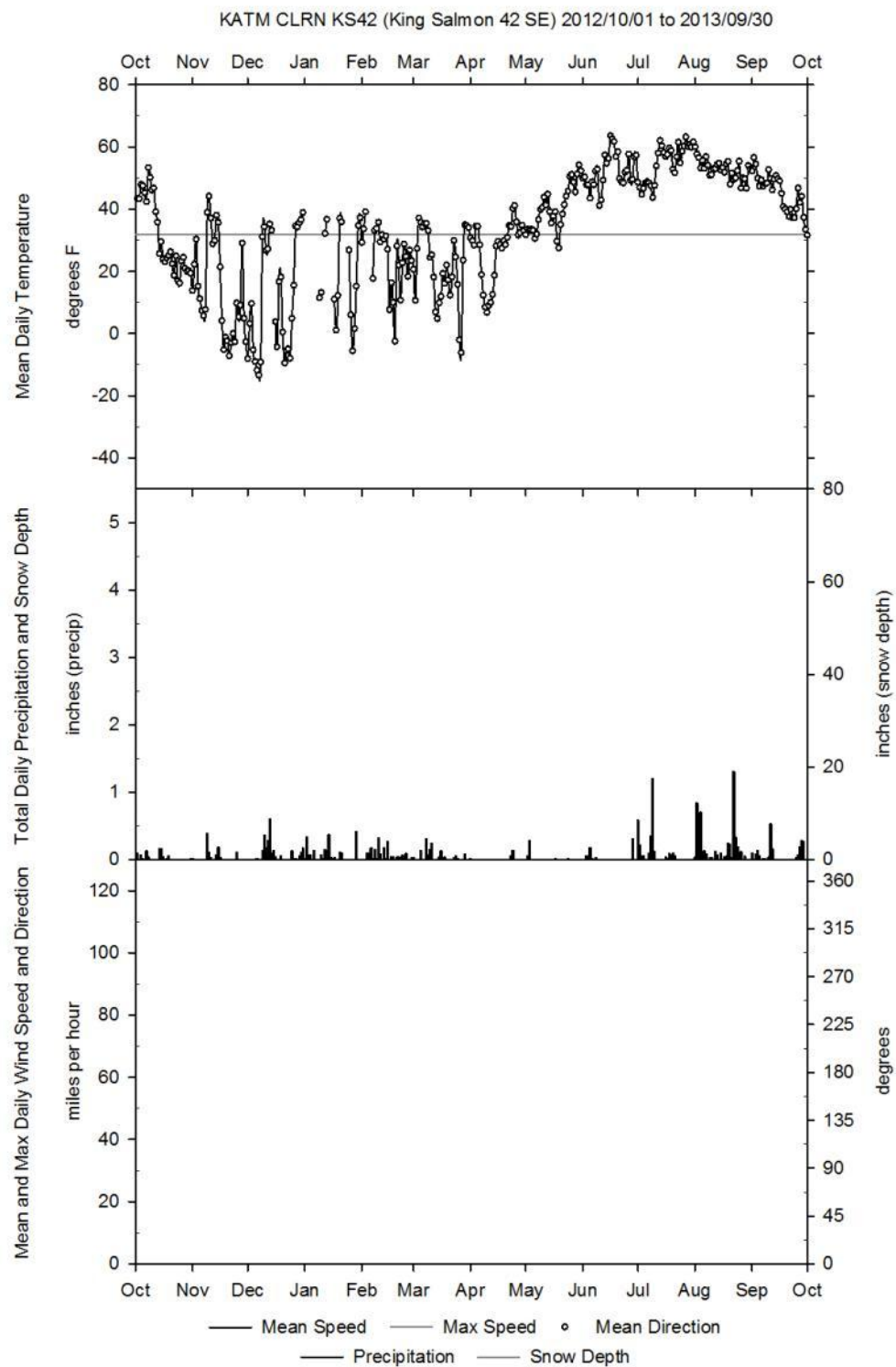
## Appendix 3-A Climate Graph for Shelikof Strait BUOY



## Appendix 3-B Climate Table for Shelikof Strait BUOY

| 2013 Hydrologic Year - KATM BUOY SHST (Shelikof Strait) |      |      |      |      |      |      |      |      |      |      |      |      |      |
|---------------------------------------------------------|------|------|------|------|------|------|------|------|------|------|------|------|------|
|                                                         | Oct  | Nov  | Dec  | Jan  | Feb  | Mar  | Apr  | May  | Jun  | Jul  | Aug  | Sep  | Year |
| <b>Minimum air temperature (F)</b>                      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| Min.                                                    | 28.6 | 25.9 | 21.2 | 19.9 | 24.4 | 12.9 | 15.3 | 31.6 | 42.8 | 46.9 | 49.6 | 42.6 | 12.9 |
| Max.                                                    | 46.8 | 41.2 | 39.4 | 39.7 | 38.7 | 39.2 | 38.3 | 43.5 | 51.4 | 55.2 | 55.4 | 52.5 | 55.4 |
| Mean                                                    | 40.1 | 34.0 | 30.0 | 33.8 | 32.1 | 31.6 | 32.2 | 38.9 | 46.3 | 51.2 | 52.5 | 48.8 | 39.3 |
| # days <32 F                                            | 3    | 13   | 21   | 8    | 13   | 13   | 8    | 1    | 0    | 0    | 0    | 0    | 80   |
| % valid obs                                             | 99   | 99   | 99   | 99   | 99   | 99   | 99   | 99   | 100  | 100  | 99   | 100  | 99   |
| <b>Maximum air temperature (F)</b>                      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| Min                                                     | 31.8 | 31.1 | 25.7 | 28.0 | 30.4 | 25.5 | 21.7 | 37.9 | 44.8 | 49.5 | 53.1 | 45.5 | 21.7 |
| Max                                                     | 52.5 | 44.8 | 42.6 | 45.1 | 42.8 | 42.1 | 44.8 | 47.3 | 55.9 | 63.1 | 59.5 | 56.3 | 63.1 |
| Mean                                                    | 43.9 | 38.8 | 35.2 | 38.4 | 37.5 | 36.6 | 36.1 | 42.3 | 49.8 | 54.6 | 55.3 | 52.2 | 43.4 |
| # days <32 F                                            | 1    | 2    | 8    | 3    | 1    | 2    | 5    | 0    | 0    | 0    | 0    | 0    | 22   |
| % valid obs                                             | 99   | 99   | 99   | 99   | 99   | 99   | 99   | 99   | 100  | 100  | 99   | 100  | 99   |
| <b>Mean air temperature (F)</b>                         |      |      |      |      |      |      |      |      |      |      |      |      |      |
| Observed                                                | 41.9 | 36.5 | 32.7 | 36.1 | 34.7 | 34.0 | 33.9 | 40.4 | 47.8 | 52.7 | 53.7 | 50.3 | 41.3 |
| % valid obs                                             | 99   | 99   | 99   | 99   | 99   | 99   | 99   | 99   | 100  | 100  | 99   | 100  | 99   |
| POR mean                                                |      |      |      |      |      |      |      |      |      |      |      |      |      |
| 1981-2010                                               |      |      |      |      |      |      |      |      |      |      |      |      |      |
| <b>Precipitation</b>                                    |      |      |      |      |      |      |      |      |      |      |      |      |      |
| Total                                                   |      |      |      |      |      |      |      |      |      |      |      |      |      |
| % valid obs                                             |      |      |      |      |      |      |      |      |      |      |      |      |      |
| POR mean                                                |      |      |      |      |      |      |      |      |      |      |      |      |      |
| 1981-2010                                               |      |      |      |      |      |      |      |      |      |      |      |      |      |
| <b>Snow depth (in)</b>                                  |      |      |      |      |      |      |      |      |      |      |      |      |      |
| Average                                                 |      |      |      |      |      |      |      |      |      |      |      |      |      |
| % valid obs                                             |      |      |      |      |      |      |      |      |      |      |      |      |      |
| POR mean                                                |      |      |      |      |      |      |      |      |      |      |      |      |      |
| <b>Wind (mph, degrees)</b>                              |      |      |      |      |      |      |      |      |      |      |      |      |      |
| Mean speed                                              | 15.5 | 18.5 | 19.4 | 20.1 | 19.4 | 16.1 | 15.1 | 12.3 | 14.7 | 13.2 | 13.2 | 13.5 |      |
| % valid obs                                             | 99   | 99   | 99   | 99   | 99   | 99   | 99   | 99   | 100  | 100  | 99   | 100  |      |
| Max speed                                               | 43.0 | 62.9 | 54.8 | 57.7 | 54.1 | 53.5 | 43.8 | 37.1 | 37.1 | 37.8 | 47.0 | 60.8 | 62.9 |
| Max direction                                           |      |      |      |      |      |      |      |      |      |      |      |      |      |
| <b>Solar radiation (KWh/m2)</b>                         |      |      |      |      |      |      |      |      |      |      |      |      |      |
| Total                                                   |      |      |      |      |      |      |      |      |      |      |      |      |      |
| % valid obs                                             |      |      |      |      |      |      |      |      |      |      |      |      |      |

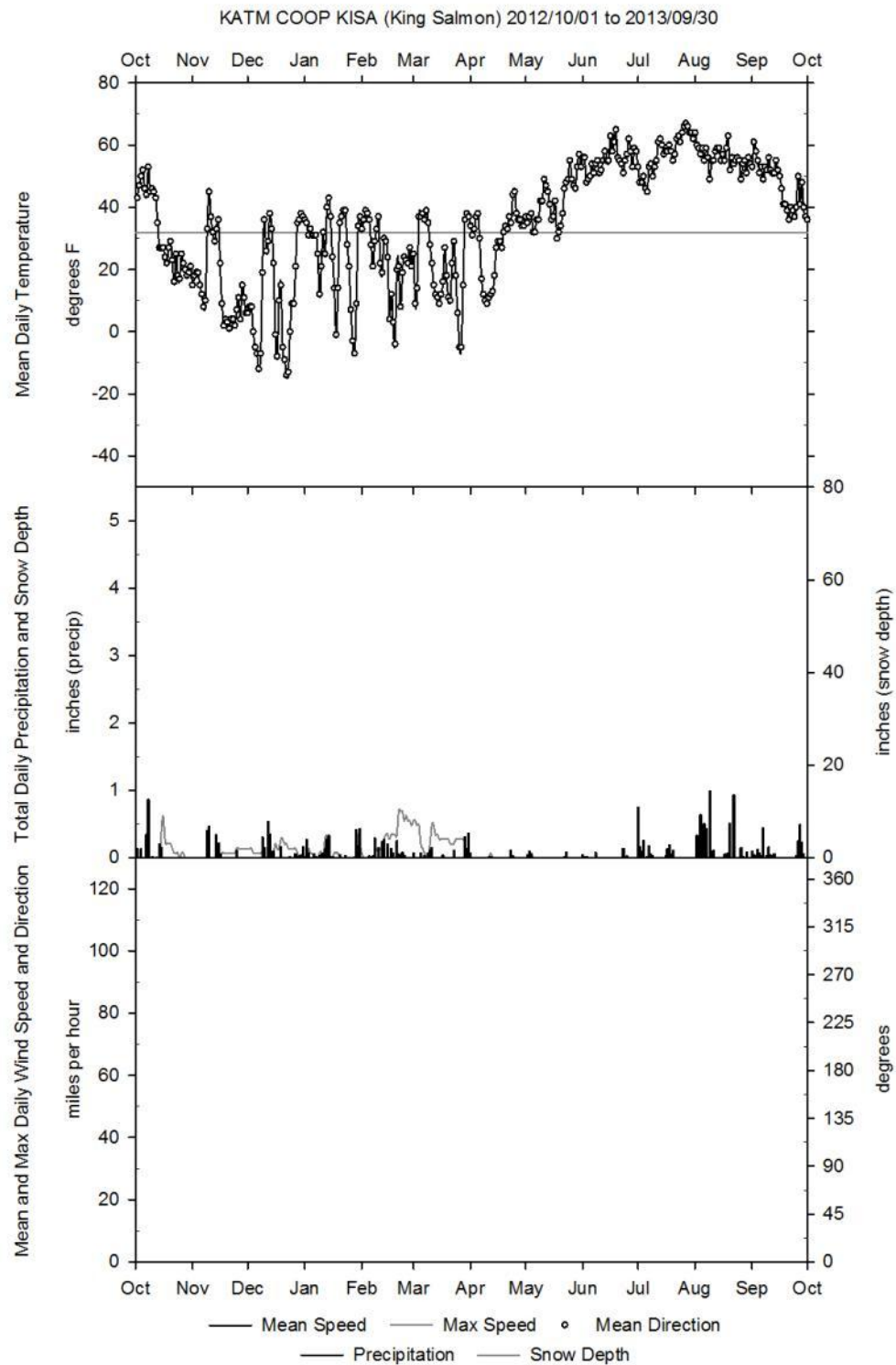
## Appendix 4-A Climate Graph for King Salmon 42 SE CLRN



## Appendix 4-B Climate Table for King Salmon 42 SE CLRN

| 2013 Hydrologic Year - KATM CLRN KS42 (King Salmon 42 SE) |      |       |       |       |       |       |       |       |       |       |      |      |       |
|-----------------------------------------------------------|------|-------|-------|-------|-------|-------|-------|-------|-------|-------|------|------|-------|
|                                                           | Oct  | Nov   | Dec   | Jan   | Feb   | Mar   | Apr   | May   | Jun   | Jul   | Aug  | Sep  | Year  |
| <b>Minimum air temperature (F)</b>                        |      |       |       |       |       |       |       |       |       |       |      |      |       |
| Min.                                                      | 2.8  | -14.8 | -21.6 | -11.0 | -15.2 | -20.6 | -2.0  | 15.1  | 27.5  | 33.1  | 36.5 | 22.6 | -21.6 |
| Max.                                                      | 49.3 | 40.6  | 35.4  | 35.2  | 35.8  | 34.2  | 34.5  | 41.2  | 50.2  | 57.7  | 56.1 | 51.1 | 57.7  |
| Mean                                                      | 23.0 | 4.4   | 2.6   | 11.7  | 14.7  | 11.9  | 16.1  | 29.6  | 39.9  | 46.4  | 47.4 | 37.4 | 24.5  |
| # days <32 F                                              | 23   | 29    | 25    | 14    | 24    | 25    | 28    | 19    | 3     | 0     | 0    | 9    | 199   |
| % valid obs                                               | 100  | 100   | 87    | 37    | 81    | 100   | 100   | 100   | 99    | 100   | 100  | 99   | 92    |
| <b>Maximum air temperature (F)</b>                        |      |       |       |       |       |       |       |       |       |       |      |      |       |
| Min                                                       | 17.8 | -1.5  | -7.1  | 1.6   | 14.7  | 9.7   | 13.1  | 33.6  | 46.4  | 45.9  | 50.7 | 35.6 | -7.1  |
| Max                                                       | 64.4 | 47.5  | 46.4  | 42.1  | 43.0  | 41.9  | 49.1  | 73.9  | 79.7  | 77.5  | 67.8 | 66.6 | 79.7  |
| Mean                                                      | 39.6 | 21.8  | 21.2  | 27.9  | 31.5  | 28.5  | 35.6  | 50.3  | 63.3  | 64.2  | 58.4 | 51.4 | 41.9  |
| # days <32 F                                              | 12   | 18    | 18    | 10    | 12    | 17    | 8     | 0     | 0     | 0     | 0    | 0    | 95    |
| % valid obs                                               | 100  | 100   | 87    | 37    | 81    | 100   | 100   | 100   | 99    | 100   | 100  | 99   | 92    |
| <b>Mean air temperature (F)</b>                           |      |       |       |       |       |       |       |       |       |       |      |      |       |
| Observed                                                  | 31.0 | 13.5  | 11.4  | 17.9  | 23.9  | 21.8  | 26.8  | 40.6  | 52.2  | 55.2  | 52.6 | 44.9 | 33.9  |
| % valid obs                                               | 100  | 100   | 87    | 37    | 81    | 100   | 100   | 100   | 99    | 100   | 100  | 99   | 92    |
| POR mean<br>1981-2010                                     |      |       |       |       |       |       |       |       |       |       |      |      |       |
| <b>Precipitation</b>                                      |      |       |       |       |       |       |       |       |       |       |      |      |       |
| Total                                                     | 0.84 | 0.92  | 2.42  | 1.98  | 1.78  | 1.33  | 0.21  | 0.40  | 1.20  | 2.52  | 5.07 | 1.89 | 20.56 |
| % valid obs                                               | 100  | 100   | 100   | 100   | 100   | 100   | 100   | 100   | 99    | 100   | 100  | 98   | 100   |
| POR mean<br>1981-2010                                     |      |       |       |       |       |       |       |       |       |       |      |      |       |
| <b>Snow depth (in)</b>                                    |      |       |       |       |       |       |       |       |       |       |      |      |       |
| Average                                                   |      |       |       |       |       |       |       |       |       |       |      |      |       |
| % valid obs                                               |      |       |       |       |       |       |       |       |       |       |      |      |       |
| POR mean                                                  |      |       |       |       |       |       |       |       |       |       |      |      |       |
| <b>Wind (mph, degrees)</b>                                |      |       |       |       |       |       |       |       |       |       |      |      |       |
| Mean speed                                                |      |       |       |       |       |       |       |       |       |       |      |      |       |
| % valid obs                                               |      |       |       |       |       |       |       |       |       |       |      |      |       |
| Max speed                                                 |      |       |       |       |       |       |       |       |       |       |      |      |       |
| Max direction                                             |      |       |       |       |       |       |       |       |       |       |      |      |       |
| <b>Solar radiation (KWh/m2)</b>                           |      |       |       |       |       |       |       |       |       |       |      |      |       |
| Total                                                     | 44.9 | 16.4  | 6.7   | 10.9  | 26.7  | 90.1  | 162.1 | 159.0 | 158.5 | 134.2 | 73.6 | 66.4 | 949.5 |
| % valid obs                                               | 100  | 100   | 100   | 100   | 100   | 100   | 100   | 100   | 99    | 100   | 100  | 99   | 100   |

## Appendix 5-A Climate Graph for King Salmon Airport COOP

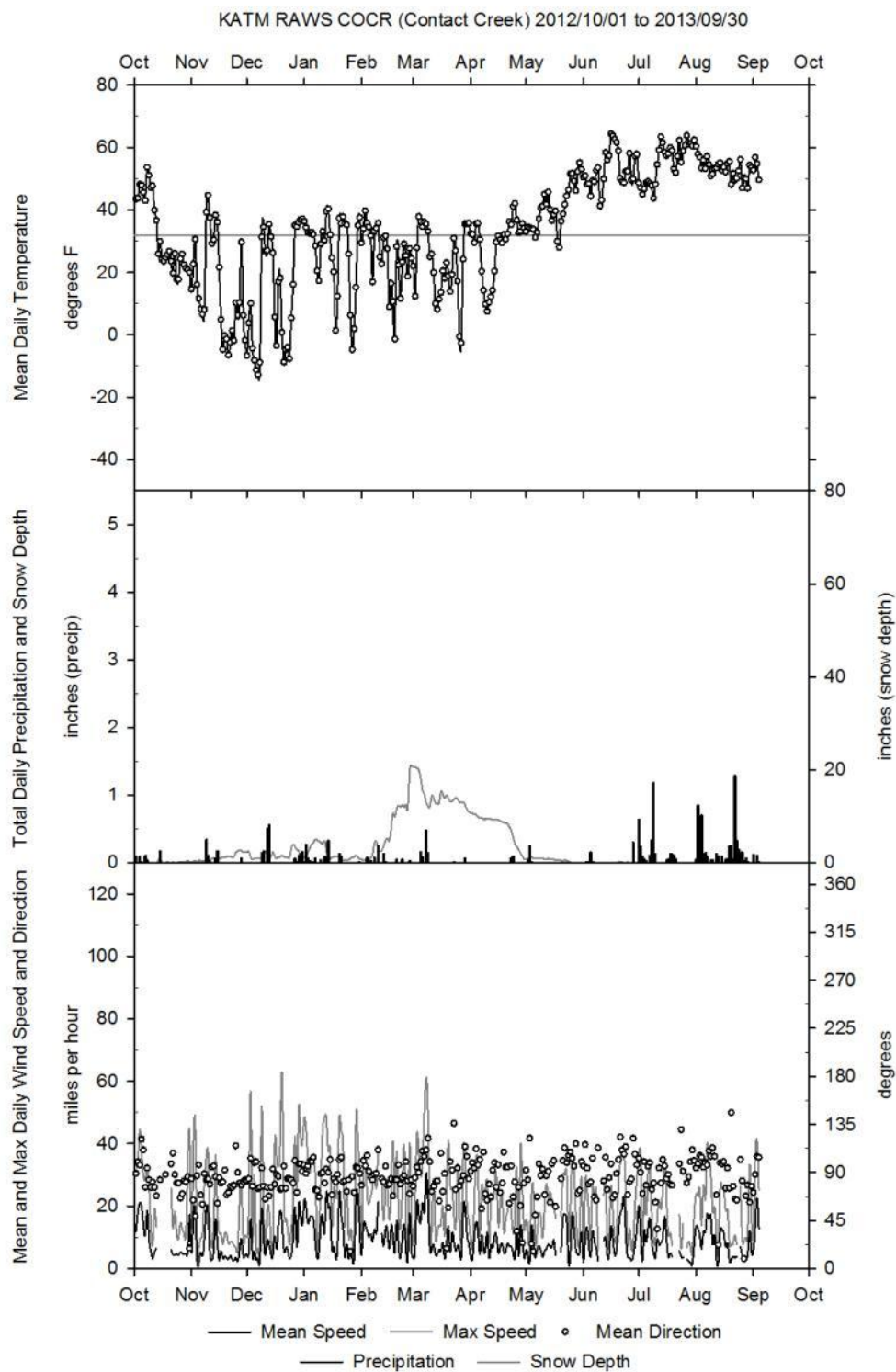


## Appendix 5-B Climate Table for King Salmon Airport COOP

| 2013 Hydrologic Year - KATM COOP KISA (King Salmon Airport) |      |      |      |      |      |      |      |      |      |      |      |      |       |
|-------------------------------------------------------------|------|------|------|------|------|------|------|------|------|------|------|------|-------|
|                                                             | Oct  | Nov  | Dec  | Jan  | Feb  | Mar  | Apr  | May  | Jun  | Jul  | Aug  | Sep  | Year  |
| <b>Minimum air temperature (F)</b>                          |      |      |      |      |      |      |      |      |      |      |      |      |       |
| Min.                                                        | 4    | -4   | -22  | -11  | -14  | -18  | 1    | 16   | 33   | 31   | 41   | 24   | -22   |
| Max.                                                        | 47   | 40   | 34   | 39   | 36   | 36   | 37   | 46   | 50   | 57   | 57   | 51   | 57    |
| Mean                                                        | 23.2 | 9.1  | 4.2  | 18.5 | 15.3 | 12.5 | 18.3 | 30.9 | 43.0 | 47.8 | 49.4 | 38.9 | 26.0  |
| # days <32 F                                                | 21   | 28   | 26   | 26   | 26   | 24   | 27   | 17   | 0    | 1    | 0    | 8    | 204   |
| % valid obs                                                 | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100   |
| <b>Maximum air temperature (F)</b>                          |      |      |      |      |      |      |      |      |      |      |      |      |       |
| Min                                                         | 21   | 4    | -7   | -3   | 6    | 4    | 17   | 36   | 55   | 51   | 55   | 41   | -7    |
| Max                                                         | 61   | 50   | 43   | 49   | 43   | 43   | 52   | 77   | 81   | 82   | 71   | 70   | 82    |
| Mean                                                        | 39.4 | 21.3 | 20.6 | 32.5 | 30.8 | 30.1 | 38.5 | 54.1 | 67.6 | 67.5 | 62.1 | 55.0 | 43.4  |
| # days <32 F                                                | 10   | 22   | 17   | 10   | 13   | 14   | 8    | 0    | 0    | 0    | 0    | 0    | 94    |
| % valid obs                                                 | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100   |
| <b>Mean air temperature (F)</b>                             |      |      |      |      |      |      |      |      |      |      |      |      |       |
| Observed                                                    | 31.3 | 15.2 | 12.4 | 25.4 | 23.1 | 21.3 | 28.6 | 42.6 | 55.4 | 57.8 | 55.8 | 47.0 | 34.7  |
| % valid obs                                                 | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100   |
| POR mean <sup>1</sup>                                       | 33.4 | 22.6 | 15.6 | 14.5 | 17.2 | 21.9 | 32.6 | 43.3 | 50.7 | 55   | 54.2 | 47.4 | 34    |
| 1981-2010                                                   | 33.5 | 22.9 | 18.6 | 16.2 | 18.8 | 24.1 | 33.7 | 44.2 | 51.5 | 55.5 | 54.6 | 47.6 | 35.2  |
| <b>Precipitation</b>                                        |      |      |      |      |      |      |      |      |      |      |      |      |       |
| Total                                                       | 1.86 | 1.60 | 2.06 | 2.41 | 1.94 | 1.51 | 0.19 | 0.33 | 1.06 | 1.31 | 5.39 | 2.08 | 21.75 |
| % valid obs                                                 | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100   |
| POR mean <sup>1</sup>                                       | 2.09 | 1.47 | 1.25 | 1.01 | 0.77 | 0.87 | 1.01 | 1.31 | 1.63 | 2.31 | 3.02 | 3.01 | 19.76 |
| 1981-2010                                                   | 2.08 | 1.39 | 1.23 | 1.02 | 0.76 | 0.70 | 0.97 | 1.25 | 1.65 | 2.30 | 2.95 | 3.19 | 19.49 |
| <b>Snow depth (in)</b>                                      |      |      |      |      |      |      |      |      |      |      |      |      |       |
| Average                                                     | 1    | 1    | 1    | 1    | 4    | 4    | 0    | 0    | 0    | 0    | 0    | 0    |       |
| % valid obs                                                 | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  |       |
| POR mean <sup>1</sup>                                       | 0    | 1    | 2    | 3    | 3    | 2    | 1    | 0    | 0    | 0    | 0    | 0    |       |
| <b>Wind (mph, degrees)</b>                                  |      |      |      |      |      |      |      |      |      |      |      |      |       |
| Mean speed                                                  |      |      |      |      |      |      |      |      |      |      |      |      |       |
| % valid obs                                                 |      |      |      |      |      |      |      |      |      |      |      |      |       |
| Max speed                                                   |      |      |      |      |      |      |      |      |      |      |      |      |       |
| Max direction                                               |      |      |      |      |      |      |      |      |      |      |      |      |       |
| <b>Solar radiation (KWh/m2)</b>                             |      |      |      |      |      |      |      |      |      |      |      |      |       |
| Total                                                       |      |      |      |      |      |      |      |      |      |      |      |      |       |
| % valid obs                                                 |      |      |      |      |      |      |      |      |      |      |      |      |       |

<sup>1</sup>Period of record used: 07/01/1955 to 09/30/2012

## Appendix 6-A Climate Graph for Contact Creek RAWS

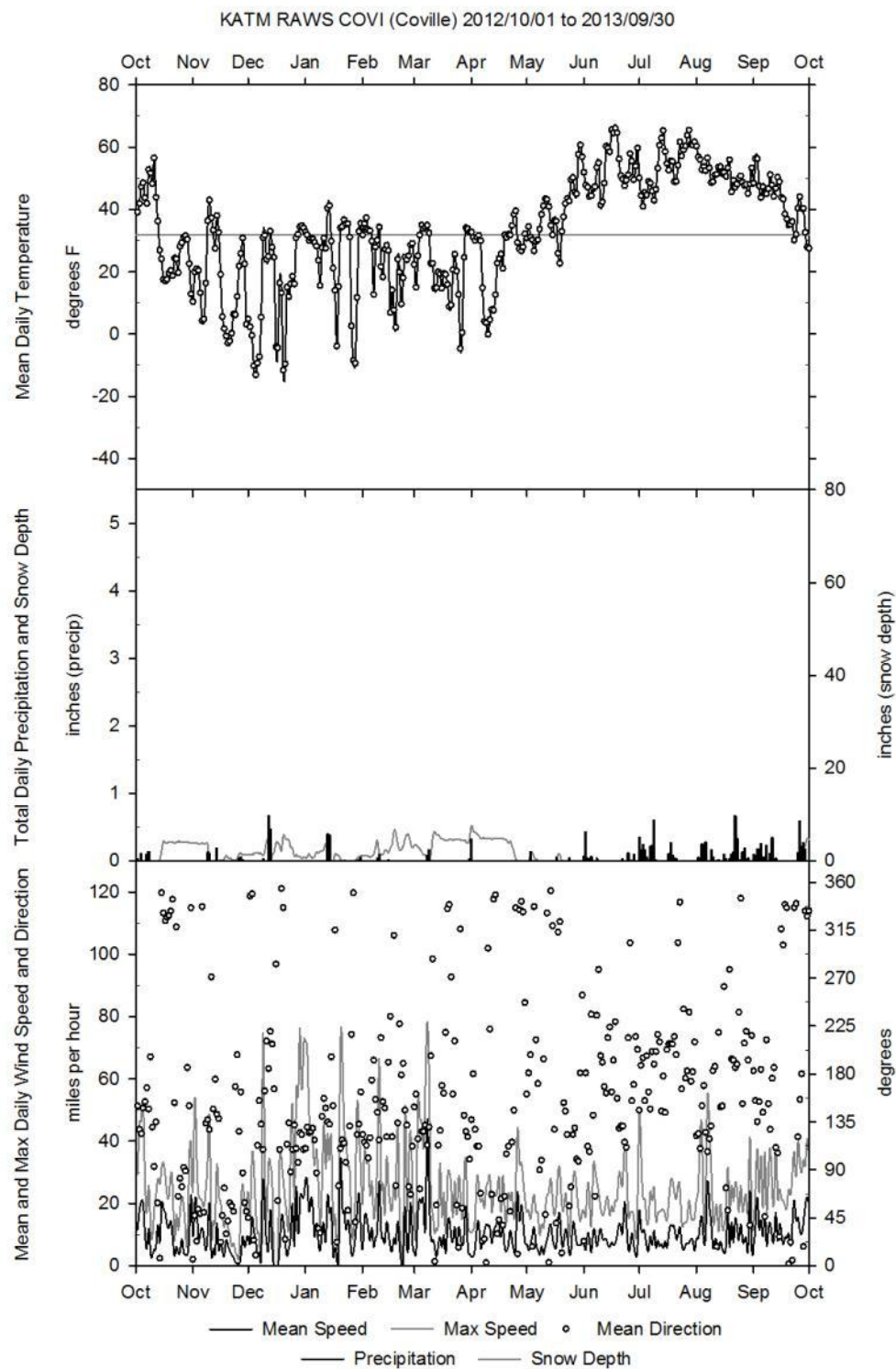


## Appendix 6-B Climate Table for Contact Creek RAWS

| 2013 Hydrologic Year - KATM RAWS COCR (Contact Creek) |      |       |       |       |       |       |       |       |       |       |      |      |       |
|-------------------------------------------------------|------|-------|-------|-------|-------|-------|-------|-------|-------|-------|------|------|-------|
|                                                       | Oct  | Nov   | Dec   | Jan   | Feb   | Mar   | Apr   | May   | Jun   | Jul   | Aug  | Sep  | Year  |
| <b>Minimum air temperature (F)</b>                    |      |       |       |       |       |       |       |       |       |       |      |      |       |
| Min.                                                  | 4.3  | -13.9 | -21.4 | -10.5 | -14.3 | -18.9 | -1.1  | 17.2  | 29.5  | 33.4  | 37.6 | 47.8 | -21.4 |
| Max.                                                  | 49.5 | 41.0  | 33.4  | 37.4  | 36.1  | 34.5  | 35.1  | 41.4  | 50.4  | 57.9  | 56.3 | 51.1 | 57.9  |
| Mean                                                  | 23.9 | 5.3   | 4.3   | 18.2  | 15.4  | 12.8  | 16.9  | 30.4  | 40.5  | 46.8  | 47.7 | 49.9 | 24.2  |
| # days <32 F                                          | 21   | 29    | 27    | 26    | 25    | 24    | 28    | 17    | 2     | 0     | 0    | 0    | 199   |
| % valid obs                                           | 100  | 100   | 100   | 100   | 100   | 100   | 100   | 100   | 100   | 100   | 100  | 8    | 93    |
| <b>Maximum air temperature (F)</b>                    |      |       |       |       |       |       |       |       |       |       |      |      |       |
| Min                                                   | 21.0 | 0.3   | -6.9  | 5.4   | 15.1  | 10.2  | 14.9  | 33.8  | 46.4  | 45.9  | 50.9 | 52.0 | -6.9  |
| Max                                                   | 66.4 | 47.7  | 45.1  | 44.8  | 43.3  | 45.9  | 51.6  | 74.7  | 80.1  | 78.3  | 68.4 | 66.9 | 80.1  |
| Mean                                                  | 41.2 | 23.2  | 22.9  | 34.1  | 33.2  | 31.9  | 38.7  | 51.1  | 63.8  | 64.8  | 58.9 | 59.9 | 42.4  |
| # days <32 F                                          | 9    | 18    | 19    | 8     | 11    | 15    | 7     | 0     | 0     | 0     | 0    | 0    | 87    |
| % valid obs                                           | 100  | 100   | 100   | 100   | 100   | 100   | 100   | 100   | 100   | 100   | 100  | 8    | 93    |
| <b>Mean air temperature (F)</b>                       |      |       |       |       |       |       |       |       |       |       |      |      |       |
| Observed                                              | 31.7 | 14.1  | 13.9  | 26.5  | 25.0  | 23.1  | 28.3  | 41.3  | 52.9  | 55.6  | 52.9 | 54.5 | 33.4  |
| % valid obs                                           | 100  | 100   | 100   | 100   | 100   | 100   | 100   | 100   | 100   | 100   | 100  | 8    | 93    |
| POR mean<br>1981-2010                                 |      |       |       |       |       |       |       |       |       |       |      |      |       |
| <b>Precipitation</b>                                  |      |       |       |       |       |       |       |       |       |       |      |      |       |
| Total <sup>2</sup>                                    | 0.53 | 0.81  | 1.91  | 1.30  | 0.77  | 0.97  | 0.17  | 0.33  | 1.16  | 2.75  | 5.39 | 0.14 | 16.23 |
| % valid obs                                           | 46   | 27    | 32    | 58    | 40    | 39    | 53    | 88    | 100   | 100   | 100  | 8    | 58    |
| POR mean<br>1981-2010                                 |      |       |       |       |       |       |       |       |       |       |      |      |       |
| <b>Snow depth (in)</b>                                |      |       |       |       |       |       |       |       |       |       |      |      |       |
| Average                                               | 0.1  | 1.2   | 1.6   | 2.1   | 7.7   | 14.1  | 7.5   | 0.6   | 0.0   | 0.0   | 0.0  | 0.0  |       |
| % valid obs                                           | 100  | 100   | 100   | 100   | 100   | 100   | 100   | 100   | 100   | 100   | 100  | 8    |       |
| POR mean                                              |      |       |       |       |       |       |       |       |       |       |      |      |       |
| <b>Wind (mph, degrees)</b>                            |      |       |       |       |       |       |       |       |       |       |      |      |       |
| Mean speed                                            | 10.5 | 7.4   | 11.0  | 14.2  | 11.4  | 12.7  | 7.9   | 9.6   | 11.7  | 9.7   | 10.4 | 16.7 |       |
| % valid obs                                           | 51   | 58    | 63    | 67    | 60    | 65    | 56    | 51    | 57    | 40    | 55   | 8    |       |
| Max speed                                             | 44.3 | 45.9  | 62.6  | 48.5  | 40.7  | 61.1  | 38.7  | 35.8  | 38.7  | 35.1  | 39.6 | 40.7 | 62.6  |
| Max direction                                         | 114  | 73    | 347   | 117   | 20    | 116   | 334   | 132   | 127   | 107   | 118  | 122  | 347   |
| <b>Solar radiation (KWh/m2)</b>                       |      |       |       |       |       |       |       |       |       |       |      |      |       |
| Total                                                 | 48.2 | 18.2  | 9.0   | 13.2  | 29.2  | 97.2  | 178.2 | 177.6 | 178.5 | 141.1 | 75.1 | 5.7  | 971.2 |
| % valid obs                                           | 100  | 100   | 100   | 100   | 100   | 100   | 100   | 100   | 100   | 100   | 100  | 8    | 93    |

<sup>2</sup>Station is only capable of measuring liquid precipitation. Precipitation reported when maximum air temperature is below 31.1 °F is not considered valid and these data are not used for summarizing purposes. The water equivalent of solid precipitation (e.g. snowfall) is not measured and this is reflected in the percentage of valid observations that are reported as a measure of the reliability of cumulative values.

## Appendix 7-A Climate Graph for Coville RAWS

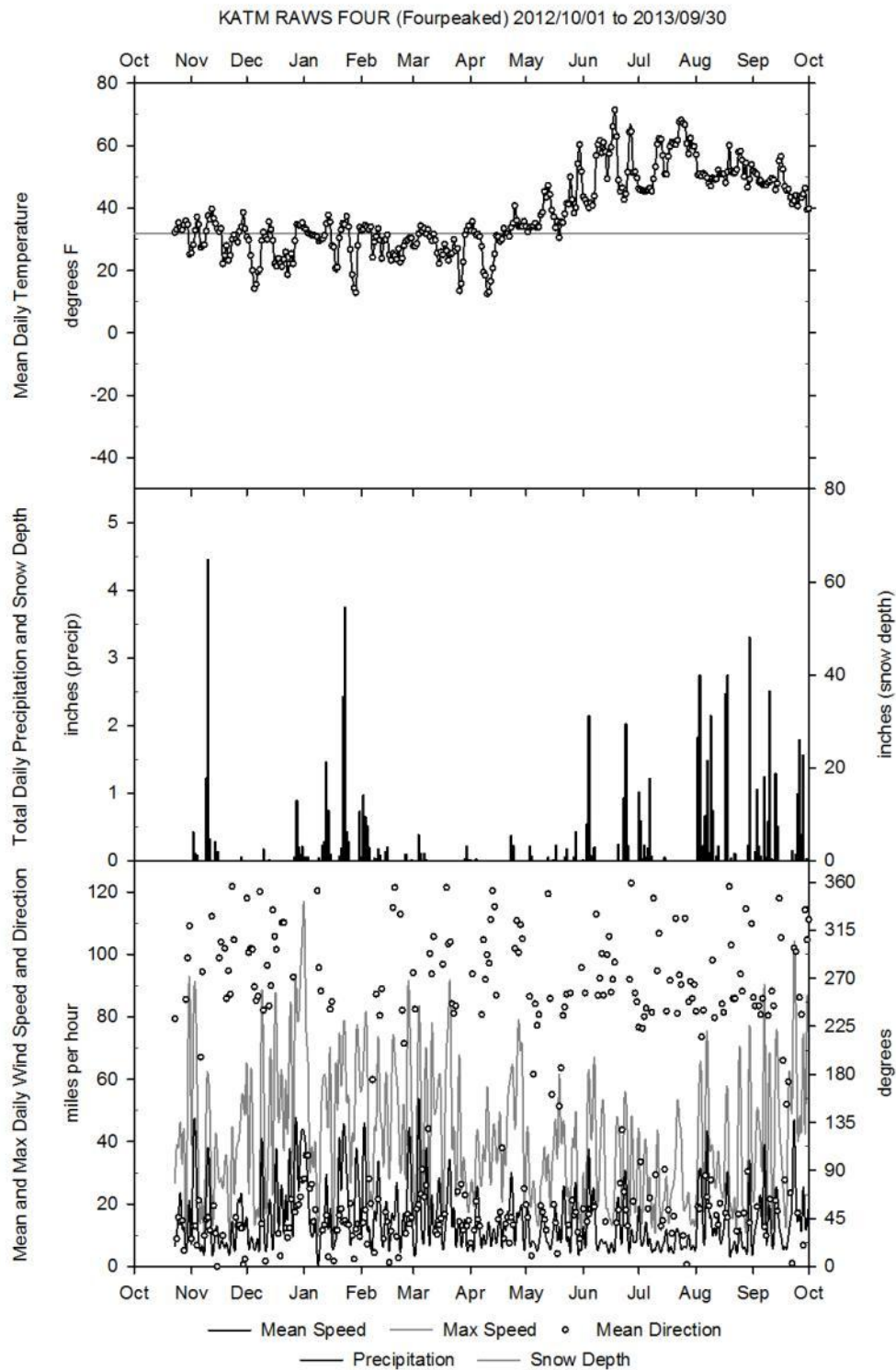


## Appendix 7-B Climate Table for Coville RAWS

| 2013 Hydrologic Year - KATM RAWS COVI (Coville) |      |      |       |       |       |       |       |      |       |       |      |      |       |
|-------------------------------------------------|------|------|-------|-------|-------|-------|-------|------|-------|-------|------|------|-------|
|                                                 | Oct  | Nov  | Dec   | Jan   | Feb   | Mar   | Apr   | May  | Jun   | Jul   | Aug  | Sep  | Year  |
| <b>Minimum air temperature (F)</b>              |      |      |       |       |       |       |       |      |       |       |      |      |       |
| Min.                                            | 7.2  | -6.9 | -16.2 | -15.3 | -11.9 | -12.1 | -7.8  | 14.7 | 32.0  | 38.8  | 41.7 | 22.5 | -16.2 |
| Max.                                            | 45.1 | 40.6 | 30.7  | 36.0  | 35.2  | 32.2  | 34.7  | 49.1 | 53.8  | 56.3  | 53.6 | 50.9 | 56.3  |
| Mean                                            | 25.8 | 10.5 | 7.2   | 17.6  | 15.7  | 15.5  | 16.1  | 32.1 | 44.1  | 48.1  | 46.9 | 36.4 | 26.4  |
| # days <32 F                                    | 21   | 28   | 31    | 27    | 27    | 30    | 28    | 16   | 0     | 0     | 0    | 10   | 218   |
| % valid obs                                     | 100  | 100  | 100   | 100   | 100   | 100   | 100   | 100  | 100   | 100   | 100  | 99   | 100   |
| <b>Maximum air temperature (F)</b>              |      |      |       |       |       |       |       |      |       |       |      |      |       |
| Min                                             | 16.3 | 2.7  | -10.5 | -4.0  | 16.2  | 3.6   | 8.1   | 32.2 | 47.8  | 43.2  | 49.3 | 30.2 | -10.5 |
| Max                                             | 68.5 | 45.5 | 43.3  | 47.1  | 41.2  | 49.8  | 47.3  | 72.0 | 77.5  | 76.5  | 63.7 | 66.9 | 77.5  |
| Mean                                            | 38.4 | 23.5 | 21.8  | 31.4  | 30.2  | 29.3  | 32.1  | 48.1 | 61.9  | 62.0  | 56.5 | 48.6 | 40.4  |
| # days <32 F                                    | 13   | 19   | 21    | 10    | 16    | 17    | 10    | 0    | 0     | 0     | 0    | 1    | 107   |
| % valid obs                                     | 100  | 100  | 100   | 100   | 100   | 100   | 100   | 100  | 100   | 100   | 100  | 99   | 100   |
| <b>Mean air temperature (F)</b>                 |      |      |       |       |       |       |       |      |       |       |      |      |       |
| Observed                                        | 31.5 | 16.7 | 14.2  | 24.8  | 23.3  | 21.8  | 23.9  | 39.6 | 52.9  | 54.5  | 51.0 | 42.2 | 33.1  |
| % valid obs                                     | 100  | 100  | 100   | 100   | 100   | 100   | 100   | 100  | 100   | 100   | 100  | 99   | 100   |
| POR mean<br>1981-2010                           |      |      |       |       |       |       |       |      |       |       |      |      |       |
| <b>Precipitation</b>                            |      |      |       |       |       |       |       |      |       |       |      |      |       |
| Total <sup>2</sup>                              | 0.39 | 0.57 | 1.17  | 0.88  | 0.16  | 0.59  | 0.02  | 0.32 | 1.19  | 2.23  | 2.90 | 2.94 | 13.36 |
| % valid obs                                     | 47   | 24   | 24    | 46    | 28    | 27    | 35    | 80   | 100   | 100   | 100  | 87   | 58    |
| POR mean<br>1981-2010                           |      |      |       |       |       |       |       |      |       |       |      |      |       |
| <b>Snow depth (in)</b>                          |      |      |       |       |       |       |       |      |       |       |      |      |       |
| Average                                         | 2.3  | 1.4  | 2.3   | 0.9   | 2.9   | 3.9   | 3.7   | 0.2  | 0.0   | 0.2   | 0.2  | 4.4  |       |
| % valid obs                                     | 100  | 100  | 100   | 100   | 100   | 100   | 100   | 100  | 82    | 1     | 1    | 8    |       |
| POR mean                                        |      |      |       |       |       |       |       |      |       |       |      |      |       |
| <b>Wind (mph, degrees)</b>                      |      |      |       |       |       |       |       |      |       |       |      |      |       |
| Mean speed                                      | 10.3 | 7.6  | 11.3  | 13.1  | 10.2  | 11.7  | 10.5  | 8.2  | 9.1   | 8.5   | 10.5 | 12.9 |       |
| % valid obs                                     | 100  | 100  | 100   | 100   | 100   | 100   | 100   | 100  | 100   | 100   | 100  | 99   |       |
| Max speed                                       | 52.6 | 53.7 | 76.3  | 71.1  | 66.4  | 78.1  | 44.3  | 30.4 | 49.4  | 36.0  | 54.8 | 40.7 | 78.1  |
| Max direction                                   | 127  | 55   | 110   | 104   | 92    | 110   | 4     | 303  | 134   | 141   | 95   | 330  | 110   |
| <b>Solar radiation (KWh/m2)</b>                 |      |      |       |       |       |       |       |      |       |       |      |      |       |
| Total                                           | 45.6 | 15.8 | 8.3   | 11.9  | 27.4  | 88.7  | 112.5 | 90.7 | 190.4 | 151.8 | 86.9 | 73.8 | 903.7 |
| % valid obs                                     | 100  | 100  | 100   | 100   | 100   | 100   | 75    | 90   | 100   | 100   | 100  | 99   | 97    |

<sup>2</sup>Station is only capable of measuring liquid precipitation. Precipitation reported when maximum air temperature is below 31.1 °F is not considered valid and these data are not used for summarizing purposes. The water equivalent of solid precipitation (e.g. snowfall) is not measured and this is reflected in the percentage of valid observations that are reported as a measure of the reliability of cumulative values.

## Appendix 8-A Climate Graph for Fourpeaked RAWS

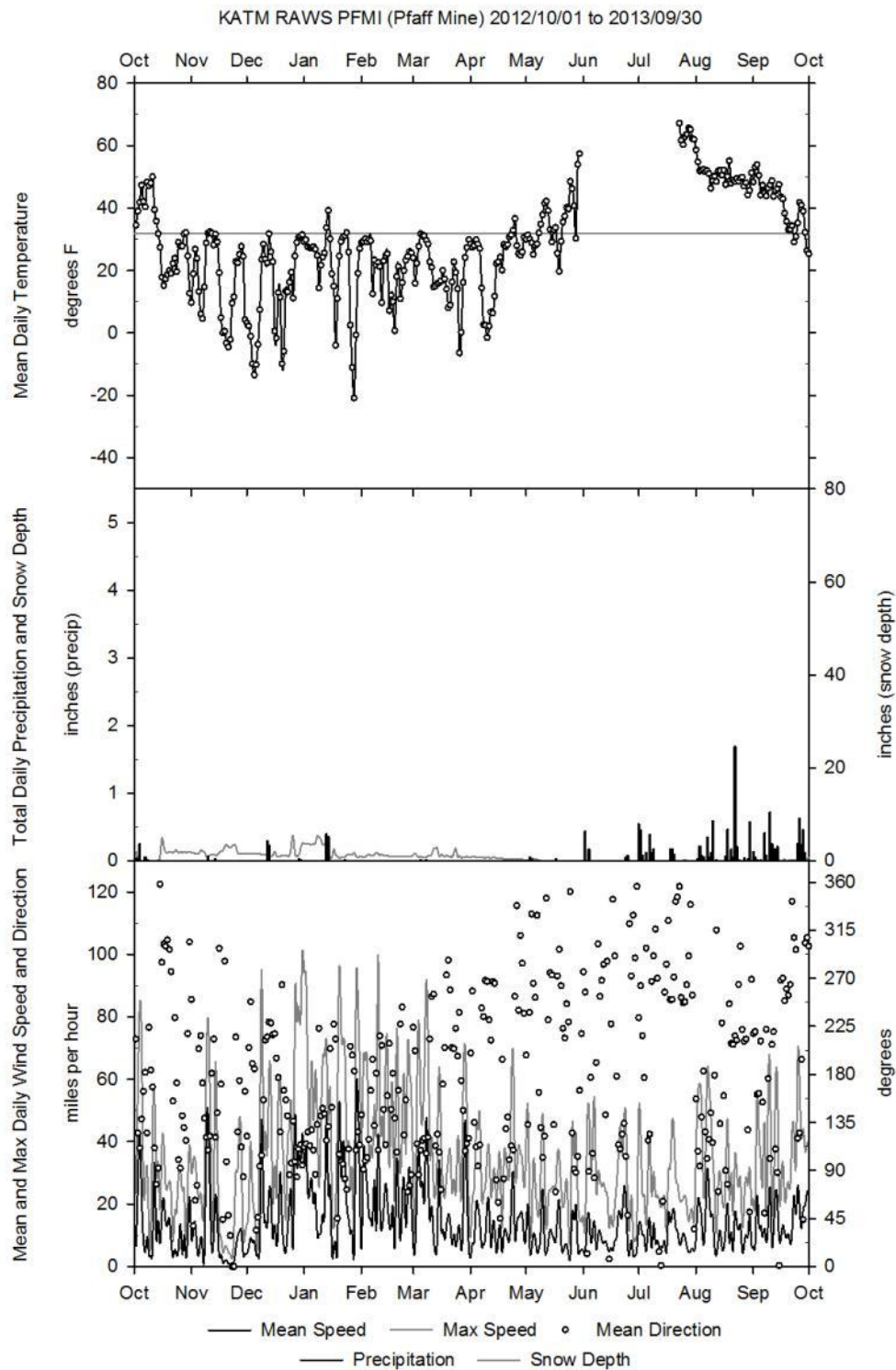


## Appendix 8-B Climate Table for Fourpeaked RAWS

| 2013 Hydrologic Year - KATM RAWS FOUR (Fourpeaked) |      |      |       |       |      |      |       |       |       |       |       |       |        |
|----------------------------------------------------|------|------|-------|-------|------|------|-------|-------|-------|-------|-------|-------|--------|
|                                                    | Oct  | Nov  | Dec   | Jan   | Feb  | Mar  | Apr   | May   | Jun   | Jul   | Aug   | Sep   | Year   |
| <b>Minimum air temperature (F)</b>                 |      |      |       |       |      |      |       |       |       |       |       |       |        |
| Min.                                               | 19.9 | 18.9 | 11.3  | 6.3   | 17.8 | 3.2  | 7.2   | 23.0  | 38.3  | 42.6  | 44.8  | 34.2  | 3.2    |
| Max.                                               | 32.7 | 38.1 | 32.5  | 36.5  | 32.5 | 32.9 | 33.4  | 52.0  | 63.3  | 64.6  | 56.5  | 51.1  | 64.6   |
| Mean                                               | 29.0 | 28.0 | 22.8  | 26.2  | 25.0 | 24.6 | 25.7  | 35.1  | 46.9  | 52.2  | 48.7  | 43.0  | 34.3   |
| # days <32 F                                       | 9    | 23   | 26    | 26    | 24   | 30   | 27    | 10    | 0     | 0     | 0     | 0     | 175    |
| % valid obs                                        | 31   | 100  | 100   | 100   | 100  | 100  | 100   | 100   | 99    | 100   | 100   | 99    | 94     |
| <b>Maximum air temperature (F)</b>                 |      |      |       |       |      |      |       |       |       |       |       |       |        |
| Min                                                | 30.0 | 26.6 | 17.1  | 17.2  | 26.6 | 23.2 | 17.1  | 33.8  | 41.4  | 47.5  | 48.2  | 43.0  | 17.1   |
| Max                                                | 41.7 | 43.7 | 42.4  | 41.0  | 42.8 | 43.3 | 48.9  | 69.6  | 78.6  | 75.0  | 64.6  | 60.8  | 78.6   |
| Mean                                               | 37.0 | 35.8 | 30.1  | 32.8  | 32.2 | 32.8 | 34.4  | 45.6  | 58.8  | 61.7  | 55.2  | 51.1  | 42.7   |
| # days <32 F                                       | 1    | 5    | 17    | 9     | 15   | 13   | 7     | 0     | 0     | 0     | 0     | 0     | 67     |
| % valid obs                                        | 31   | 100  | 100   | 100   | 100  | 100  | 100   | 100   | 99    | 100   | 100   | 99    | 94     |
| <b>Mean air temperature (F)</b>                    |      |      |       |       |      |      |       |       |       |       |       |       |        |
| Observed                                           | 32.3 | 31.5 | 26.3  | 29.6  | 28.6 | 28.0 | 29.4  | 40.1  | 52.6  | 56.5  | 51.4  | 46.7  | 38.1   |
| % valid obs                                        | 31   | 100  | 100   | 100   | 100  | 100  | 100   | 100   | 99    | 100   | 100   | 99    | 94     |
| POR mean                                           |      |      |       |       |      |      |       |       |       |       |       |       |        |
| 1981-2010                                          |      |      |       |       |      |      |       |       |       |       |       |       |        |
| <b>Precipitation</b>                               |      |      |       |       |      |      |       |       |       |       |       |       |        |
| Total <sup>2</sup>                                 | 0.01 | 7.09 | 1.70  | 10.92 | 3.14 | 0.91 | 0.63  | 1.32  | 7.44  | 2.45  | 19.37 | 12.69 | 67.67  |
| % valid obs                                        | 23   | 60   | 29    | 56    | 36   | 38   | 60    | 98    | 99    | 100   | 98    | 93    | 66     |
| POR mean                                           |      |      |       |       |      |      |       |       |       |       |       |       |        |
| 1981-2010                                          |      |      |       |       |      |      |       |       |       |       |       |       |        |
| <b>Snow depth (in)</b>                             |      |      |       |       |      |      |       |       |       |       |       |       |        |
| Average                                            |      |      |       |       |      |      |       |       |       |       |       |       |        |
| % valid obs                                        |      |      |       |       |      |      |       |       |       |       |       |       |        |
| POR mean                                           |      |      |       |       |      |      |       |       |       |       |       |       |        |
| <b>Wind (mph, degrees)</b>                         |      |      |       |       |      |      |       |       |       |       |       |       |        |
| Mean speed                                         | 12.9 | 14.3 | 20.6  | 18.7  | 18.1 | 16.3 | 13.2  | 11.5  | 12.9  | 7.5   | 14.2  | 16.7  |        |
| % valid obs                                        | 31   | 100  | 100   | 100   | 100  | 100  | 100   | 100   | 99    | 100   | 100   | 99    |        |
| Max speed                                          | 90.8 | 89.7 | 115.0 | 76.3  | 85.5 | 89.0 | 79.0  | 61.5  | 66.9  | 53.2  | 77.2  | 102.0 | 115.0  |
| Max direction                                      | 290  | 48   | 78    | 76    | 57   | 296  | 316   | 312   | 56    | 290   | 54    | 304   | 78     |
| <b>Solar radiation (KWh/m2)</b>                    |      |      |       |       |      |      |       |       |       |       |       |       |        |
| Total                                              | 17.8 | 22.3 | 11.2  | 14.3  | 34.7 | 96.0 | 176.7 | 183.5 | 178.4 | 195.7 | 79.6  | 79.3  | 1089.0 |
| % valid obs                                        | 31   | 100  | 100   | 100   | 100  | 100  | 100   | 100   | 99    | 100   | 100   | 99    | 94     |

<sup>2</sup>Station is only capable of measuring liquid precipitation. Precipitation reported when maximum air temperature is below 31.1 °F is not considered valid and these data are not used for summarizing purposes. The water equivalent of solid precipitation (e.g. snowfall) is not measured and this is reflected in the percentage of valid observations that are reported as a measure of the reliability of cumulative values.

## Appendix 9-A Climate Graph for Pfaff Mine RAWS



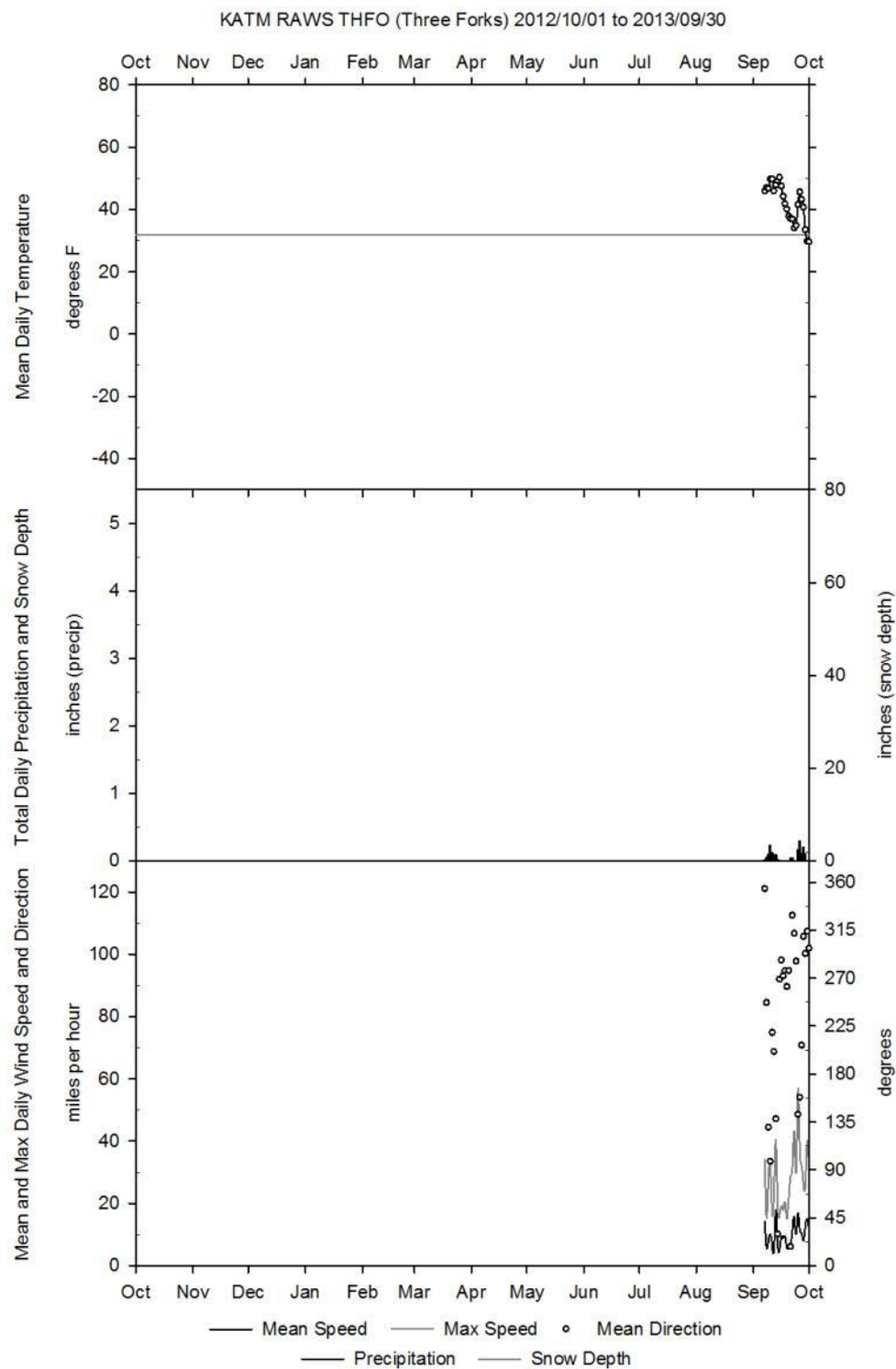
## Appendix 9-B Climate Table for Pfaff Mine RAWS

| 2013 Hydrologic Year - KATM RAWS PFMI (Pfaff Mine) |      |      |       |       |      |       |       |       |       |       |      |      |        |
|----------------------------------------------------|------|------|-------|-------|------|-------|-------|-------|-------|-------|------|------|--------|
|                                                    | Oct  | Nov  | Dec   | Jan   | Feb  | Mar   | Apr   | May   | Jun   | Jul   | Aug  | Sep  | Year   |
| <b>Minimum air temperature (F)</b>                 |      |      |       |       |      |       |       |       |       |       |      |      |        |
| Min.*                                              | 6.8  | -8.7 | -16.1 | -47.7 | -9.6 | -12.1 | -6.3  | 13.1  |       | 52.5  | 39.9 | 22.8 | -47.7  |
| Max.*                                              | 43.9 | 31.1 | 29.1  | 33.8  | 28.4 | 29.3  | 31.1  | 52.9  |       | 61.9  | 50.0 | 49.1 | 61.9   |
| Mean*                                              | 25.8 | 10.8 | 7.3   | 12.4  | 13.4 | 14.3  | 15.9  | 28.2  |       | 56.0  | 45.8 | 36.3 | 22.2   |
| # days <32 F*                                      | 21   | 30   | 31    | 30    | 28   | 31    | 30    | 19    |       | 0     | 0    | 10   | 230    |
| % valid obs                                        | 100  | 100  | 100   | 99    | 97   | 100   | 100   | 90    | 0     | 30    | 100  | 100  | 85     |
| <b>Maximum air temperature (F)</b>                 |      |      |       |       |      |       |       |       |       |       |      |      |        |
| Min*                                               | 13.1 | 3.9  | -8.5  | -11.4 | 13.3 | 1.9   | 3.2   | 28.0  |       | 66.0  | 48.9 | 27.7 | -11.4  |
| Max*                                               | 57.2 | 38.5 | 38.1  | 46.6  | 32.5 | 35.1  | 43.3  | 69.1  |       | 75.0  | 63.9 | 67.3 | 75.0   |
| Mean*                                              | 35.8 | 23.0 | 18.7  | 26.7  | 25.8 | 24.9  | 28.2  | 42.7  |       | 70.8  | 55.3 | 46.5 | 34.0   |
| # days <32 F*                                      | 13   | 20   | 26    | 23    | 25   | 25    | 16    | 2     |       | 0     | 0    | 2    | 152    |
| % valid obs                                        | 100  | 100  | 100   | 100   | 99   | 100   | 100   | 91    | 0     | 30    | 100  | 100  | 85     |
| <b>Mean air temperature (F)</b>                    |      |      |       |       |      |       |       |       |       |       |      |      |        |
| Observed*                                          | 30.4 | 16.2 | 13.1  | 20.7  | 20.4 | 19.3  | 21.8  | 35.2  |       | 62.6  | 49.9 | 40.8 | 27.9   |
| % valid obs                                        | 100  | 100  | 100   | 100   | 99   | 100   | 100   | 91    | 0     | 30    | 100  | 100  | 85     |
| POR mean                                           |      |      |       |       |      |       |       |       |       |       |      |      |        |
| 1981-2010                                          |      |      |       |       |      |       |       |       |       |       |      |      |        |
| <b>Precipitation</b>                               |      |      |       |       |      |       |       |       |       |       |      |      |        |
| Total <sup>2</sup>                                 | 0.40 | 0.11 | 0.58  | 0.78  | 0.00 | 0.04  | 0.00  | 0.11  | 1.30  | 1.80  | 5.01 | 3.69 | 13.82  |
| % valid obs                                        | 48   | 15   | 7     | 17    | 5    | 11    | 23    | 74    | 100   | 100   | 100  | 85   | 49     |
| POR mean                                           |      |      |       |       |      |       |       |       |       |       |      |      |        |
| 1981-2010                                          |      |      |       |       |      |       |       |       |       |       |      |      |        |
| <b>Snow depth (in)</b>                             |      |      |       |       |      |       |       |       |       |       |      |      |        |
| Average                                            | 1.3  | 1.9  | 1.7   | 2.2   | 1.1  | 1.2   | 0.5   | 0.1   |       | 0.1   | 0.0  | 0.1  |        |
| % valid obs                                        | 100  | 100  | 100   | 99    | 99   | 100   | 100   | 74    | 0     | 1     | 44   | 55   |        |
| POR mean                                           |      |      |       |       |      |       |       |       |       |       |      |      |        |
| <b>Wind (mph, degrees)</b>                         |      |      |       |       |      |       |       |       |       |       |      |      |        |
| Mean speed                                         | 12.4 | 9.6  | 18.6  | 22.7  | 20.7 | 17.5  | 12.5  | 9.7   | 10.0  | 9.5   | 12.4 | 15.1 |        |
| % valid obs                                        | 100  | 100  | 100   | 100   | 100  | 100   | 100   | 100   | 100   | 100   | 100  | 100  |        |
| Max speed                                          | 84.1 | 79.4 | 100.9 | 96.2  | 99.8 | 91.5  | 68.2  | 51.2  | 53.7  | 46.1  | 62.2 | 68.2 | 100.9  |
| Max direction                                      | 114  | 115  | 99    | 94    | 104  | 117   | 116   | 95    | 105   | 233   | 126  | 117  | 99     |
| <b>Solar radiation (KWh/m2)</b>                    |      |      |       |       |      |       |       |       |       |       |      |      |        |
| Total                                              | 48.6 | 16.5 | 9.0   | 13.7  | 34.5 | 99.5  | 162.9 | 220.2 | 203.2 | 159.1 | 86.2 | 77.2 | 1130.7 |
| % valid obs                                        | 100  | 100  | 100   | 100   | 100  | 100   | 100   | 100   | 100   | 100   | 100  | 100  | 100    |

\*Temperature not available from 05/29/2013 to 07/22/2013 because of data logger problem. Yearly summary reflects missing values.

<sup>2</sup>Station is only capable of measuring liquid precipitation. Precipitation reported when maximum air temperature is below 31.1 °F is not considered valid and these data are not used for summarizing purposes. The water equivalent of solid precipitation (e.g. snowfall) is not measured and this is reflected in the percentage of valid observations that are reported as a measure of the reliability of cumulative values.

## Appendix 10-A Climate Graph for Three Forks RAWS



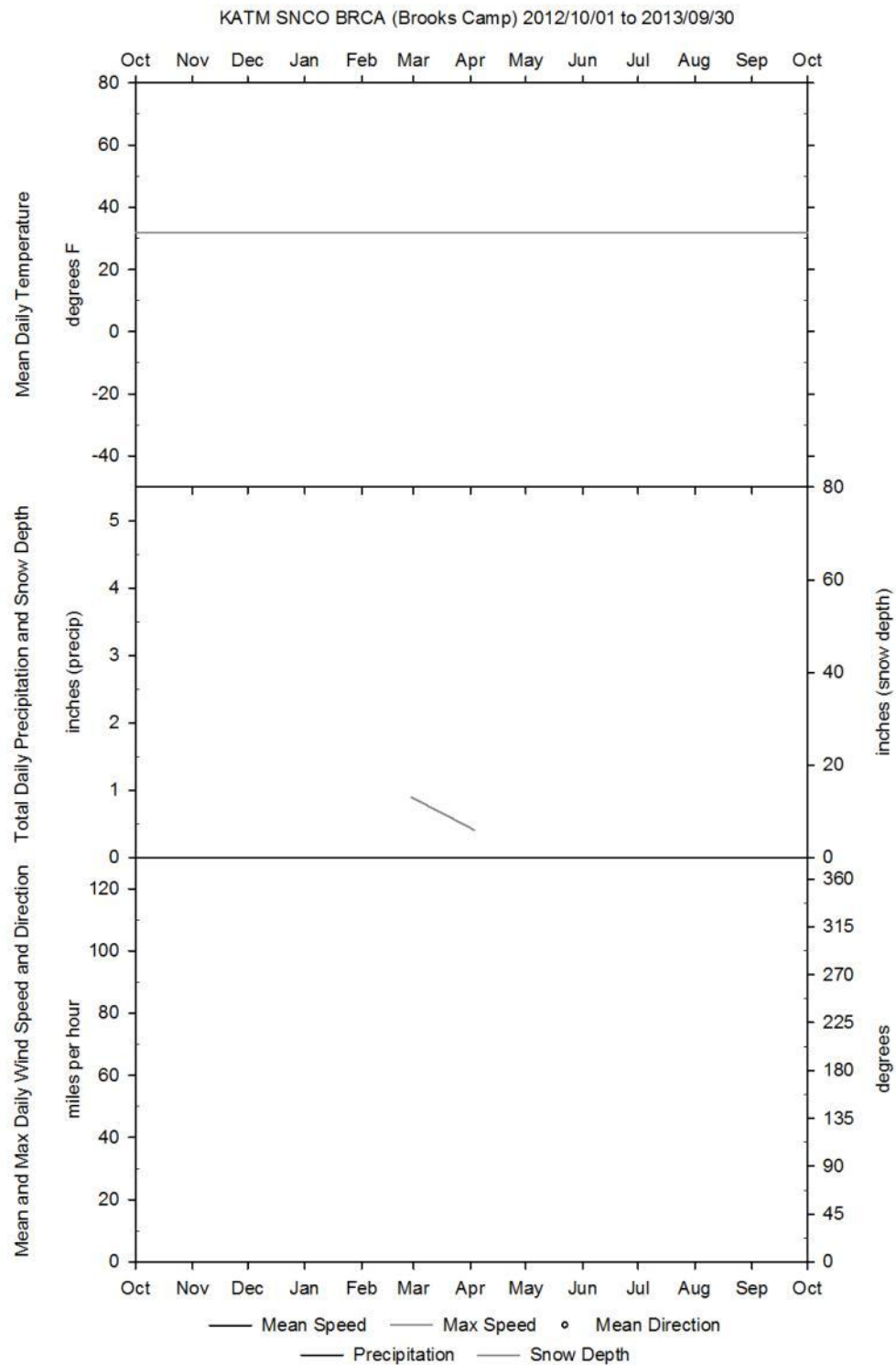
## Appendix 10-B Climate Table for Three Forks RAWS

| 2013 Hydrologic Year - KATM RAWS THFO (Three Forks) |     |     |     |     |     |     |     |     |     |     |     |      |      |
|-----------------------------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|
|                                                     | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep  | Year |
| Minimum air temperature (F)                         |     |     |     |     |     |     |     |     |     |     |     |      |      |
| Min.*                                               |     |     |     |     |     |     |     |     |     |     |     | 26.4 | 26.4 |
| Max.*                                               |     |     |     |     |     |     |     |     |     |     |     | 47.1 | 47.1 |
| Mean*                                               |     |     |     |     |     |     |     |     |     |     |     | 37.1 | 37.1 |
| # days <32 F*                                       |     |     |     |     |     |     |     |     |     |     |     | 7    | 7    |
| % valid obs                                         | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 70   | 6    |
| Maximum air temperature (F)                         |     |     |     |     |     |     |     |     |     |     |     |      |      |
| Min*                                                |     |     |     |     |     |     |     |     |     |     |     | 32.0 | 32.0 |
| Max*                                                |     |     |     |     |     |     |     |     |     |     |     | 57.0 | 57.0 |
| Mean*                                               |     |     |     |     |     |     |     |     |     |     |     | 48.2 | 48.2 |
| # days <32 F*                                       |     |     |     |     |     |     |     |     |     |     |     | 0    | 0    |
| % valid obs                                         | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 70   | 6    |
| Mean air temperature (F)                            |     |     |     |     |     |     |     |     |     |     |     |      |      |
| Observed*                                           |     |     |     |     |     |     |     |     |     |     |     | 41.8 | 41.8 |
| % valid obs                                         | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 71   | 6    |
| POR mean                                            |     |     |     |     |     |     |     |     |     |     |     |      |      |
| 1981-2010                                           |     |     |     |     |     |     |     |     |     |     |     |      |      |
| Precipitation                                       |     |     |     |     |     |     |     |     |     |     |     |      |      |
| Total <sup>2</sup>                                  |     |     |     |     |     |     |     |     |     |     |     | 1.63 | 1.63 |
| % valid obs                                         | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 64   | 5    |
| POR mean                                            |     |     |     |     |     |     |     |     |     |     |     |      |      |
| 1981-2010                                           |     |     |     |     |     |     |     |     |     |     |     |      |      |
| Snow depth (in)                                     |     |     |     |     |     |     |     |     |     |     |     |      |      |
| Average*                                            |     |     |     |     |     |     |     |     |     |     |     | 1.7  |      |
| % valid obs                                         | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 4    |      |
| POR mean                                            |     |     |     |     |     |     |     |     |     |     |     |      |      |
| Wind (mph, degrees)                                 |     |     |     |     |     |     |     |     |     |     |     |      |      |
| Mean speed*                                         |     |     |     |     |     |     |     |     |     |     |     | 9.9  |      |
| % valid obs                                         | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 70   |      |
| Max speed*                                          |     |     |     |     |     |     |     |     |     |     |     | 56.8 | 56.8 |
| Max direction*                                      |     |     |     |     |     |     |     |     |     |     |     | 148  | 148  |
| Solar radiation (KWh/m2)                            |     |     |     |     |     |     |     |     |     |     |     |      |      |
| Total*                                              | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 50.1 | 50.1 |
| % valid obs                                         |     |     |     |     |     |     |     |     |     |     |     | 72   | 6    |

\*Station started operation on September 6, 2013. Yearly summaries reflect missing values.

<sup>2</sup>Station is only capable of measuring liquid precipitation. Precipitation reported when maximum air temperature is below 31.1 °F is not considered valid and these data are not used for summarizing purposes. The water equivalent of solid precipitation (e.g. snowfall) is not measured and this is reflected in the percentage of valid observations that are reported as a measure of the reliability of cumulative values.

## Appendix 11-A Climate Graph for Brooks Camp SNCO



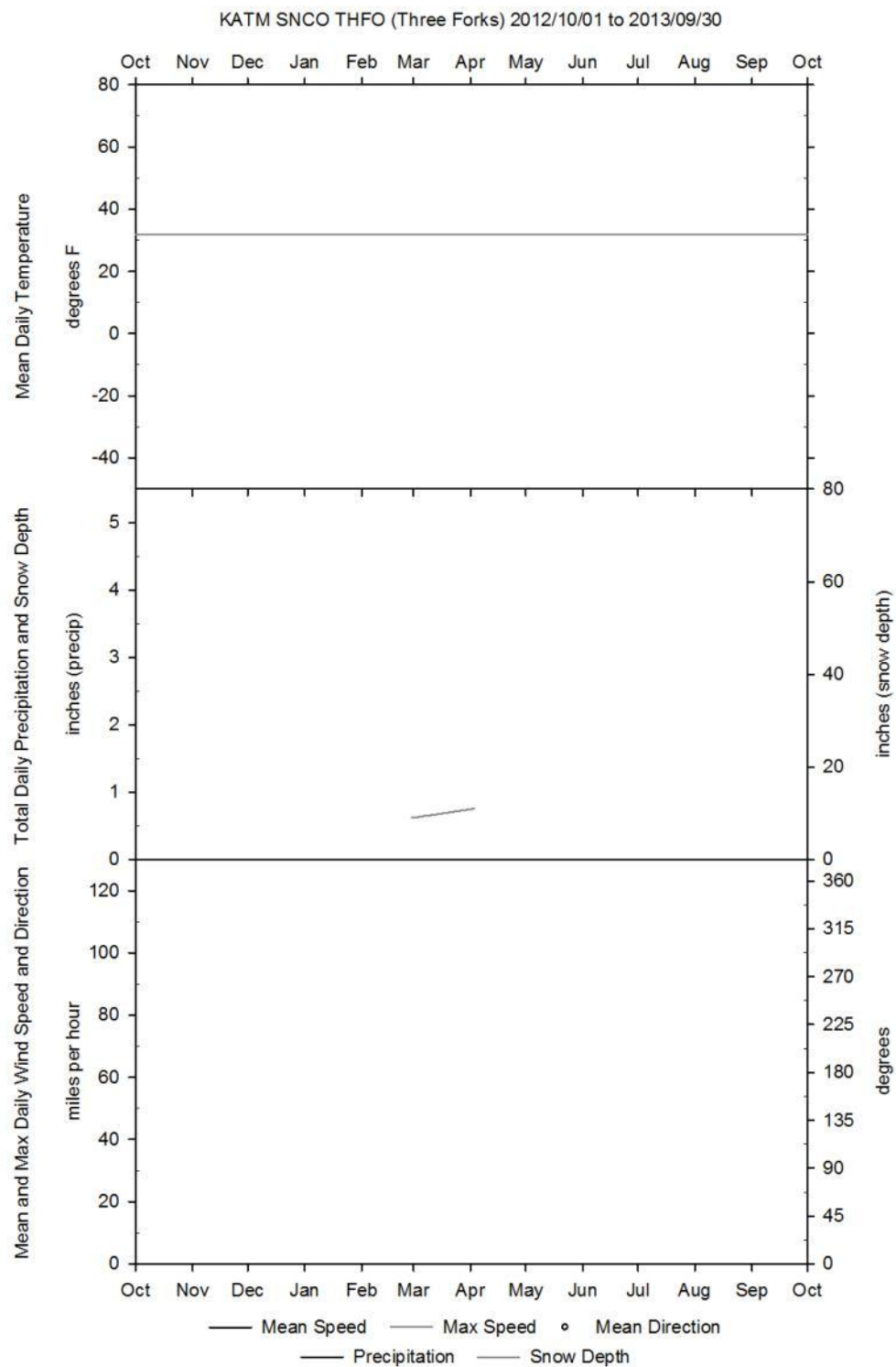
## Appendix 11-B Climate Table for Brooks Camp SNCO

| 2013 Hydrologic Year - KATM SNCO BRCA (Brooks Camp) |     |     |     |     |     |     |     |     |     |     |     |     |      |
|-----------------------------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|
|                                                     | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Year |
| <b>Minimum air temperature (F)</b>                  |     |     |     |     |     |     |     |     |     |     |     |     |      |
| Min.                                                |     |     |     |     |     |     |     |     |     |     |     |     |      |
| Max.                                                |     |     |     |     |     |     |     |     |     |     |     |     |      |
| Mean                                                |     |     |     |     |     |     |     |     |     |     |     |     |      |
| # days <32 F                                        |     |     |     |     |     |     |     |     |     |     |     |     |      |
| % valid obs                                         |     |     |     |     |     |     |     |     |     |     |     |     |      |
| <b>Maximum air temperature (F)</b>                  |     |     |     |     |     |     |     |     |     |     |     |     |      |
| Min                                                 |     |     |     |     |     |     |     |     |     |     |     |     |      |
| Max                                                 |     |     |     |     |     |     |     |     |     |     |     |     |      |
| Mean                                                |     |     |     |     |     |     |     |     |     |     |     |     |      |
| # days <32 F                                        |     |     |     |     |     |     |     |     |     |     |     |     |      |
| % valid obs                                         |     |     |     |     |     |     |     |     |     |     |     |     |      |
| <b>Mean air temperature (F)</b>                     |     |     |     |     |     |     |     |     |     |     |     |     |      |
| Observed                                            |     |     |     |     |     |     |     |     |     |     |     |     |      |
| % valid obs                                         |     |     |     |     |     |     |     |     |     |     |     |     |      |
| POR mean                                            |     |     |     |     |     |     |     |     |     |     |     |     |      |
| 1981-2010                                           |     |     |     |     |     |     |     |     |     |     |     |     |      |
| <b>Precipitation</b>                                |     |     |     |     |     |     |     |     |     |     |     |     |      |
| Total <sup>3</sup>                                  |     | 1.1 |     |     | 2.3 | 1.6 |     |     |     |     |     |     |      |
| % valid obs                                         |     | 100 | 0   | 0   | 100 | 100 | 0   |     |     |     |     |     |      |
| POR mean                                            |     |     |     |     |     |     |     |     |     |     |     |     |      |
| 1981-2010 <sup>5</sup>                              |     |     |     |     |     |     |     |     |     |     |     |     |      |
| <b>Snow depth (in)</b>                              |     |     |     |     |     |     |     |     |     |     |     |     |      |
| Average <sup>4</sup>                                |     | 6   |     |     | 13  | 6   |     |     |     |     |     |     |      |
| % valid obs                                         |     | 100 | 0   | 0   | 100 | 100 | 0   |     |     |     |     |     |      |
| POR mean <sup>5</sup>                               |     |     |     |     |     |     |     |     |     |     |     |     |      |
| <b>Wind (mph, degrees)</b>                          |     |     |     |     |     |     |     |     |     |     |     |     |      |
| Mean speed                                          |     |     |     |     |     |     |     |     |     |     |     |     |      |
| % valid obs                                         |     |     |     |     |     |     |     |     |     |     |     |     |      |
| Max speed                                           |     |     |     |     |     |     |     |     |     |     |     |     |      |
| Max direction                                       |     |     |     |     |     |     |     |     |     |     |     |     |      |
| <b>Solar radiation (KWh/m2)</b>                     |     |     |     |     |     |     |     |     |     |     |     |     |      |
| Total                                               |     |     |     |     |     |     |     |     |     |     |     |     |      |
| % valid obs                                         |     |     |     |     |     |     |     |     |     |     |     |     |      |

<sup>3</sup>Snow water equivalent measured close to the end of the month listed.  
depth measured close to the end of the month listed.  
course.

<sup>4</sup>Cummulative snow  
<sup>5</sup>Values are not available for this snow  
course.

## Appendix 12-A Climate Graph for Three Forks SNCO



## Appendix 12-B Climate Table for Three Forks SNCO

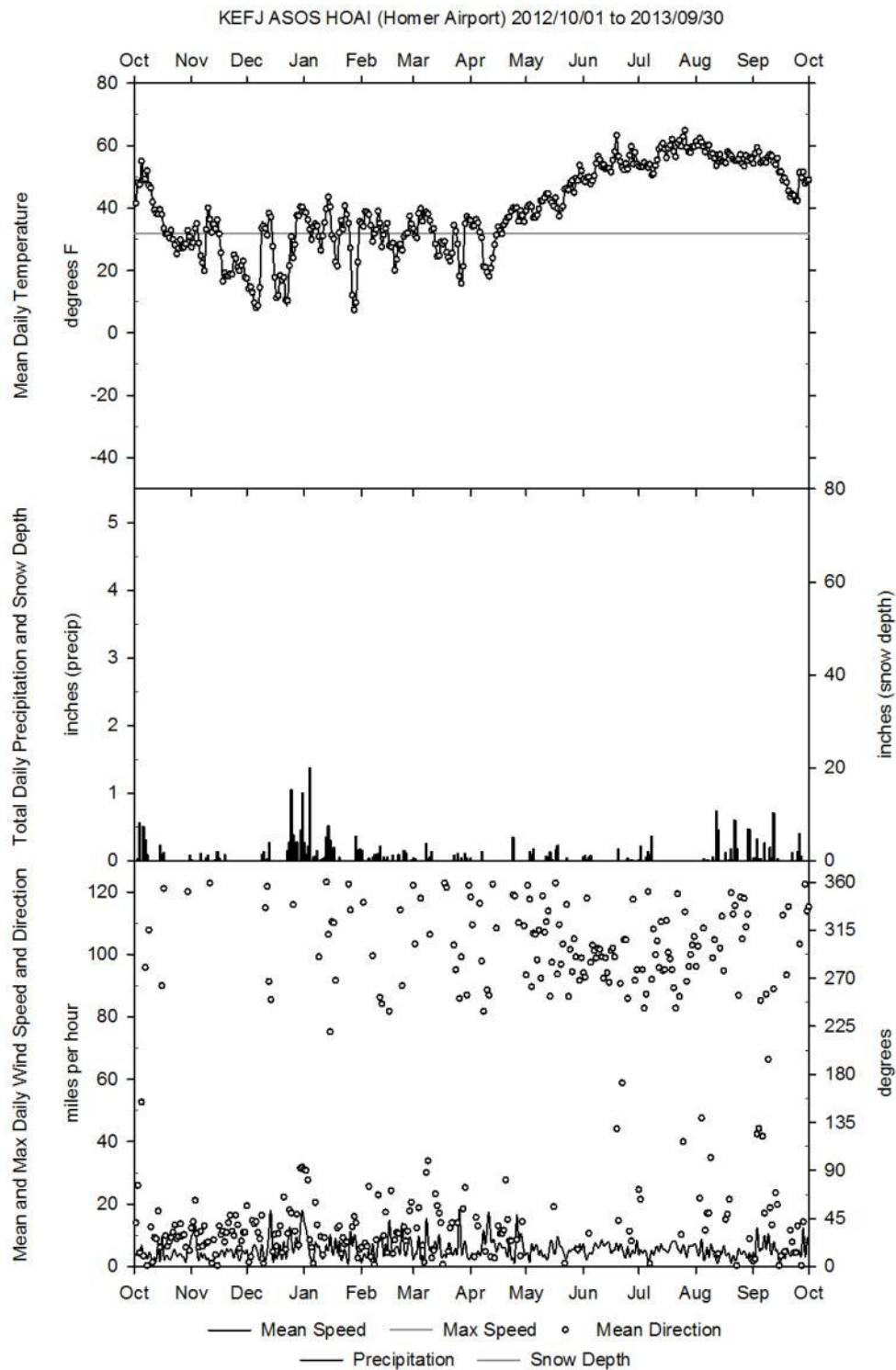
| 2013 Hydrologic Year - KAMT SNCO THFO (Three Forks) |     |     |     |     |     |     |     |     |     |     |     |      |
|-----------------------------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|
|                                                     | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Year |
| <b>Minimum air temperature (F)</b>                  |     |     |     |     |     |     |     |     |     |     |     |      |
| Min.                                                |     |     |     |     |     |     |     |     |     |     |     |      |
| Max.                                                |     |     |     |     |     |     |     |     |     |     |     |      |
| Mean                                                |     |     |     |     |     |     |     |     |     |     |     |      |
| # days <32 F                                        |     |     |     |     |     |     |     |     |     |     |     |      |
| % valid obs                                         |     |     |     |     |     |     |     |     |     |     |     |      |
| <b>Maximum air temperature (F)</b>                  |     |     |     |     |     |     |     |     |     |     |     |      |
| Min                                                 |     |     |     |     |     |     |     |     |     |     |     |      |
| Max                                                 |     |     |     |     |     |     |     |     |     |     |     |      |
| Mean                                                |     |     |     |     |     |     |     |     |     |     |     |      |
| # days <32 F                                        |     |     |     |     |     |     |     |     |     |     |     |      |
| % valid obs                                         |     |     |     |     |     |     |     |     |     |     |     |      |
| <b>Mean air temperature (F)</b>                     |     |     |     |     |     |     |     |     |     |     |     |      |
| Observed                                            |     |     |     |     |     |     |     |     |     |     |     |      |
| % valid obs                                         |     |     |     |     |     |     |     |     |     |     |     |      |
| POR mean                                            |     |     |     |     |     |     |     |     |     |     |     |      |
| 1981-2010                                           |     |     |     |     |     |     |     |     |     |     |     |      |
| <b>Precipitation</b>                                |     |     |     |     |     |     |     |     |     |     |     |      |
| Total <sup>3</sup>                                  |     | 1.3 |     |     | 1.5 | 2.9 |     |     |     |     |     |      |
| % valid obs                                         |     | 100 | 0   | 0   | 100 | 100 | 0   |     |     |     |     |      |
| POR mean                                            |     |     |     |     |     |     |     |     |     |     |     |      |
| 1981-2010 <sup>5</sup>                              |     |     |     |     |     |     |     |     |     |     |     |      |
| <b>Snow depth (in)</b>                              |     |     |     |     |     |     |     |     |     |     |     |      |
| Average <sup>4</sup>                                |     | 7   |     |     | 9   | 11  |     |     |     |     |     |      |
| % valid obs                                         |     | 100 | 0   | 0   | 100 | 100 | 0   |     |     |     |     |      |
| 1981-2010 <sup>5</sup>                              |     |     |     |     |     |     |     |     |     |     |     |      |
| <b>Wind (mph, degrees)</b>                          |     |     |     |     |     |     |     |     |     |     |     |      |
| Mean speed                                          |     |     |     |     |     |     |     |     |     |     |     |      |
| % valid obs                                         |     |     |     |     |     |     |     |     |     |     |     |      |
| Max speed                                           |     |     |     |     |     |     |     |     |     |     |     |      |
| Max direction                                       |     |     |     |     |     |     |     |     |     |     |     |      |
| <b>Solar radiation (KWh/m2)</b>                     |     |     |     |     |     |     |     |     |     |     |     |      |
| Total                                               |     |     |     |     |     |     |     |     |     |     |     |      |
| % valid obs                                         |     |     |     |     |     |     |     |     |     |     |     |      |

<sup>3</sup>Snow water equivalent measured close to the end of the month listed.

<sup>4</sup>Cummulative snow depth measured close to the end of the month listed.

<sup>5</sup>Values cited are from National Water and Climate Data Center (current Feb. 7, 2014).

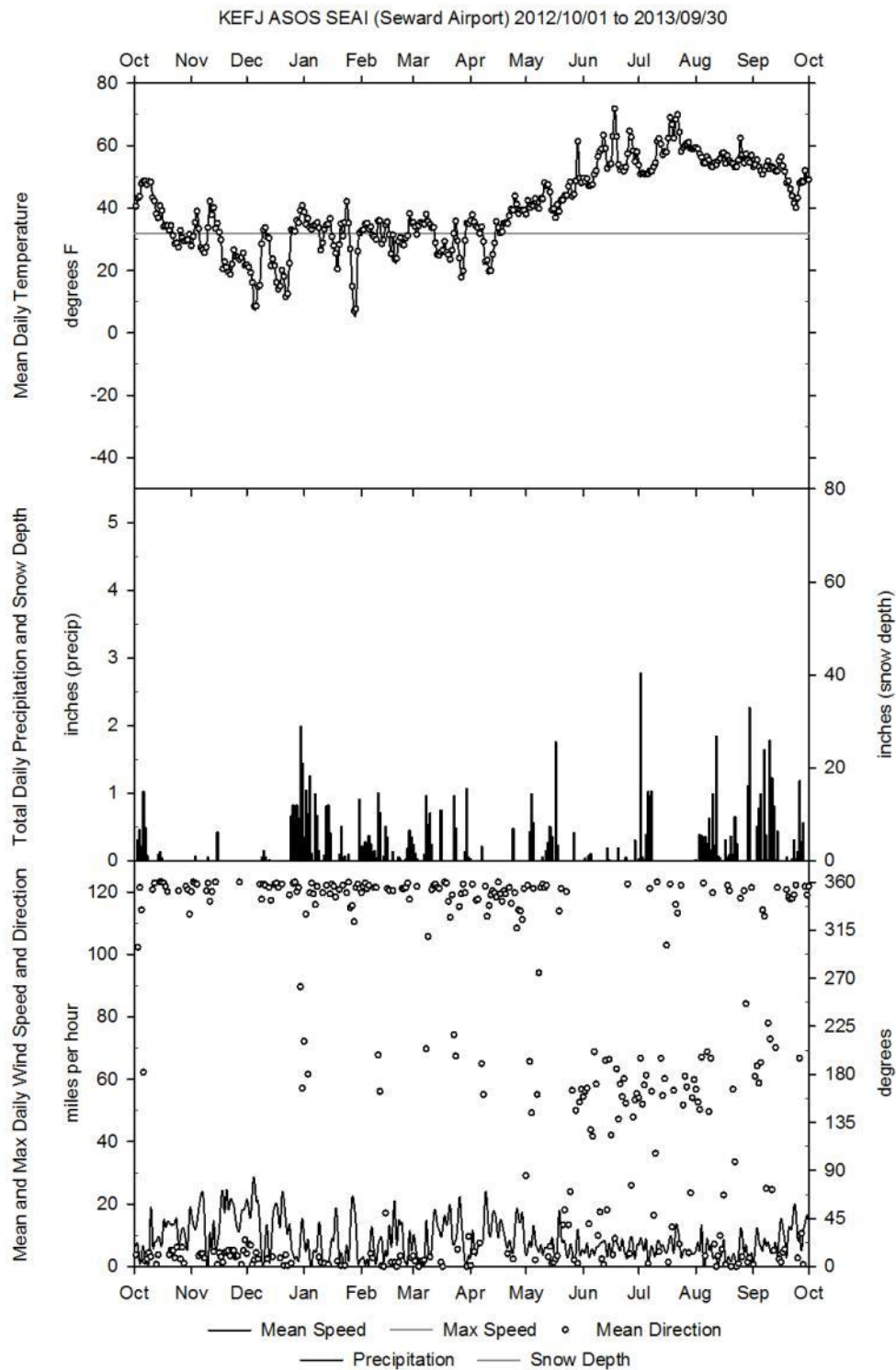
## Appendix 13-A Climate Graph for Homer Airport ASOS



## Appendix 13-B Climate Table for Homer Airport ASOS

| 2013 Hydrologic Year - KEFJ ASOS HOAI (Homer Airport) |      |      |      |      |      |      |      |      |      |      |      |      |       |
|-------------------------------------------------------|------|------|------|------|------|------|------|------|------|------|------|------|-------|
|                                                       | Oct  | Nov  | Dec  | Jan  | Feb  | Mar  | Apr  | May  | Jun  | Jul  | Aug  | Sep  | Year  |
| <b>Minimum air temperature (F)</b>                    |      |      |      |      |      |      |      |      |      |      |      |      |       |
| Min.                                                  | 18   | 9    | 2    | 2    | 12   | 8    | 13   | 28   | 37   | 44   | 43   | 31   | 2     |
| Max.                                                  | 52   | 36   | 38   | 39   | 36   | 36   | 39   | 45   | 54   | 56   | 59   | 56   | 59    |
| Mean                                                  | 30.9 | 19.8 | 18.0 | 25.6 | 26.8 | 24.9 | 24.8 | 36.5 | 46.0 | 50.5 | 51.6 | 45.3 | 33.4  |
| # days <32 F                                          | 17   | 27   | 24   | 24   | 23   | 24   | 26   | 7    | 0    | 0    | 0    | 1    | 173   |
| % valid obs                                           | 100  | 100  | 100  | 99   | 100  | 100  | 100  | 100  | 100  | 100  | 99   | 100  | 100   |
| <b>Maximum air temperature (F)</b>                    |      |      |      |      |      |      |      |      |      |      |      |      |       |
| Min                                                   | 30   | 21   | 14   | 13   | 27   | 20   | 21   | 42   | 52   | 53   | 55   | 47   | 13    |
| Max                                                   | 60   | 44   | 43   | 49   | 43   | 45   | 47   | 61   | 74   | 76   | 71   | 63   | 76    |
| Mean                                                  | 43.2 | 31.8 | 29.1 | 35.6 | 36.1 | 35.6 | 38.8 | 49.6 | 60.4 | 64.3 | 61.8 | 56.7 | 45.3  |
| # days <32 F                                          | 1    | 17   | 17   | 6    | 6    | 7    | 6    | 0    | 0    | 0    | 0    | 0    | 60    |
| % valid obs                                           | 100  | 100  | 100  | 99   | 100  | 100  | 100  | 100  | 100  | 100  | 99   | 100  | 100   |
| <b>Mean air temperature (F)</b>                       |      |      |      |      |      |      |      |      |      |      |      |      |       |
| Observed                                              | 37.0 | 25.9 | 23.6 | 31.0 | 31.8 | 30.7 | 32.5 | 43.5 | 53.8 | 57.7 | 56.8 | 51.3 | 39.7  |
| % valid obs                                           | 100  | 100  | 100  | 99   | 100  | 100  | 100  | 100  | 100  | 100  | 99   | 100  | 100   |
| POR mean<br>1981-2010                                 |      |      |      |      |      |      |      |      |      |      |      |      |       |
| <b>Precipitation</b>                                  |      |      |      |      |      |      |      |      |      |      |      |      |       |
| Total                                                 | 2.06 | 0.53 | 4.60 | 4.33 | 1.23 | 0.93 | 0.52 | 1.15 | 0.49 | 0.86 | 3.39 | 2.39 | 22.48 |
| % valid obs                                           | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100   |
| POR mean<br>1981-2010                                 |      |      |      |      |      |      |      |      |      |      |      |      |       |
| <b>Snow depth (in)</b>                                |      |      |      |      |      |      |      |      |      |      |      |      |       |
| Average                                               |      |      |      |      |      |      |      |      |      |      |      |      |       |
| % valid obs                                           |      |      |      |      |      |      |      |      |      |      |      |      |       |
| POR mean                                              |      |      |      |      |      |      |      |      |      |      |      |      |       |
| <b>Wind (mph, degrees)</b>                            |      |      |      |      |      |      |      |      |      |      |      |      |       |
| Mean speed                                            | 4.1  | 4.2  | 6.7  | 5.5  | 6.0  | 6.0  | 6.8  | 5.3  | 5.5  | 5.5  | 4.0  | 5.7  |       |
| % valid obs                                           | 99   | 100  | 100  | 100  | 100  | 97   | 100  | 100  | 99   | 100  | 100  | 99   |       |
| Max speed                                             |      |      |      |      |      |      |      |      |      |      |      |      |       |
| Max direction                                         |      |      |      |      |      |      |      |      |      |      |      |      |       |
| <b>Solar radiation (KWh/m2)</b>                       |      |      |      |      |      |      |      |      |      |      |      |      |       |
| Total                                                 |      |      |      |      |      |      |      |      |      |      |      |      |       |
| % valid obs                                           |      |      |      |      |      |      |      |      |      |      |      |      |       |

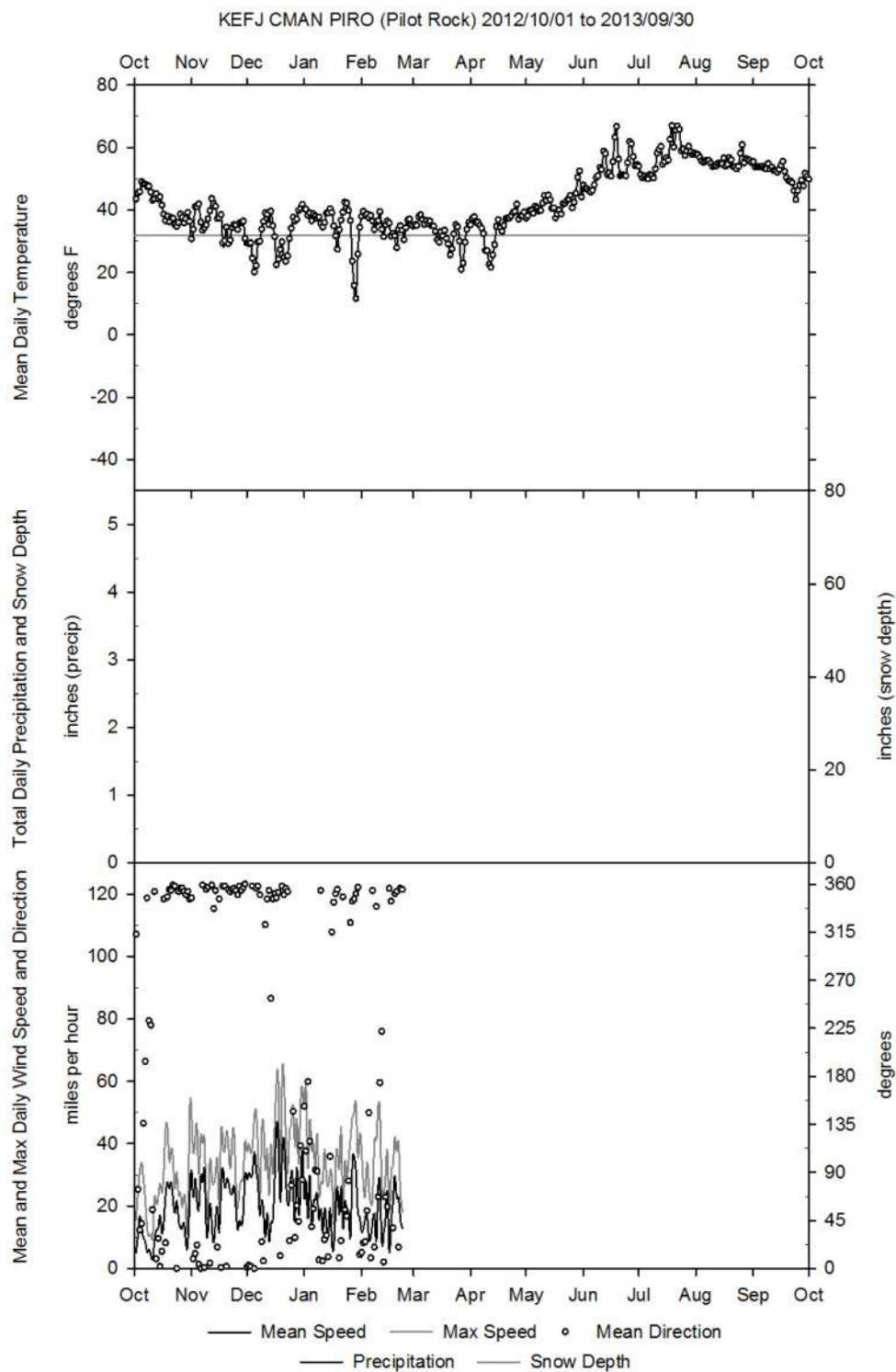
## Appendix 14-A Climate Graph for Seward Airport ASOS



## Appendix 14-B Climate Table for Seward Airport ASOS

| 2013 Hydrologic Year - KEFJ ASOS SEAI (Seward Airport) |      |      |      |      |      |      |      |      |      |      |       |       |       |
|--------------------------------------------------------|------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
|                                                        | Oct  | Nov  | Dec  | Jan  | Feb  | Mar  | Apr  | May  | Jun  | Jul  | Aug   | Sep   | Year  |
| <b>Minimum air temperature (F)</b>                     |      |      |      |      |      |      |      |      |      |      |       |       |       |
| Min.                                                   | 19   | 16   | 2    | 2    | 16   | 9    | 11   | 30   | 36   | 48   | 46    | 34    | 2     |
| Max.                                                   | 48   | 36   | 37   | 34   | 36   | 34   | 37   | 48   | 60   | 61   | 56    | 53    | 61    |
| Mean                                                   | 32.6 | 24.6 | 19.4 | 26.0 | 27.0 | 25.7 | 27.2 | 37.4 | 48.3 | 52.6 | 51.7  | 45.7  | 34.9  |
| # days <32 F                                           | 15   | 23   | 25   | 21   | 18   | 23   | 21   | 3    | 0    | 0    | 0     | 0     | 149   |
| % valid obs                                            | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100   | 100   | 100   |
| <b>Maximum air temperature (F)</b>                     |      |      |      |      |      |      |      |      |      |      |       |       |       |
| Min                                                    | 30   | 22   | 11   | 12   | 28   | 23   | 24   | 40   | 50   | 53   | 54    | 43    | 11    |
| Max                                                    | 54   | 45   | 46   | 45   | 41   | 41   | 51   | 80   | 88   | 80   | 69    | 64    | 88    |
| Mean                                                   | 43.3 | 31.7 | 28.1 | 33.7 | 36.0 | 34.7 | 39.6 | 51.0 | 63.5 | 64.6 | 59.7  | 54.6  | 45.1  |
| # days <32 F                                           | 1    | 17   | 17   | 6    | 2    | 6    | 5    | 0    | 0    | 0    | 0     | 0     | 54    |
| % valid obs                                            | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100   | 100   | 100   |
| <b>Mean air temperature (F)</b>                        |      |      |      |      |      |      |      |      |      |      |       |       |       |
| Observed                                               | 37.2 | 28.2 | 24.0 | 30.0 | 31.6 | 30.2 | 33.7 | 44.2 | 55.7 | 58.8 | 55.5  | 50.4  | 40.0  |
| % valid obs                                            | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100   | 100   | 100   |
| POR mean                                               |      |      |      |      |      |      |      |      |      |      |       |       |       |
| 1981-2010                                              |      |      |      |      |      |      |      |      |      |      |       |       |       |
| <b>Precipitation</b>                                   |      |      |      |      |      |      |      |      |      |      |       |       |       |
| Total                                                  | 2.84 | 0.55 | 7.10 | 8.97 | 5.66 | 6.14 | 0.69 | 5.74 | 1.02 | 6.28 | 10.72 | 11.20 | 66.91 |
| % valid obs                                            | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100   | 100   | 100   |
| POR mean                                               |      |      |      |      |      |      |      |      |      |      |       |       |       |
| 1981-2010                                              |      |      |      |      |      |      |      |      |      |      |       |       |       |
| <b>Snow depth (in)</b>                                 |      |      |      |      |      |      |      |      |      |      |       |       |       |
| Average                                                |      |      |      |      |      |      |      |      |      |      |       |       |       |
| % valid obs                                            |      |      |      |      |      |      |      |      |      |      |       |       |       |
| POR mean                                               |      |      |      |      |      |      |      |      |      |      |       |       |       |
| <b>Wind (mph, degrees)</b>                             |      |      |      |      |      |      |      |      |      |      |       |       |       |
| Mean speed                                             | 9.6  | 15.3 | 12.7 | 6.6  | 7.2  | 9.2  | 11.2 | 6.6  | 6.1  | 6.1  | 4.4   | 9.6   |       |
| % valid obs                                            | 100  | 100  | 100  | 99   | 100  | 99   | 100  | 100  | 100  | 99   | 99    | 100   |       |
| Max speed                                              |      |      |      |      |      |      |      |      |      |      |       |       |       |
| Max direction                                          |      |      |      |      |      |      |      |      |      |      |       |       |       |
| <b>Solar radiation (KWh/m2)</b>                        |      |      |      |      |      |      |      |      |      |      |       |       |       |
| Total                                                  |      |      |      |      |      |      |      |      |      |      |       |       |       |
| % valid obs                                            |      |      |      |      |      |      |      |      |      |      |       |       |       |

## Appendix 15-A Climate Graph for Pilot Rock CMAN

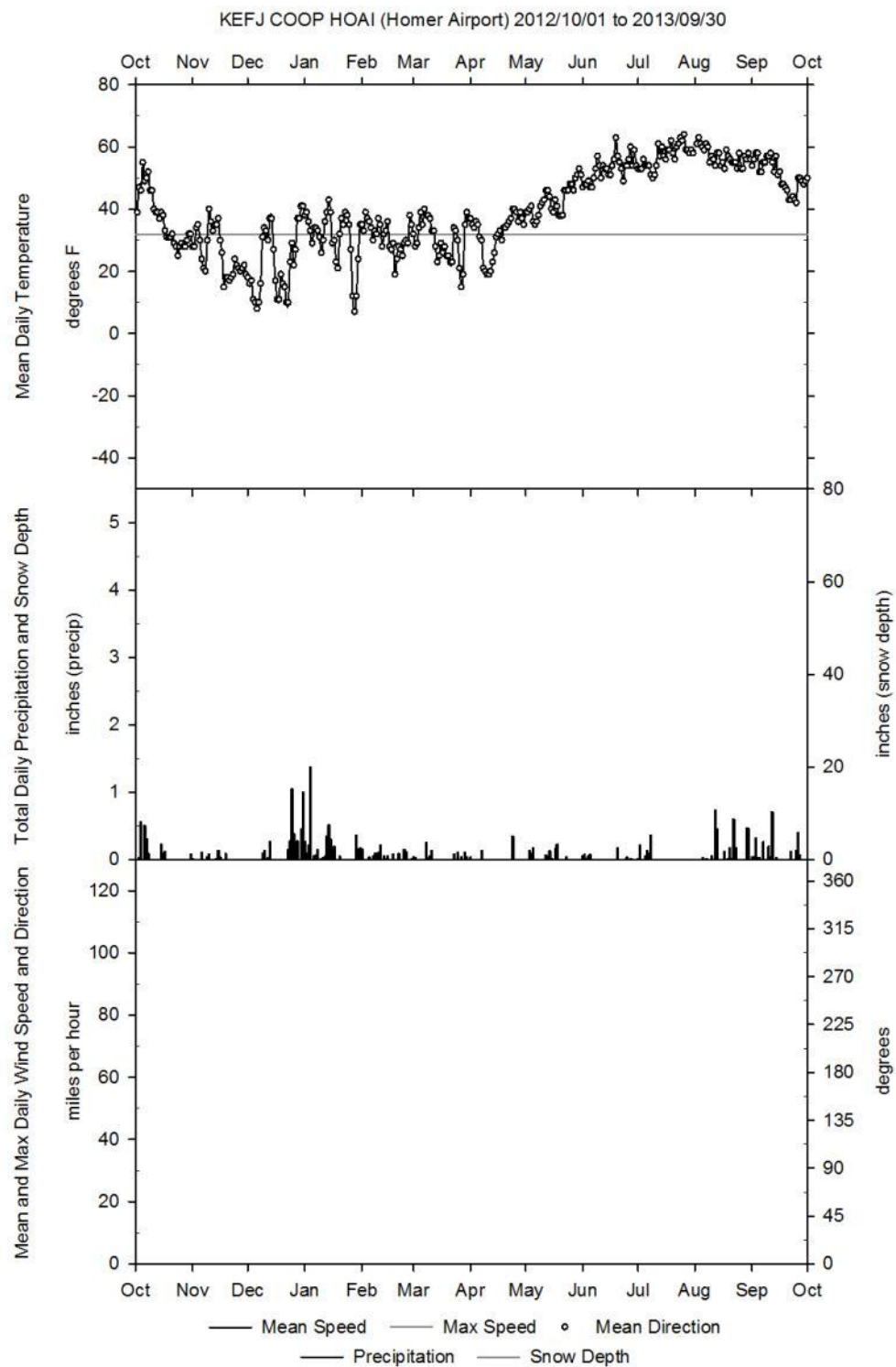


## Appendix 15-B Climate Table for Pilot Rock CMAN

| 2013 Hydrologic Year - KEFJ CMAN PIRO (Pilot Rock) |      |      |      |      |      |      |      |      |      |      |      |      |      |
|----------------------------------------------------|------|------|------|------|------|------|------|------|------|------|------|------|------|
|                                                    | Oct  | Nov  | Dec  | Jan  | Feb  | Mar  | Apr  | May  | Jun  | Jul  | Aug  | Sep  | Year |
| <b>Minimum air temperature (F)</b>                 |      |      |      |      |      |      |      |      |      |      |      |      |      |
| Min.                                               | 28.8 | 25.2 | 18.0 | 8.2  | 24.6 | 19.4 | 19.6 | 33.3 | 44.1 | 47.8 | 51.8 | 38.3 | 8.2  |
| Max.                                               | 47.1 | 41.7 | 38.5 | 39.9 | 37.0 | 36.1 | 39.0 | 46.0 | 58.6 | 61.7 | 56.8 | 53.1 | 61.7 |
| Mean                                               | 38.6 | 33.1 | 29.4 | 31.9 | 32.6 | 30.1 | 31.7 | 39.9 | 50.8 | 55.0 | 53.6 | 49.0 | 39.7 |
| # days <32 F                                       | 2    | 10   | 18   | 9    | 8    | 15   | 10   | 0    | 0    | 0    | 0    | 0    | 72   |
| % valid obs                                        | 100  | 100  | 100  | 99   | 98   | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  |
| <b>Maximum air temperature (F)</b>                 |      |      |      |      |      |      |      |      |      |      |      |      |      |
| Min                                                | 33.1 | 31.1 | 22.6 | 18.3 | 32.2 | 24.3 | 23.9 | 40.5 | 47.1 | 50.7 | 54.0 | 45.3 | 18.3 |
| Max                                                | 51.3 | 45.7 | 44.2 | 44.8 | 42.8 | 39.6 | 46.8 | 66.9 | 74.5 | 72.7 | 66.2 | 59.0 | 74.5 |
| Mean                                               | 43.5 | 38.9 | 35.0 | 37.8 | 37.9 | 35.2 | 37.9 | 45.7 | 57.0 | 60.5 | 57.8 | 54.0 | 45.1 |
| # days <32 F                                       | 0    | 1    | 11   | 4    | 0    | 5    | 5    | 0    | 0    | 0    | 0    | 0    | 26   |
| % valid obs                                        | 100  | 100  | 100  | 99   | 98   | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  |
| <b>Mean air temperature (F)</b>                    |      |      |      |      |      |      |      |      |      |      |      |      |      |
| Observed                                           | 40.9 | 35.8 | 31.9 | 34.9 | 35.1 | 32.6 | 34.5 | 42.2 | 53.4 | 57.2 | 55.5 | 51.3 | 42.2 |
| % valid obs                                        | 100  | 100  | 100  | 99   | 98   | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  |
| POR mean                                           |      |      |      |      |      |      |      |      |      |      |      |      |      |
| 1981-2010                                          |      |      |      |      |      |      |      |      |      |      |      |      |      |
| <b>Precipitation</b>                               |      |      |      |      |      |      |      |      |      |      |      |      |      |
| Total                                              |      |      |      |      |      |      |      |      |      |      |      |      |      |
| % valid obs                                        |      |      |      |      |      |      |      |      |      |      |      |      |      |
| POR mean                                           |      |      |      |      |      |      |      |      |      |      |      |      |      |
| 1981-2010                                          |      |      |      |      |      |      |      |      |      |      |      |      |      |
| <b>Snow depth (in)</b>                             |      |      |      |      |      |      |      |      |      |      |      |      |      |
| Average                                            |      |      |      |      |      |      |      |      |      |      |      |      |      |
| % valid obs                                        |      |      |      |      |      |      |      |      |      |      |      |      |      |
| POR mean                                           |      |      |      |      |      |      |      |      |      |      |      |      |      |
| <b>Wind (mph, degrees)</b>                         |      |      |      |      |      |      |      |      |      |      |      |      |      |
| Mean speed                                         | 14.6 | 21.7 | 25.9 | 19.2 | 16.6 |      |      |      |      |      |      |      |      |
| % valid obs                                        | 100  | 100  | 100  | 99   | 75   | 0    | 0    | 0    | 0    | 0    | 0    | 0    |      |
| Max speed                                          | 50.1 | 45.4 | 60.8 | 58.2 | 51.7 |      |      |      |      |      |      |      | 60.8 |
| Max direction                                      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| <b>Solar radiation (KWh/m2)</b>                    |      |      |      |      |      |      |      |      |      |      |      |      |      |
| Total                                              |      |      |      |      |      |      |      |      |      |      |      |      |      |
| % valid obs                                        |      |      |      |      |      |      |      |      |      |      |      |      |      |

Station stopped reporting wind data on 02/22/2013.

## Appendix 16-A Climate Graph for Homer Airport COOP

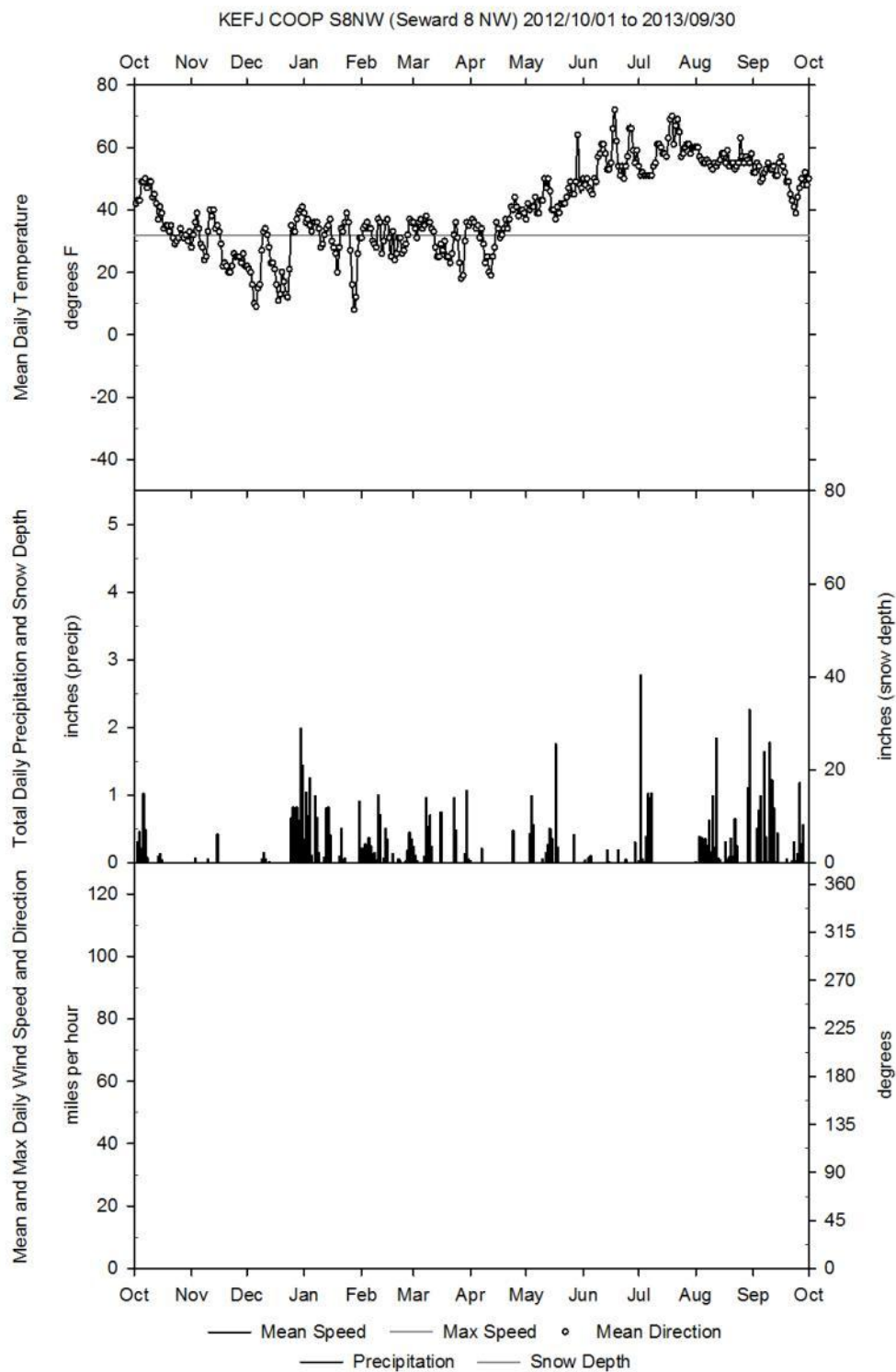


## Appendix 16-B Climate Table for Homer Airport COOP

| 2013 Hydrologic Year - KEFJ COOP HOAI (Homer Airport) |      |      |      |      |      |      |      |      |      |      |      |      |       |
|-------------------------------------------------------|------|------|------|------|------|------|------|------|------|------|------|------|-------|
|                                                       | Oct  | Nov  | Dec  | Jan  | Feb  | Mar  | Apr  | May  | Jun  | Jul  | Aug  | Sep  | Year  |
| <b>Minimum air temperature (F)</b>                    |      |      |      |      |      |      |      |      |      |      |      |      |       |
| Min.                                                  | 14   | 8    | -1   | 2    | 11   | 6    | 12   | 27   | 37   | 42   | 41   | 29   | -1    |
| Max.                                                  | 50   | 36   | 38   | 38   | 33   | 35   | 38   | 43   | 53   | 56   | 58   | 54   | 58    |
| Mean                                                  | 29.9 | 18.8 | 16.7 | 25.0 | 25.9 | 24.1 | 23.9 | 35.5 | 44.9 | 49.4 | 50.7 | 44.3 | 32.4  |
| # days <32 F                                          | 19   | 27   | 25   | 24   | 25   | 25   | 27   | 8    | 0    | 0    | 0    | 1    | 181   |
| % valid obs                                           | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 97   | 100  | 100  | 100   |
| <b>Maximum air temperature (F)</b>                    |      |      |      |      |      |      |      |      |      |      |      |      |       |
| Min                                                   | 31   | 22   | 14   | 13   | 28   | 21   | 22   | 43   | 53   | 54   | 56   | 47   | 13    |
| Max                                                   | 60   | 45   | 45   | 49   | 44   | 46   | 48   | 62   | 74   | 76   | 72   | 64   | 76    |
| Mean                                                  | 43.6 | 32.3 | 29.9 | 36.3 | 36.8 | 36.2 | 39.4 | 50.6 | 61.4 | 65.2 | 62.6 | 57.4 | 46.0  |
| # days <32 F                                          | 1    | 17   | 16   | 6    | 6    | 6    | 6    | 0    | 0    | 0    | 0    | 0    | 58    |
| % valid obs                                           | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100   |
| <b>Mean air temperature (F)</b>                       |      |      |      |      |      |      |      |      |      |      |      |      |       |
| Observed                                              | 36.7 | 25.5 | 23.3 | 30.7 | 31.3 | 30.3 | 31.9 | 43.1 | 53.2 | 57.3 | 56.8 | 50.8 | 39.2  |
| % valid obs                                           | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 97   | 100  | 100  | 100   |
| POR mean <sup>1</sup>                                 | 37.9 | 28.9 | 24.1 | 22.8 | 25.6 | 28.4 | 36.0 | 43.2 | 49.6 | 53.6 | 53.3 | 47.6 | 37.6  |
| 1981-2010                                             | 38.1 | 29.5 | 27.1 | 24.8 | 26.2 | 29.9 | 37.0 | 44.5 | 50.6 | 54.6 | 53.9 | 48.1 | 38.7  |
| <b>Precipitation</b>                                  |      |      |      |      |      |      |      |      |      |      |      |      |       |
| Total                                                 | 2.06 | 0.53 | 4.61 | 4.34 | 1.23 | 0.94 | 0.53 | 1.15 | 0.49 | 0.86 | 3.39 | 2.39 | 22.51 |
| % valid obs                                           | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100   |
| POR mean <sup>1</sup>                                 | 3.13 | 2.74 | 2.83 | 2.22 | 1.81 | 1.52 | 1.20 | 0.97 | 0.96 | 1.56 | 2.46 | 3.06 | 24.47 |
| 1981-2010                                             | 2.57 | 2.79 | 3.08 | 2.63 | 1.71 | 1.65 | 1.07 | 0.82 | 0.82 | 1.56 | 2.34 | 3.31 | 24.32 |
| <b>Snow depth (in)</b>                                |      |      |      |      |      |      |      |      |      |      |      |      |       |
| Average                                               |      |      |      |      |      |      |      |      |      |      |      |      |       |
| % valid obs                                           |      |      |      |      |      |      |      |      |      |      |      |      |       |
| POR mean <sup>1</sup>                                 | 0    | 1    | 4    | 4    | 5    | 5    | 2    | 0    | 0    | 0    | 0    | 0    |       |
| <b>Wind (mph, degrees)</b>                            |      |      |      |      |      |      |      |      |      |      |      |      |       |
| Mean speed                                            |      |      |      |      |      |      |      |      |      |      |      |      |       |
| % valid obs                                           |      |      |      |      |      |      |      |      |      |      |      |      |       |
| Max speed                                             |      |      |      |      |      |      |      |      |      |      |      |      |       |
| Max direction                                         |      |      |      |      |      |      |      |      |      |      |      |      |       |
| <b>Solar radiation (KWh/m2)</b>                       |      |      |      |      |      |      |      |      |      |      |      |      |       |
| Total                                                 |      |      |      |      |      |      |      |      |      |      |      |      |       |
| % valid obs                                           |      |      |      |      |      |      |      |      |      |      |      |      |       |

<sup>1</sup>Period of record used: 09/01/1932 to 09/30/2012

## Appendix 17-A Climate Graph for Seward 8 NW COOP

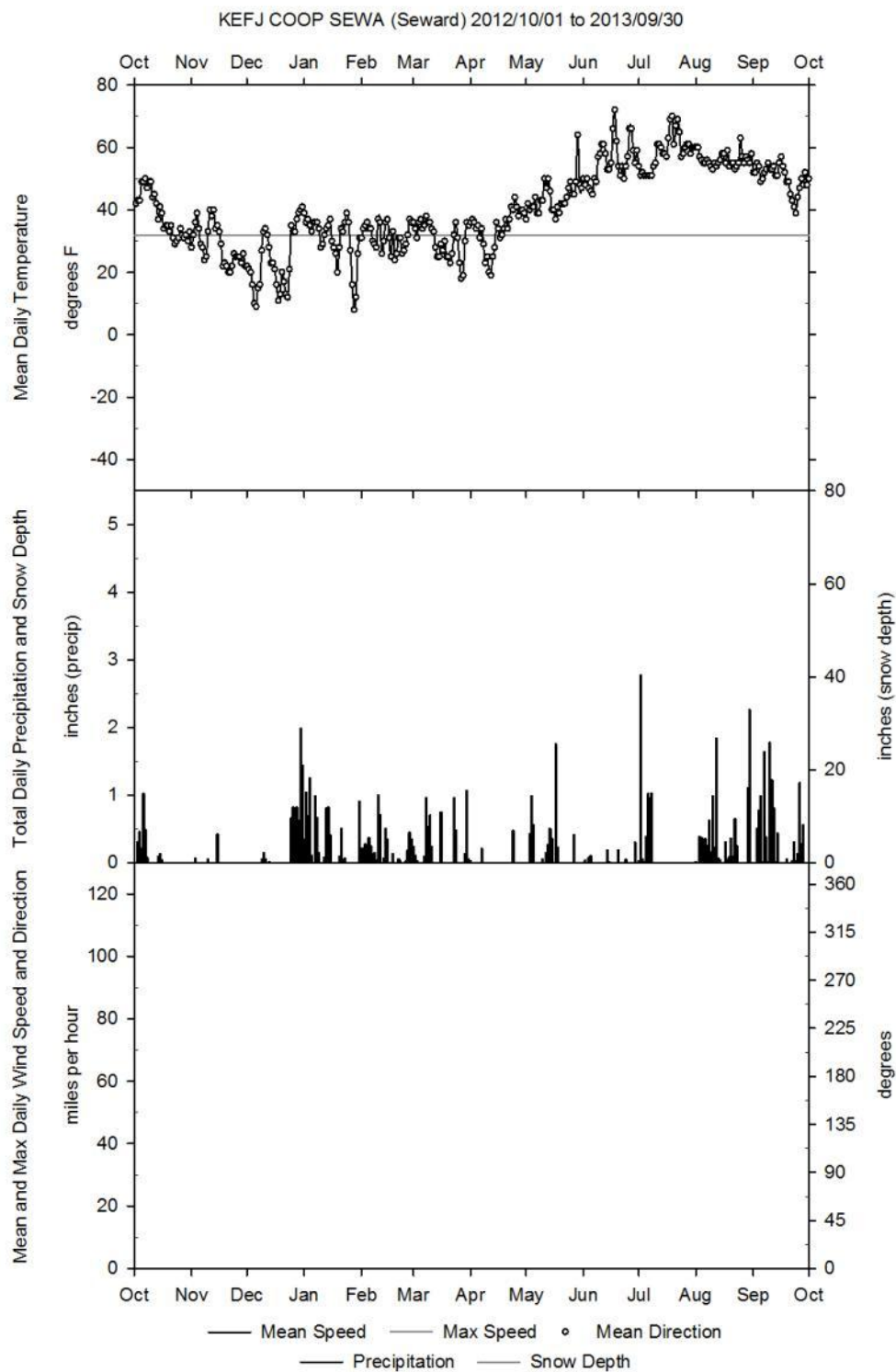


## Appendix 17-B Climate Table for Seward 8 NW COOP

| 2013 Hydrologic Year - KEFJ COOP S8NW (Seward 8 NW) |       |      |      |       |      |      |      |      |      |      |       |      |       |
|-----------------------------------------------------|-------|------|------|-------|------|------|------|------|------|------|-------|------|-------|
|                                                     | Oct   | Nov  | Dec  | Jan   | Feb  | Mar  | Apr  | May  | Jun  | Jul  | Aug   | Sep  | Year  |
| <b>Minimum air temperature (F)</b>                  |       |      |      |       |      |      |      |      |      |      |       |      |       |
| Min.                                                | 3     | -9   | -18  | -13   | -5   | -15  | -6   | 18   | 28   | 35   | 31    | 23   | -18   |
| Max.                                                | 42    | 31   | 32   | 32    | 31   | 32   | 21   | 35   | 58   | 54   | 49    | 45   | 58    |
| Mean                                                | 21.5  | 8.4  | 5.8  | 19.6  | 19.4 | 13.4 | 11.2 | 27.0 | 38.4 | 43.4 | 42.3  | 35.9 | 24.0  |
| # days <32 F                                        | 23    | 30   | 28   | 28    | 28   | 28   | 17   | 8    | 4    | 0    | 1     | 7    | 202   |
| % valid obs                                         | 100   | 100  | 97   | 100   | 100  | 94   | 57   | 39   | 93   | 100  | 100   | 77   | 88    |
| <b>Maximum air temperature (F)</b>                  |       |      |      |       |      |      |      |      |      |      |       |      |       |
| Min                                                 | 29    | 3    | -7   | 6     | 24   | 21   | 31   | 46   | 53   | 52   | 55    | 46   | -7    |
| Max                                                 | 53    | 37   | 44   | 42    | 40   | 45   | 50   | 76   | 85   | 82   | 70    | 63   | 85    |
| Mean                                                | 40.0  | 23.3 | 20.8 | 32.0  | 34.5 | 35.6 | 41.6 | 58.6 | 70.0 | 70.8 | 62.5  | 55.0 | 44.8  |
| # days <32 F                                        | 6     | 20   | 17   | 10    | 2    | 6    | 1    | 0    | 0    | 0    | 0     | 0    | 62    |
| % valid obs                                         | 100   | 100  | 97   | 100   | 100  | 94   | 57   | 39   | 100  | 100  | 100   | 77   | 89    |
| <b>Mean air temperature (F)</b>                     |       |      |      |       |      |      |      |      |      |      |       |      |       |
| Observed                                            | 30.7  | 15.9 | 13.2 | 25.7  | 27.0 | 24.6 | 26.4 | 42.8 | 53.9 | 57.1 | 52.5  | 45.4 | 34.3  |
| % valid obs                                         | 100   | 100  | 97   | 100   | 100  | 94   | 57   | 39   | 93   | 100  | 100   | 77   | 88    |
| POR mean <sup>1</sup>                               | 34.8  | 23.0 | 19.0 | 18.7  | 21.8 | 27.5 | 35.4 | 43.8 | 51.2 | 55.0 | 53.0  | 46.1 | 35.8  |
| 1981-2010                                           | 34.9  | 22.9 | 20.2 | 17.7  | 21.9 | 27.3 | 35.7 | 44.2 | 51.4 | 55.1 | 53.2  | 46.1 | 36.0  |
| <b>Precipitation</b>                                |       |      |      |       |      |      |      |      |      |      |       |      |       |
| Total                                               | 3.11  | 2.00 | 9.47 | 11.78 | 8.96 | 4.60 | 0.05 | 2.73 | 0.44 | 2.81 | 12.52 | 7.99 | 66.47 |
| % valid obs                                         | 100   | 100  | 97   | 100   | 100  | 94   | 50   | 39   | 100  | 100  | 100   | 73   | 88    |
| POR mean <sup>1</sup>                               | 10.53 | 5.87 | 8.77 | 6.99  | 5.90 | 4.62 | 3.97 | 3.31 | 2.48 | 2.83 | 6.43  | 9.06 | 70.76 |
| 1981-2010                                           | 9.34  | 5.75 | 8.96 | 6.97  | 5.24 | 5.16 | 4.16 | 2.97 | 2.10 | 2.67 | 5.66  | 8.43 | 67.41 |
| <b>Snow depth (in)</b>                              |       |      |      |       |      |      |      |      |      |      |       |      |       |
| Average                                             | 0     | 5    | 19   | 33    | 51   | 62   | 65   | 38   | 0    | 0    | 0     | 0    |       |
| % valid obs                                         | 100   | 97   | 74   | 100   | 100  | 90   | 57   | 23   | 100  | 100  | 100   | 77   |       |
| POR mean <sup>1</sup>                               | 1     | 8    | 23   | 36    | 49   | 56   | 48   | 12   | 0    | 0    | 0     | 0    |       |
| <b>Wind (mph, degrees)</b>                          |       |      |      |       |      |      |      |      |      |      |       |      |       |
| Mean speed                                          |       |      |      |       |      |      |      |      |      |      |       |      |       |
| % valid obs                                         |       |      |      |       |      |      |      |      |      |      |       |      |       |
| Max speed                                           |       |      |      |       |      |      |      |      |      |      |       |      |       |
| Max direction                                       |       |      |      |       |      |      |      |      |      |      |       |      |       |
| <b>Solar radiation (KWh/m2)</b>                     |       |      |      |       |      |      |      |      |      |      |       |      |       |
| Total                                               |       |      |      |       |      |      |      |      |      |      |       |      |       |
| % valid obs                                         |       |      |      |       |      |      |      |      |      |      |       |      |       |

<sup>1</sup>Period of record used: 07/01/1983 to 09/30/2012

## Appendix 18-A Climate Graph for Seward COOP

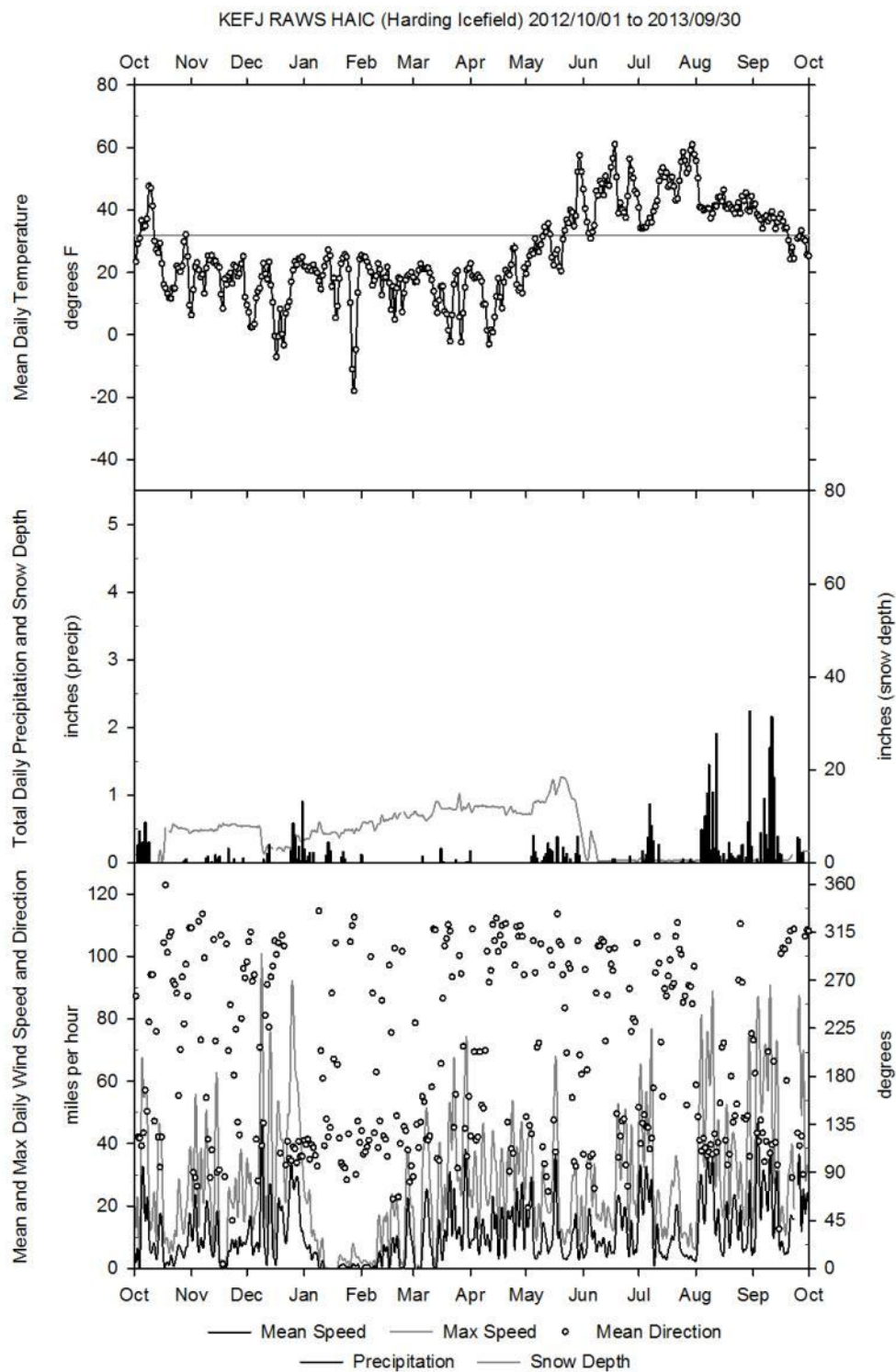


## Appendix 18-B Climate Table for Seward COOP

| 2013 Hydrologic Year - KEFJ COOP SEWA (Seward) |      |      |      |      |      |      |      |      |      |      |       |       |       |
|------------------------------------------------|------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
|                                                | Oct  | Nov  | Dec  | Jan  | Feb  | Mar  | Apr  | May  | Jun  | Jul  | Aug   | Sep   | Year  |
| <b>Minimum air temperature (F)</b>             |      |      |      |      |      |      |      |      |      |      |       |       |       |
| Min.                                           | 19   | 15   | 1    | 2    | 16   | 8    | 10   | 30   | 35   | 47   | 44    | 34    | 1     |
| Max.                                           | 47   | 35   | 36   | 34   | 34   | 34   | 36   | 47   | 56   | 60   | 56    | 52    | 60    |
| Mean                                           | 32.3 | 23.9 | 18.9 | 25.6 | 26.3 | 25.2 | 26.8 | 36.8 | 47.2 | 52.2 | 50.9  | 45.2  | 34.3  |
| # days <32 F                                   | 16   | 26   | 25   | 21   | 19   | 24   | 23   | 4    | 0    | 0    | 0     | 0     | 158   |
| % valid obs                                    | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100   | 100   | 100   |
| <b>Maximum air temperature (F)</b>             |      |      |      |      |      |      |      |      |      |      |       |       |       |
| Min                                            | 30   | 22   | 12   | 12   | 29   | 23   | 25   | 40   | 51   | 53   | 55    | 43    | 12    |
| Max                                            | 54   | 46   | 47   | 45   | 44   | 42   | 51   | 80   | 88   | 81   | 69    | 65    | 88    |
| Mean                                           | 43.8 | 32.3 | 28.9 | 34.4 | 36.5 | 35.1 | 40.1 | 51.7 | 64.1 | 65.3 | 60.5  | 55.1  | 45.7  |
| # days <32 F                                   | 1    | 16   | 17   | 6    | 2    | 6    | 5    | 0    | 0    | 0    | 0     | 0     | 53    |
| % valid obs                                    | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100   | 100   | 100   |
| <b>Mean air temperature (F)</b>                |      |      |      |      |      |      |      |      |      |      |       |       |       |
| Observed                                       | 38.1 | 28.4 | 24.1 | 30.3 | 31.6 | 30.4 | 33.7 | 44.4 | 55.7 | 58.7 | 55.8  | 50.2  | 40.2  |
| % valid obs                                    | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100   | 100   | 100   |
| POR mean <sup>1</sup>                          | 39.6 | 31.0 | 26.6 | 25.0 | 27.5 | 31.0 | 38.1 | 45.5 | 51.8 | 56.1 | 55.7  | 49.4  | 39.8  |
| 1981-2010                                      | 39.6 | 30.9 | 28.9 | 27.1 | 28.3 | 32.1 | 38.7 | 46.4 | 52.2 | 56.0 | 55.7  | 49.5  | 40.5  |
| <b>Precipitation</b>                           |      |      |      |      |      |      |      |      |      |      |       |       |       |
| Total                                          | 2.84 | 0.55 | 7.09 | 8.88 | 5.67 | 6.15 | 0.69 | 5.74 | 1.02 | 6.28 | 10.72 | 11.22 | 66.85 |
| % valid obs                                    | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100   | 100   | 100   |
| POR mean <sup>1</sup>                          | 9.99 | 7.10 | 7.58 | 6.13 | 5.78 | 3.73 | 4.03 | 3.88 | 2.27 | 2.63 | 5.19  | 10.42 | 68.72 |
| 1981-2010                                      | 9.35 | 7.31 | 9.54 | 8.07 | 6.05 | 4.42 | 4.52 | 3.37 | 2.42 | 2.80 | 5.61  | 9.86  | 73.32 |
| <b>Snow depth (in)</b>                         |      |      |      |      |      |      |      |      |      |      |       |       |       |
| Average                                        |      |      |      |      |      |      |      |      |      |      |       |       |       |
| % valid obs                                    |      |      |      |      |      |      |      |      |      |      |       |       |       |
| POR mean <sup>1</sup>                          | 0    | 1    | 4    | 6    | 8    | 7    | 2    | 0    | 0    | 0    | 0     | 0     |       |
| <b>Wind (mph, degrees)</b>                     |      |      |      |      |      |      |      |      |      |      |       |       |       |
| Mean speed                                     |      |      |      |      |      |      |      |      |      |      |       |       |       |
| % valid obs                                    |      |      |      |      |      |      |      |      |      |      |       |       |       |
| Max speed                                      |      |      |      |      |      |      |      |      |      |      |       |       |       |
| Max direction                                  |      |      |      |      |      |      |      |      |      |      |       |       |       |
| <b>Solar radiation (KWh/m2)</b>                |      |      |      |      |      |      |      |      |      |      |       |       |       |
| Total                                          |      |      |      |      |      |      |      |      |      |      |       |       |       |
| % valid obs                                    |      |      |      |      |      |      |      |      |      |      |       |       |       |

<sup>1</sup>Period of record used: 09/01/1949 to 09/30/2012. Values cited are from <http://www.wrcc.dri.edu/cgi-bin/cliMAIN.pl?ak8371> (current Feb 11, 2014). All other summary data are derived from data acquired from the GHCN-Daily database for Station ID# USW00026438. Note that GHCN-Daily records for USW00026438 are integrated (mingled) records for stations with WBAN# 26438. These stations include 'Seward', which reportedly ceased operation on (07/24/2010, NOAA Multi-Network Metadata System), and 'Seward Airport'.

## Appendix 19-A Climate Graph for Harding Icefield RAWS

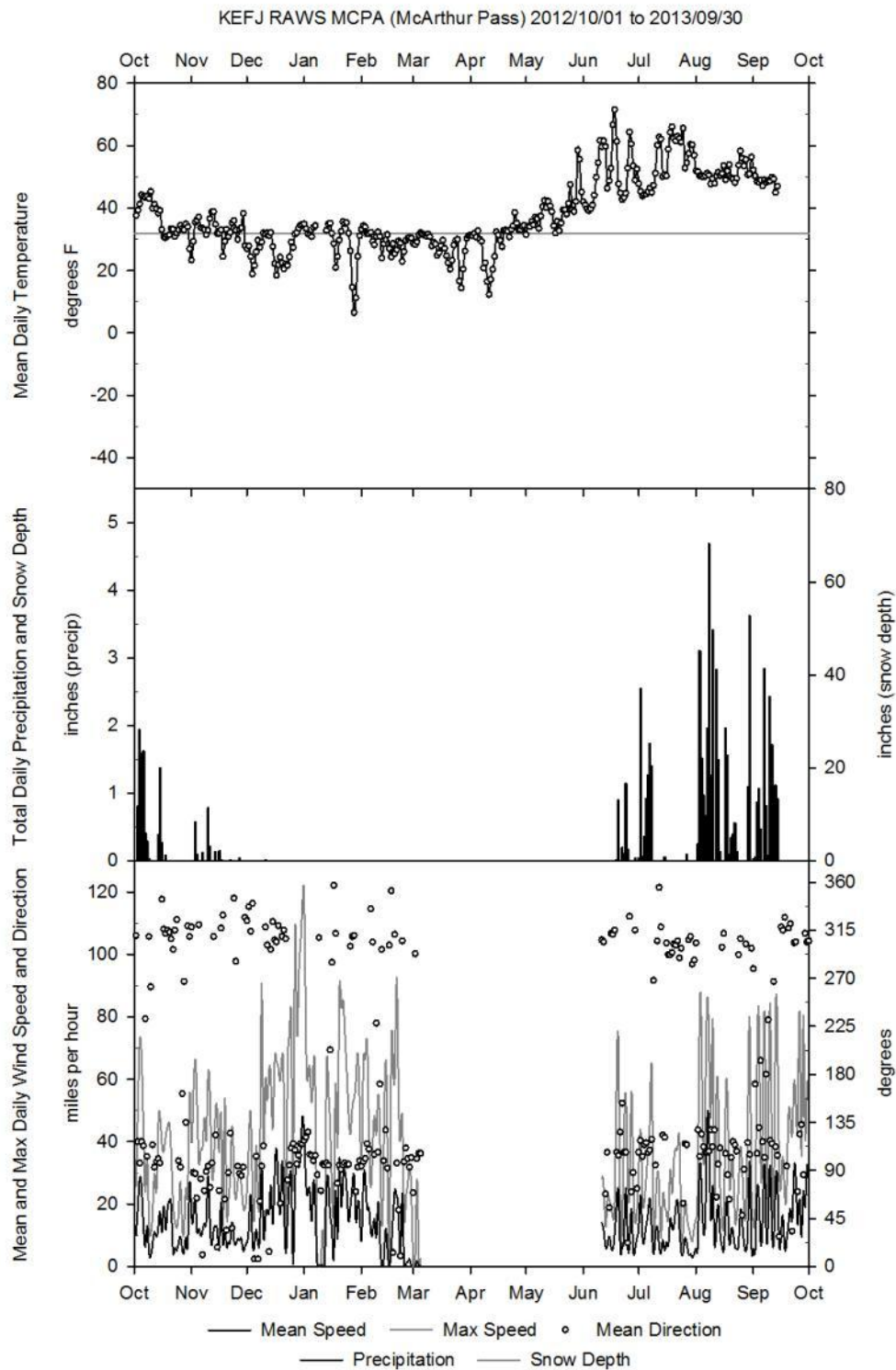


## Appendix 19-B Climate Table for Harding Icefield RAWS

| 2013 Hydrologic Year - KEFJ RAWS HAIC (Harding Icefield) |      |      |       |       |      |      |       |       |       |       |       |      |        |
|----------------------------------------------------------|------|------|-------|-------|------|------|-------|-------|-------|-------|-------|------|--------|
|                                                          | Oct  | Nov  | Dec   | Jan   | Feb  | Mar  | Apr   | May   | Jun   | Jul   | Aug   | Sep  | Year   |
| <b>Minimum air temperature (F)</b>                       |      |      |       |       |      |      |       |       |       |       |       |      |        |
| Min.                                                     | 2.5  | 3.0  | -9.0  | -21.3 | 1.2  | -8.7 | -9.2  | 14.2  | 25.0  | 31.6  | 34.2  | 19.2 | -21.3  |
| Max.                                                     | 42.1 | 22.6 | 23.0  | 25.2  | 23.4 | 21.4 | 25.2  | 49.5  | 56.5  | 54.1  | 41.2  | 38.1 | 56.5   |
| Mean                                                     | 20.8 | 14.9 | 8.5   | 12.9  | 13.9 | 9.9  | 9.0   | 26.8  | 39.0  | 42.9  | 38.4  | 30.9 | 22.4   |
| # days <32 F                                             | 26   | 30   | 31    | 31    | 28   | 31   | 30    | 26    | 5     | 1     | 0     | 12   | 251    |
| % valid obs                                              | 100  | 100  | 100   | 100   | 100  | 100  | 97    | 94    | 99    | 100   | 100   | 90   | 98     |
| <b>Maximum air temperature (F)</b>                       |      |      |       |       |      |      |       |       |       |       |       |      |        |
| Min                                                      | 12.0 | 14.4 | -5.3  | -13.5 | 9.3  | 2.3  | 6.3   | 22.3  | 35.1  | 35.2  | 40.3  | 24.8 | -13.5  |
| Max                                                      | 52.5 | 30.4 | 30.0  | 31.5  | 27.0 | 36.9 | 41.5  | 72.9  | 72.1  | 67.8  | 58.8  | 47.5 | 72.9   |
| Mean                                                     | 30.4 | 23.5 | 17.0  | 20.4  | 20.9 | 20.0 | 23.0  | 42.7  | 52.4  | 53.0  | 45.7  | 37.4 | 32.3   |
| # days <32 F                                             | 18   | 30   | 31    | 31    | 28   | 30   | 24    | 9     | 0     | 0     | 0     | 6    | 207    |
| % valid obs                                              | 100  | 100  | 100   | 100   | 100  | 100  | 97    | 94    | 99    | 100   | 100   | 90   | 98     |
| <b>Mean air temperature (F)</b>                          |      |      |       |       |      |      |       |       |       |       |       |      |        |
| Observed                                                 | 25.3 | 19.3 | 12.5  | 16.8  | 17.6 | 14.1 | 14.5  | 33.5  | 44.9  | 47.3  | 41.6  | 34.2 | 26.8   |
| % valid obs                                              | 100  | 100  | 100   | 100   | 100  | 100  | 97    | 94    | 99    | 100   | 100   | 91   | 98     |
| POR mean<br>1981-2010                                    |      |      |       |       |      |      |       |       |       |       |       |      |        |
| <b>Precipitation</b>                                     |      |      |       |       |      |      |       |       |       |       |       |      |        |
| Total <sup>2</sup>                                       | 2.39 | 0.80 | 3.03  | 1.43  | 0.01 | 0.58 | 0.01  | 3.16  | 0.22  | 2.86  | 11.75 | 8.89 | 35.13  |
| % valid obs                                              | 100  | 100  | 100   | 100   | 100  | 100  | 97    | 94    | 99    | 100   | 100   | 91   | 98     |
| POR mean<br>1981-2010                                    |      |      |       |       |      |      |       |       |       |       |       |      |        |
| <b>Snow depth (in)</b>                                   |      |      |       |       |      |      |       |       |       |       |       |      |        |
| Average                                                  | 3.9  | 7.6  | 4.9   | 6.7   | 9.4  | 11.4 | 11.6  | 13.4  | 1.1   | 0.5   | 0.6   | 1.0  |        |
| % valid obs                                              | 89   | 100  | 89    | 92    | 91   | 96   | 97    | 93    | 97    | 97    | 95    | 71   |        |
| POR mean                                                 |      |      |       |       |      |      |       |       |       |       |       |      |        |
| <b>Wind (mph, degrees)</b>                               |      |      |       |       |      |      |       |       |       |       |       |      |        |
| Mean speed                                               | 8.3  | 8.5  | 16.0  | 1.7   | 4.6  | 11.6 | 13.1  | 10.3  | 10.6  | 11.0  | 16.7  | 20.4 |        |
| % valid obs                                              | 100  | 100  | 100   | 100   | 100  | 100  | 97    | 94    | 99    | 100   | 100   | 91   |        |
| Max speed                                                | 62.9 | 56.6 | 100.9 | 24.4  | 38.3 | 71.8 | 51.5  | 68.0  | 51.9  | 75.8  | 88.4  | 90.6 | 100.9  |
| Max direction                                            | 98   | 103  | 117   | 86    | 122  | 114  | 107   | 109   | 99    | 103   | 103   | 102  | 117    |
| <b>Solar radiation (KWh/m2)</b>                          |      |      |       |       |      |      |       |       |       |       |       |      |        |
| Total                                                    | 47.7 | 10.5 | 4.8   | 9.7   | 26.8 | 86.8 | 178.2 | 239.4 | 263.3 | 246.7 | 130.5 | 0.1  | 1244.4 |
| % valid obs                                              | 100  | 100  | 100   | 100   | 100  | 100  | 97    | 94    | 99    | 100   | 100   | 1    | 91     |

<sup>2</sup>A displacement precipitation gauge (filled with an antifreeze solution) is used at the Harding Icefield RAWS. By design, this gauge is capable of accurately measuring winter-time precipitation. In reality, undercatch (the difference between the actual amount of snow and the amount measured by a precipitation gauge) is a significant problem because of the extremely windy nature of the site. Measured precipitation is only a fraction of the snow water equivalent reflected by the adjacent snowpack.

## Appendix 20-A Climate Graph for McArthur Pass RAWS



## Appendix 20-B Climate Table for McArthur Pass RAWS

| 2013 Hydrologic Year - KEFJ RAWS MCPA (McArthur Pass) |      |      |       |      |      |      |       |       |       |       |       |       |        |
|-------------------------------------------------------|------|------|-------|------|------|------|-------|-------|-------|-------|-------|-------|--------|
|                                                       | Oct  | Nov  | Dec   | Jan  | Feb  | Mar  | Apr   | May   | Jun   | Jul   | Aug   | Sep   | Year   |
| <b>Minimum air temperature (F)</b>                    |      |      |       |      |      |      |       |       |       |       |       |       |        |
| Min.                                                  | 21.7 | 21.9 | 15.8  | 2.5  | 20.1 | 8.6  | 8.8   | 29.8  | 37.0  | 40.8  | 45.5  | 42.6  | 2.5    |
| Max.                                                  | 42.8 | 36.9 | 32.5  | 33.8 | 32.7 | 31.8 | 33.1  | 48.7  | 64.2  | 59.9  | 53.2  | 49.1  | 64.2   |
| Mean                                                  | 33.2 | 30.2 | 24.5  | 26.1 | 26.8 | 24.4 | 25.6  | 35.4  | 46.6  | 50.6  | 48.8  | 46.1  | 34.5   |
| # days <32 F                                          | 16   | 22   | 27    | 20   | 26   | 31   | 28    | 8     | 0     | 0     | 0     | 0     | 178    |
| % valid obs                                           | 100  | 100  | 100   | 74   | 100  | 100  | 100   | 100   | 100   | 100   | 100   | 41    | 93     |
| <b>Maximum air temperature (F)</b>                    |      |      |       |      |      |      |       |       |       |       |       |       |        |
| Min                                                   | 25.9 | 27.3 | 20.8  | 13.3 | 26.2 | 20.8 | 16.7  | 34.0  | 40.3  | 45.7  | 49.1  | 46.9  | 13.3   |
| Max                                                   | 53.8 | 45.0 | 39.7  | 37.2 | 37.6 | 42.8 | 43.5  | 69.4  | 79.3  | 72.7  | 63.1  | 57.4  | 79.3   |
| Mean                                                  | 39.7 | 36.3 | 30.4  | 31.4 | 31.4 | 30.7 | 33.9  | 45.3  | 57.7  | 60.2  | 54.5  | 52.0  | 41.7   |
| # days <32 F                                          | 2    | 4    | 17    | 9    | 19   | 17   | 7     | 0     | 0     | 0     | 0     | 0     | 75     |
| % valid obs                                           | 100  | 100  | 100   | 73   | 100  | 100  | 100   | 100   | 100   | 100   | 100   | 41    | 93     |
| <b>Mean air temperature (F)</b>                       |      |      |       |      |      |      |       |       |       |       |       |       |        |
| Observed                                              | 36.1 | 33.1 | 27.3  | 28.4 | 29.2 | 27.3 | 29.2  | 39.5  | 51.4  | 55.1  | 51.4  | 48.4  | 37.8   |
| % valid obs                                           | 100  | 100  | 100   | 74   | 100  | 100  | 100   | 100   | 100   | 100   | 100   | 41    | 93     |
| POR mean<br>1981-2010                                 |      |      |       |      |      |      |       |       |       |       |       |       |        |
| <b>Precipitation</b>                                  |      |      |       |      |      |      |       |       |       |       |       |       |        |
| Total <sup>2</sup>                                    | 8.84 | 2.16 | 0.02  |      |      |      |       |       | 2.64  | 8.47  | 32.12 | 13.00 | 67.25  |
| % valid obs                                           | 84   | 78   | 6     | 0    | 0    | 0    | 0     | 0     | 68    | 100   | 100   | 41    | 40     |
| POR mean<br>1981-2010                                 |      |      |       |      |      |      |       |       |       |       |       |       |        |
| <b>Snow depth (in)</b>                                |      |      |       |      |      |      |       |       |       |       |       |       |        |
| Average**                                             |      |      |       |      |      |      |       |       |       |       |       |       |        |
| % valid obs                                           | 0    | 0    | 0     | 0    | 0    | 0    | 0     | 0     | 0     | 0     | 0     | 0     |        |
| POR mean                                              |      |      |       |      |      |      |       |       |       |       |       |       |        |
| <b>Wind (mph, degrees)</b>                            |      |      |       |      |      |      |       |       |       |       |       |       |        |
| Mean speed                                            | 12.5 | 11.3 | 21.6  | 17.3 | 10.9 | 0.6  |       |       | 10.8  | 10.0  | 15.3  | 17.9  |        |
| % valid obs                                           | 100  | 100  | 100   | 100  | 100  | 11   | 0     | 0     | 68    | 100   | 100   | 100   |        |
| Max speed                                             | 72.7 | 66.4 | 117.4 | 87.9 | 92.6 | 28.0 |       |       | 70.5  | 63.8  | 85.5  | 84.3  | 117.4  |
| Max direction                                         | 119  | 115  | 116   | 99   | 119  | 111  |       |       | 115   | 112   | 128   | 121   | 116    |
| <b>Solar radiation (KWh/m2)</b>                       |      |      |       |      |      |      |       |       |       |       |       |       |        |
| Total                                                 | 50.4 | 18.2 | 8.7   | 11.0 | 27.2 | 88.5 | 185.2 | 186.5 | 180.2 | 188.3 | 84.6  | 73.7  | 1102.5 |
| % valid obs                                           | 100  | 100  | 100   | 100  | 100  | 100  | 100   | 100   | 100   | 100   | 100   | 100   | 100    |

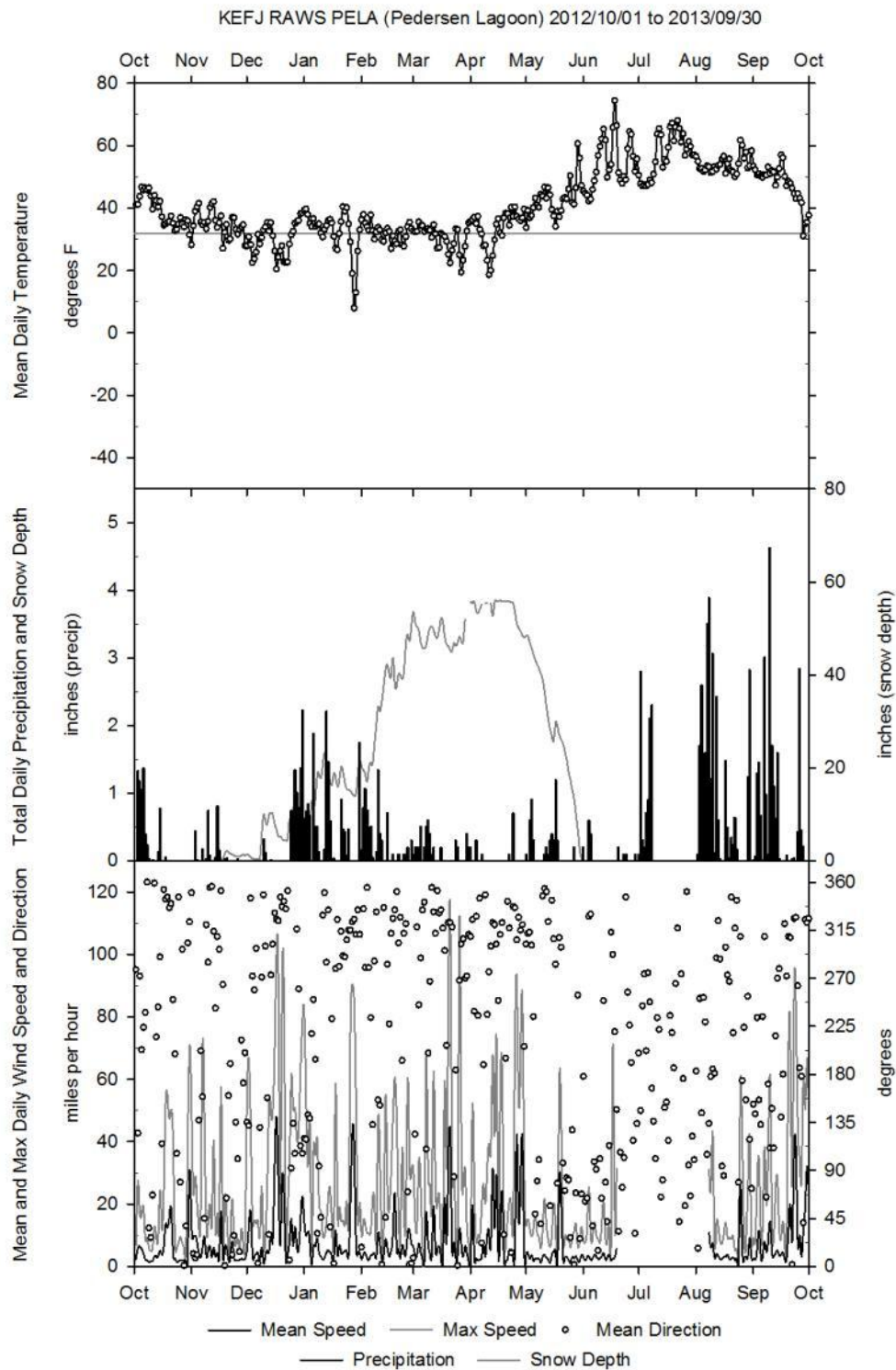
\*Tipping bucket was not working 12/11/2012 to 06/09/2013. Yearly summary reflects missing data.

<sup>2</sup>Station is only capable of measuring liquid precipitation. Precipitation reported when maximum air temperature is below 31.1

°F is not considered valid and these data are not used for summarizing purposes. The water equivalent of solid precipitation (e.g. snowfall) is not measured and this is reflected in the percentage of valid observations that are reported as a measure of the reliability of cumulative values.

\*\*Station is no longer equipped with a snow depth sensor.

## Appendix 21-A Climate Graph for Pedersen Lagoon RAWS

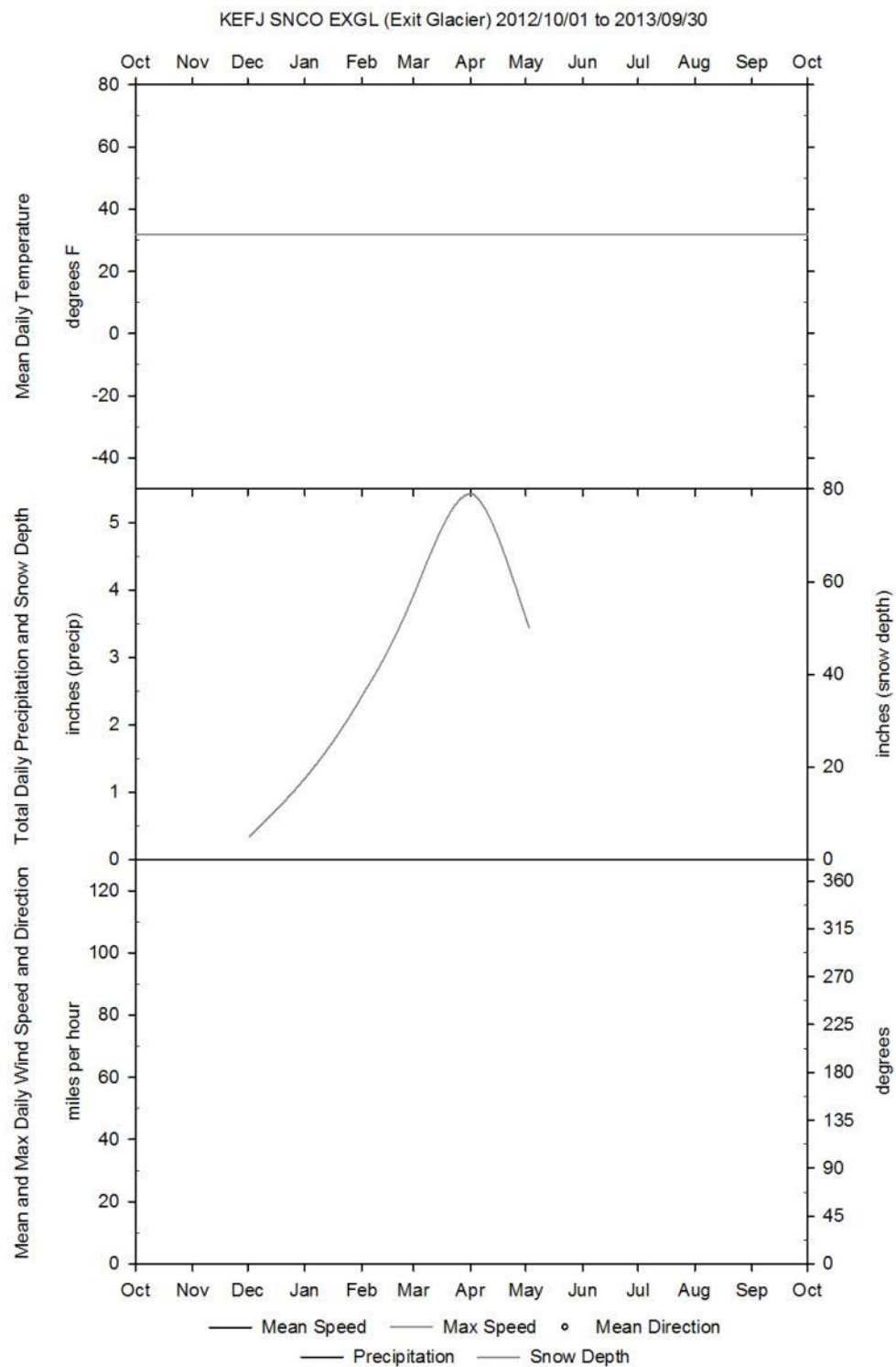


## Appendix 21-B Climate Table for Pedersen Lagoon RAWs

| 2013 Hydrologic Year - KEFJ RAWs PELA (Pedersen Lagoon) |      |      |       |       |      |       |       |       |       |       |       |       |        |
|---------------------------------------------------------|------|------|-------|-------|------|-------|-------|-------|-------|-------|-------|-------|--------|
|                                                         | Oct  | Nov  | Dec   | Jan   | Feb  | Mar   | Apr   | May   | Jun   | Jul   | Aug   | Sep   | Year   |
| <b>Minimum air temperature (F)</b>                      |      |      |       |       |      |       |       |       |       |       |       |       |        |
| Min.                                                    | 25.5 | 22.8 | 17.4  | 2.1   | 23.5 | 15.1  | 13.5  | 31.8  | 40.3  | 44.2  | 47.7  | 27.9  | 2.1    |
| Max.                                                    | 44.8 | 38.8 | 38.5  | 36.9  | 34.9 | 32.7  | 35.2  | 47.8  | 63.5  | 64.0  | 54.0  | 50.5  | 64.0   |
| Mean                                                    | 35.2 | 31.2 | 26.7  | 28.9  | 29.0 | 26.8  | 28.2  | 37.7  | 48.2  | 52.1  | 50.6  | 43.9  | 36.6   |
| # days <32 F                                            | 9    | 20   | 24    | 17    | 24   | 28    | 20    | 1     | 0     | 0     | 0     | 2     | 145    |
| % valid obs                                             | 100  | 100  | 96    | 100   | 100  | 100   | 100   | 100   | 100   | 100   | 100   | 100   | 100    |
| <b>Maximum air temperature (F)</b>                      |      |      |       |       |      |       |       |       |       |       |       |       |        |
| Min                                                     | 32.5 | 30.9 | 24.4  | 14.5  | 31.8 | 27.0  | 28.2  | 36.1  | 45.9  | 49.1  | 51.8  | 34.2  | 14.5   |
| Max                                                     | 53.1 | 48.6 | 42.1  | 45.9  | 45.5 | 47.7  | 54.0  | 79.3  | 84.9  | 78.4  | 67.1  | 66.4  | 84.9   |
| Mean                                                    | 43.6 | 39.2 | 33.8  | 36.1  | 36.2 | 36.8  | 42.8  | 52.9  | 62.4  | 64.0  | 58.4  | 51.7  | 46.6   |
| # days <32 F                                            | 0    | 1    | 12    | 6     | 1    | 4     | 3     | 0     | 0     | 0     | 0     | 0     | 27     |
| % valid obs                                             | 100  | 100  | 96    | 100   | 100  | 100   | 100   | 100   | 100   | 100   | 100   | 100   | 100    |
| <b>Mean air temperature (F)</b>                         |      |      |       |       |      |       |       |       |       |       |       |       |        |
| Observed                                                | 38.6 | 34.9 | 29.6  | 32.1  | 32.2 | 30.4  | 33.4  | 43.1  | 54.6  | 57.5  | 54.0  | 47.4  | 40.7   |
| % valid obs                                             | 100  | 100  | 96    | 100   | 100  | 100   | 100   | 100   | 100   | 100   | 100   | 100   | 100    |
| POR mean<br>1981-2010                                   |      |      |       |       |      |       |       |       |       |       |       |       |        |
| <b>Precipitation</b>                                    |      |      |       |       |      |       |       |       |       |       |       |       |        |
| Total <sup>2</sup>                                      | 6.61 | 2.62 | 9.14  | 14.02 | 7.25 | 4.60  | 1.30  | 5.10  | 1.60  | 9.30  | 29.22 | 21.37 | 112.13 |
| % valid obs                                             | 94   | 83   | 51    | 75    | 72   | 63    | 71    | 100   | 100   | 100   | 100   | 96    | 84     |
| POR mean<br>1981-2010                                   |      |      |       |       |      |       |       |       |       |       |       |       |        |
| <b>Snow depth (in)</b>                                  |      |      |       |       |      |       |       |       |       |       |       |       |        |
| Average                                                 | 0.0  | 0.7  | 5.4   | 16.0  | 35.6 | 48.4  | 53.7  | 27.1  | 0.0   |       |       |       |        |
| % valid obs                                             | 100  | 100  | 99    | 100   | 100  | 92    | 78    | 100   | 60    | 0     | 0     | 0     |        |
| POR mean                                                |      |      |       |       |      |       |       |       |       |       |       |       |        |
| <b>Wind (mph, degrees)</b>                              |      |      |       |       |      |       |       |       |       |       |       |       |        |
| Mean speed                                              | 6.0  | 5.0  | 11.8  | 8.0   | 6.2  | 8.3   | 11.5  | 4.2   | 3.0   |       | 4.6   | 10.5  |        |
| % valid obs                                             | 100  | 100  | 100   | 100   | 100  | 100   | 100   | 100   | 60    | 0     | 79    | 100   |        |
| Max speed                                               | 70.9 | 71.6 | 100.0 | 90.4  | 60.6 | 112.3 | 91.3  | 59.1  | 71.4  |       | 59.5  | 86.8  | 112.3  |
| Max direction                                           | 316  | 325  | 312   | 312   | 309  | 333   | 325   | 311   | 271   |       | 311   | 318   | 333    |
| <b>Solar radiation (KWh/m2)</b>                         |      |      |       |       |      |       |       |       |       |       |       |       |        |
| Total                                                   | 45.3 | 16.1 | 7.6   | 9.5   | 21.2 | 75.9  | 158.9 | 165.3 | 163.7 | 178.7 | 79.3  | 57.4  | 978.9  |
| % valid obs                                             | 100  | 100  | 100   | 100   | 100  | 100   | 100   | 100   | 100   | 100   | 100   | 100   | 100    |

<sup>2</sup>Station is only capable of measuring liquid precipitation. Precipitation reported when maximum air temperature is below 31.1 °F is not considered valid and these data are not used for summarizing purposes. The water equivalent of solid precipitation (e.g. snowfall) is not measured and this is reflected in the percentage of valid observations that are reported as a measure of the reliability of cumulative values.

## Appendix 22-A Climate Graph for Exit Glacier SNCO



## Appendix 22-B Climate Table for Exit Glacier SNCO

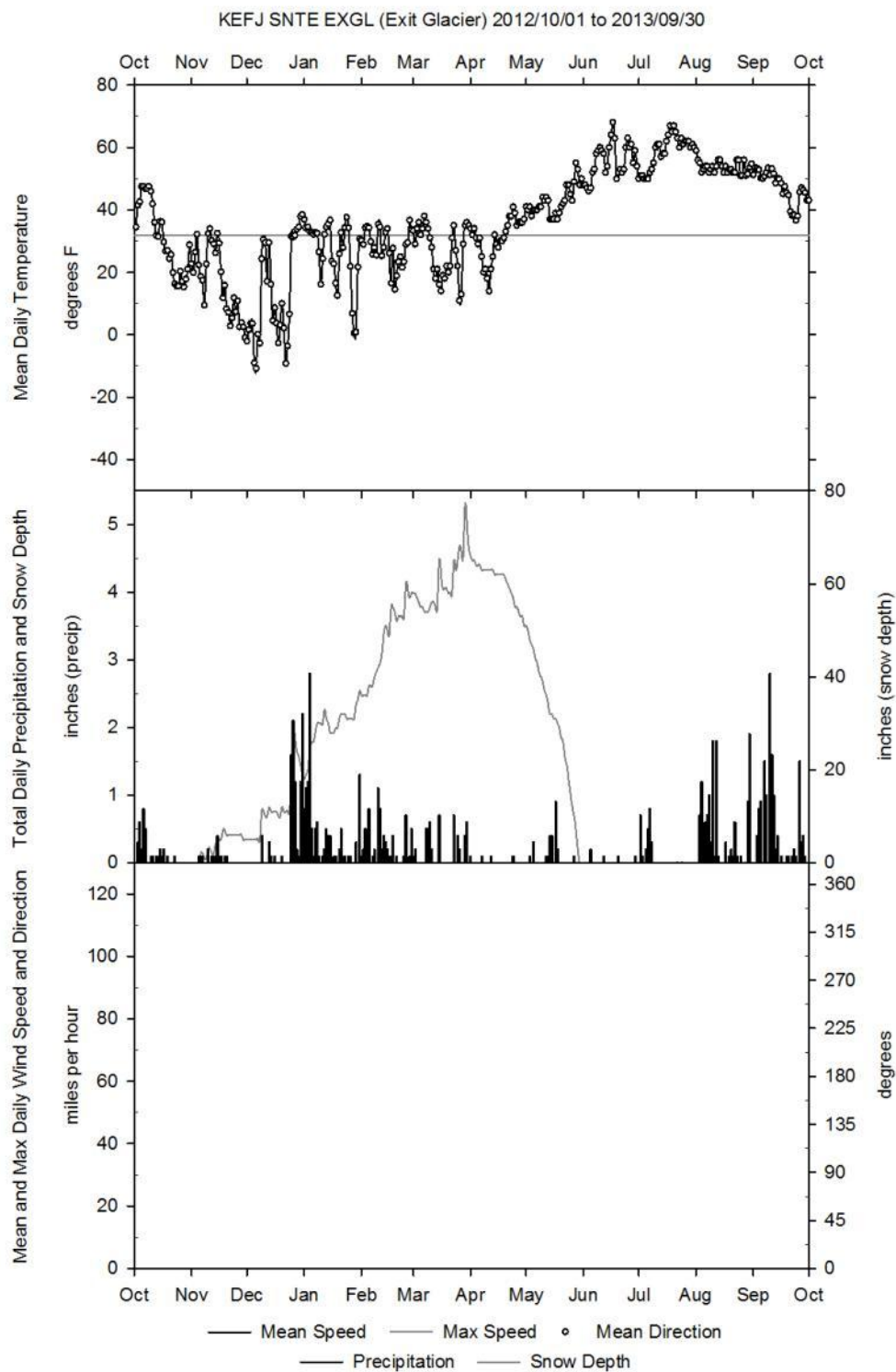
| 2013 Hydrologic Year - KEFJ SNCO EXGL (Exit Glacier) |     |     |     |      |      |      |      |     |     |     |     |     |      |
|------------------------------------------------------|-----|-----|-----|------|------|------|------|-----|-----|-----|-----|-----|------|
|                                                      | Oct | Nov | Dec | Jan  | Feb  | Mar  | Apr  | May | Jun | Jul | Aug | Sep | Year |
| Minimum air temperature (F)                          |     |     |     |      |      |      |      |     |     |     |     |     |      |
| Min.                                                 |     |     |     |      |      |      |      |     |     |     |     |     |      |
| Max.                                                 |     |     |     |      |      |      |      |     |     |     |     |     |      |
| Mean                                                 |     |     |     |      |      |      |      |     |     |     |     |     |      |
| # days <32 F                                         |     |     |     |      |      |      |      |     |     |     |     |     |      |
| % valid obs                                          |     |     |     |      |      |      |      |     |     |     |     |     |      |
| Maximum air temperature (F)                          |     |     |     |      |      |      |      |     |     |     |     |     |      |
| Min                                                  |     |     |     |      |      |      |      |     |     |     |     |     |      |
| Max                                                  |     |     |     |      |      |      |      |     |     |     |     |     |      |
| Mean                                                 |     |     |     |      |      |      |      |     |     |     |     |     |      |
| # days <32 F                                         |     |     |     |      |      |      |      |     |     |     |     |     |      |
| % valid obs                                          |     |     |     |      |      |      |      |     |     |     |     |     |      |
| Mean air temperature (F)                             |     |     |     |      |      |      |      |     |     |     |     |     |      |
| Observed                                             |     |     |     |      |      |      |      |     |     |     |     |     |      |
| % valid obs                                          |     |     |     |      |      |      |      |     |     |     |     |     |      |
| POR mean                                             |     |     |     |      |      |      |      |     |     |     |     |     |      |
| 1981-2010                                            |     |     |     |      |      |      |      |     |     |     |     |     |      |
| Precipitation                                        |     |     |     |      |      |      |      |     |     |     |     |     |      |
| Total <sup>3</sup>                                   |     | 1.4 | 6.9 | 11.0 | 14.5 | 21.2 | 19.2 |     |     |     |     |     |      |
| % valid obs                                          |     | 100 | 100 | 100  | 100  | 100  | 100  |     |     |     |     |     |      |
| POR mean                                             |     |     |     |      |      |      |      |     |     |     |     |     |      |
| 1981-2010 <sup>5</sup>                               |     | 3.1 | 8.0 | 11.7 | 15.9 | 18.2 | 10.8 |     |     |     |     |     |      |
| Snow depth (in)                                      |     |     |     |      |      |      |      |     |     |     |     |     |      |
| Average <sup>4</sup>                                 |     | 5   | 18  | 36   | 58   | 79   | 50   |     |     |     |     |     |      |
| % valid obs                                          |     | 100 | 100 | 100  | 100  | 100  | 100  |     |     |     |     |     |      |
| POR mean <sup>5</sup>                                |     | 16  | 34  | 43   | 49   | 55   | 31   |     |     |     |     |     |      |
| Wind (mph, degrees)                                  |     |     |     |      |      |      |      |     |     |     |     |     |      |
| Mean speed                                           |     |     |     |      |      |      |      |     |     |     |     |     |      |
| % valid obs                                          |     |     |     |      |      |      |      |     |     |     |     |     |      |
| Max speed                                            |     |     |     |      |      |      |      |     |     |     |     |     |      |
| Max direction                                        |     |     |     |      |      |      |      |     |     |     |     |     |      |
| Solar radiation (KWh/m2)                             |     |     |     |      |      |      |      |     |     |     |     |     |      |
| Total                                                |     |     |     |      |      |      |      |     |     |     |     |     |      |
| % valid obs                                          |     |     |     |      |      |      |      |     |     |     |     |     |      |

<sup>3</sup>Snow water equivalent measured close to the end of the month listed.

<sup>4</sup>Cummulative snow depth measured close to the end of the month listed.  
from National Water and Climate Data Center (current Feb. 7, 2014).

<sup>5</sup>Values cited are

## Appendix 23-A Climate Graph for Exit Glacier SNT



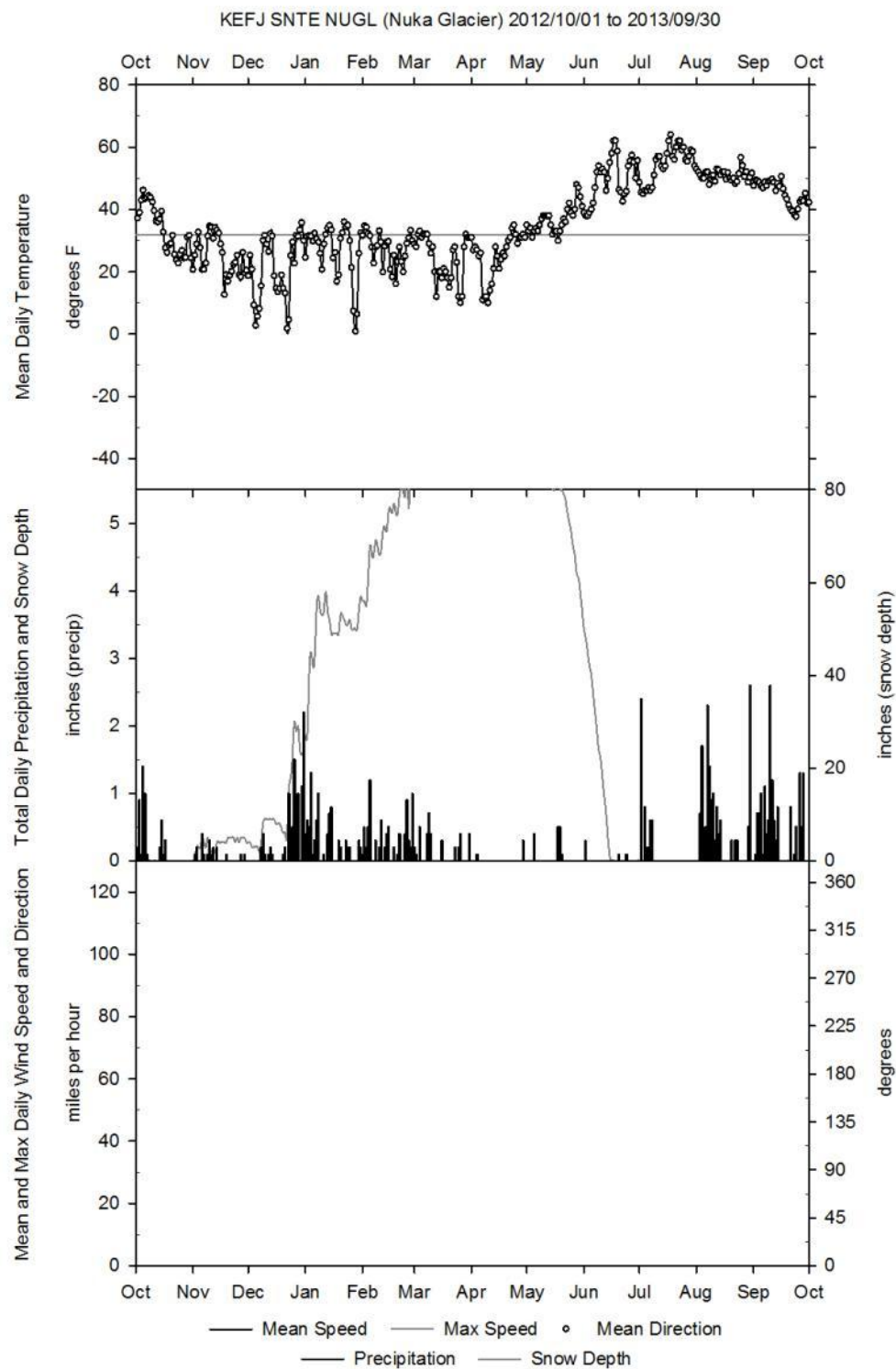
## Appendix 23-B Climate Table for Exit Glacier SNT

| 2013 Hydrologic Year - KEFJ SNT EXGL (Exit Glacier) |      |      |       |       |      |       |      |      |      |      |       |       |       |
|-----------------------------------------------------|------|------|-------|-------|------|-------|------|------|------|------|-------|-------|-------|
|                                                     | Oct  | Nov  | Dec   | Jan   | Feb  | Mar   | Apr  | May  | Jun  | Jul  | Aug   | Sep   | Year  |
| <b>Minimum air temperature (F)</b>                  |      |      |       |       |      |       |      |      |      |      |       |       |       |
| Min.                                                | 5.5  | -6.3 | -17.0 | -10.7 | -1.8 | -12.0 | -4.0 | 24.0 | 31.0 | 41.0 | 34.0  | 24.3  | -17.0 |
| Max.                                                | 45.0 | 31.3 | 35.1  | 33.4  | 32.7 | 34.0  | 34.0 | 43.0 | 52.0 | 54.0 | 52.0  | 50.0  | 54.0  |
| Mean                                                | 23.7 | 9.6  | 7.2   | 20.5  | 20.5 | 16.9  | 18.2 | 32.4 | 42.3 | 47.5 | 46.8  | 40.3  | 27.2  |
| # days <32 F                                        | 22   | 30   | 26    | 24    | 21   | 28    | 27   | 11   | 1    | 0    | 0     | 6     | 196   |
| % valid obs                                         | 100  | 100  | 100   | 100   | 100  | 100   | 100  | 100  | 100  | 100  | 100   | 100   | 100   |
| <b>Maximum air temperature (F)</b>                  |      |      |       |       |      |       |      |      |      |      |       |       |       |
| Min*                                                | 27.0 | 2.7  | -3.5  | 8.2   | 25.2 | 23.0  | 28.0 | 42.0 |      |      |       |       | -3.5  |
| Max*                                                | 53.6 | 39.9 | 46.6  | 43.9  | 42.1 | 49.0  | 55.0 | 63.0 |      |      |       |       | 63.0  |
| Mean*                                               | 41.4 | 23.7 | 22.0  | 31.9  | 35.3 | 36.6  | 42.6 | 52.1 |      |      |       |       | 35.3  |
| # days <32 F*                                       | 2    | 19   | 19    | 10    | 3    | 6     | 3    | 0    |      |      |       |       | 62    |
| % valid obs                                         | 100  | 100  | 100   | 100   | 100  | 100   | 97   | 84   | 0    | 0    | 0     | 0     | 65    |
| <b>Mean air temperature (F)</b>                     |      |      |       |       |      |       |      |      |      |      |       |       |       |
| Observed                                            | 30.9 | 16.3 | 14.0  | 26.4  | 28.2 | 26.8  | 30.9 | 43.0 | 55.7 | 59.0 | 53.4  | 47.1  | 36.0  |
| % valid obs                                         | 100  | 100  | 100   | 100   | 100  | 100   | 100  | 100  | 100  | 100  | 100   | 100   | 100   |
| POR mean<br>1981-2010                               |      |      |       |       |      |       |      |      |      |      |       |       |       |
| <b>Precipitation</b>                                |      |      |       |       |      |       |      |      |      |      |       |       |       |
| Total                                               | 3.50 | 1.50 | 10.40 | 11.50 | 7.20 | 5.10  | 0.30 | 2.60 | 0.50 | 2.60 | 12.80 | 13.60 | 71.60 |
| % valid obs                                         | 100  | 100  | 100   | 100   | 100  | 100   | 100  | 100  | 100  | 100  | 97    | 90    | 99    |
| POR mean<br>1981-2010                               |      |      |       |       |      |       |      |      |      |      |       |       |       |
| <b>Snow depth (in)</b>                              |      |      |       |       |      |       |      |      |      |      |       |       |       |
| Average                                             | 0.0  | 3.9  | 12.5  | 29.8  | 48.3 | 60.5  | 60.1 | 27.5 | 0.0  | 0.0  | 0.0   | 0.0   |       |
| % valid obs                                         | 100  | 100  | 100   | 100   | 100  | 100   | 100  | 100  | 100  | 100  | 100   | 100   |       |
| POR mean <sup>5</sup>                               |      |      |       |       |      |       |      |      |      |      |       |       |       |
| <b>Wind (mph, degrees)</b>                          |      |      |       |       |      |       |      |      |      |      |       |       |       |
| Mean speed                                          |      |      |       |       |      |       |      |      |      |      |       |       |       |
| % valid obs                                         |      |      |       |       |      |       |      |      |      |      |       |       |       |
| Max speed                                           |      |      |       |       |      |       |      |      |      |      |       |       |       |
| Max direction                                       |      |      |       |       |      |       |      |      |      |      |       |       |       |
| <b>Solar radiation (KWh/m2)</b>                     |      |      |       |       |      |       |      |      |      |      |       |       |       |
| Total                                               |      |      |       |       |      |       |      |      |      |      |       |       |       |
| % valid obs                                         |      |      |       |       |      |       |      |      |      |      |       |       |       |

<sup>5</sup>Values are not available for this SNOTEL.  
temperature values are erroneous beginning May 27, 2013.

\*Maximum air

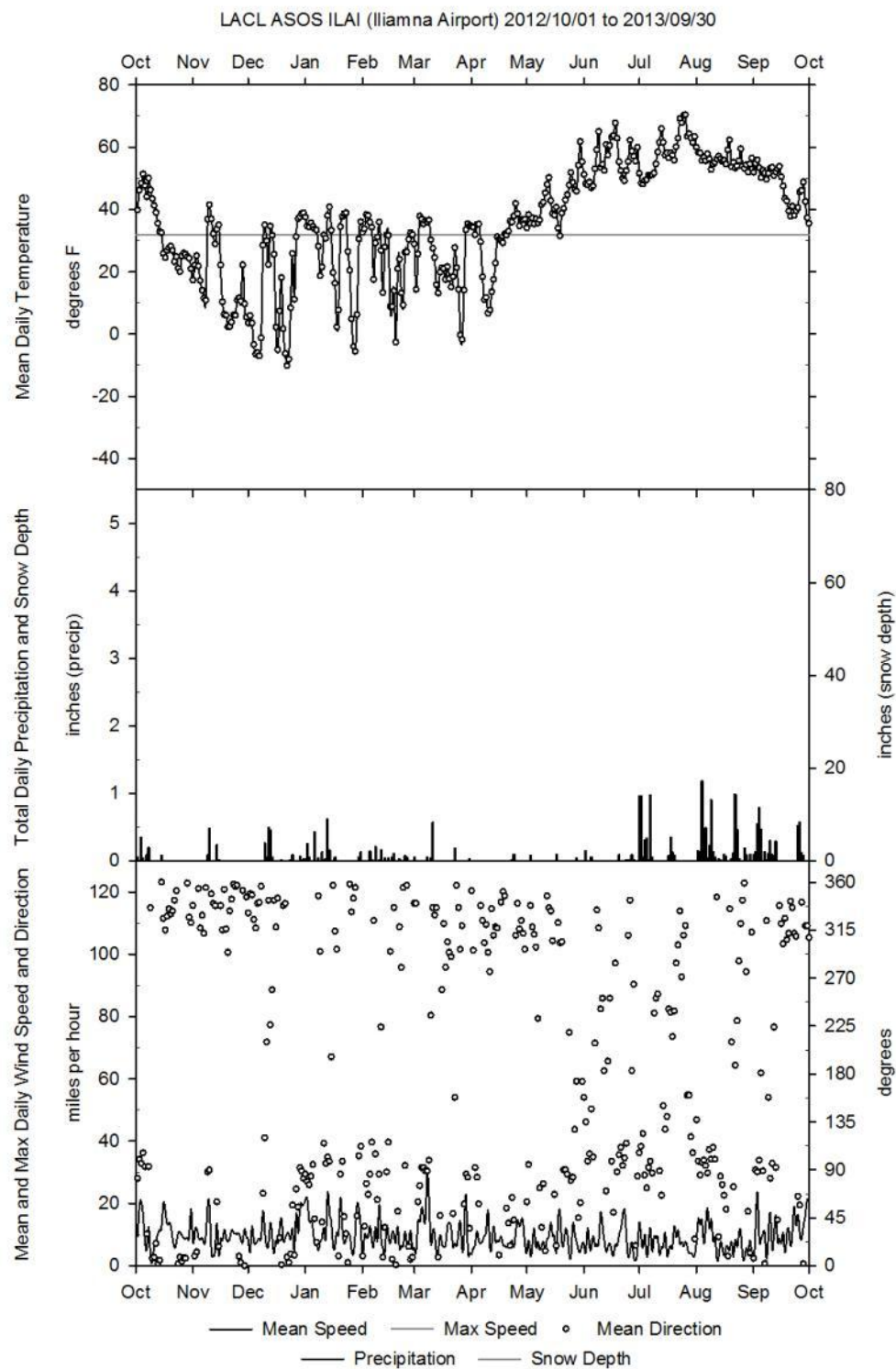
## Appendix 24-A Climate Graph for Nuka Glacier SNT



## Appendix 24-B Climate Table for Nuka Glacier SNTE

| 2013 Hydrologic Year - KEFJ SNTE NUGL (Nuka Glacier) |      |      |       |      |      |       |       |      |      |      |       |       |       |
|------------------------------------------------------|------|------|-------|------|------|-------|-------|------|------|------|-------|-------|-------|
|                                                      | Oct  | Nov  | Dec   | Jan  | Feb  | Mar   | Apr   | May  | Jun  | Jul  | Aug   | Sep   | Year  |
| <b>Minimum air temperature (F)</b>                   |      |      |       |      |      |       |       |      |      |      |       |       |       |
| Min.                                                 | 12.7 | 7.9  | -10.5 | -5.8 | 4.8  | -6.0  | -4.0  | 21.0 | 35.0 | 33.0 | 36.3  | 27.2  | -10.5 |
| Max.                                                 | 43.0 | 32.9 | 30.0  | 33.3 | 32.2 | 32.0  | 33.0  | 39.0 | 49.6 | 57.0 | 50.0  | 46.8  | 57.0  |
| Mean                                                 | 27.3 | 18.2 | 13.0  | 21.6 | 21.8 | 18.2  | 16.7  | 31.5 | 40.5 | 46.0 | 46.0  | 40.5  | 28.5  |
| # days <32 F                                         | 21   | 29   | 31    | 26   | 26   | 30    | 28    | 15   | 0    | 0    | 0     | 1     | 207   |
| % valid obs                                          | 100  | 100  | 100   | 100  | 100  | 100   | 100   | 100  | 100  | 100  | 100   | 100   | 100   |
| <b>Maximum air temperature (F)</b>                   |      |      |       |      |      |       |       |      |      |      |       |       |       |
| Min                                                  | 22.3 | 19.4 | 8.2   | 5.5  | 22.1 | 15.0  | 13.0  | 32.0 | 41.0 | 47.9 | 50.5  | 39.7  | 5.5   |
| Max                                                  | 50.2 | 38.8 | 44.2  | 40.1 | 38.7 | 41.0  | 45.0  | 63.0 | 80.0 | 74.4 | 65.0  | 57.3  | 80.0  |
| Mean                                                 | 39.3 | 31.0 | 26.6  | 31.3 | 31.2 | 29.7  | 32.4  | 44.2 | 59.0 | 63.1 | 56.0  | 49.7  | 41.2  |
| # days <32 F                                         | 6    | 18   | 19    | 12   | 15   | 16    | 9     | 0    | 0    | 0    | 0     | 0     | 95    |
| % valid obs                                          | 100  | 100  | 100   | 100  | 100  | 100   | 100   | 100  | 100  | 100  | 100   | 100   | 100   |
| <b>Mean air temperature (F)</b>                      |      |      |       |      |      |       |       |      |      |      |       |       |       |
| Observed                                             | 33.2 | 24.8 | 20.9  | 27.0 | 27.2 | 24.2  | 25.2  | 36.9 | 50.0 | 54.8 | 50.9  | 45.2  | 35.1  |
| % valid obs                                          | 100  | 100  | 100   | 100  | 100  | 100   | 100   | 100  | 100  | 100  | 100   | 100   | 100   |
| POR mean<br>1981-2010                                |      |      |       |      |      |       |       |      |      |      |       |       |       |
| <b>Precipitation</b>                                 |      |      |       |      |      |       |       |      |      |      |       |       |       |
| Total                                                | 4.90 | 2.00 | 10.20 | 8.20 | 8.30 | 3.60  | 0.40  | 1.50 | 0.50 | 4.80 | 15.00 | 14.70 | 74.10 |
| % valid obs                                          | 100  | 100  | 100   | 97   | 100  | 100   | 13    | 94   | 17   | 74   | 71    | 70    | 78    |
| POR mean<br>1981-2010                                |      |      |       |      |      |       |       |      |      |      |       |       |       |
| <b>Snow depth (in)</b>                               |      |      |       |      |      |       |       |      |      |      |       |       |       |
| Average                                              | 0.0  | 3.9  | 12.0  | 50.3 | 74.3 | 103.0 | 103.0 | 78.8 | 11.6 | 0.0  | 0.0   | -0.4  |       |
| % valid obs                                          | 100  | 100  | 100   | 100  | 100  | 100   | 100   | 100  | 100  | 100  | 100   | 100   |       |
| POR mean                                             |      |      |       |      |      |       |       |      |      |      |       |       |       |
| <b>Wind (mph, degrees)</b>                           |      |      |       |      |      |       |       |      |      |      |       |       |       |
| Mean speed                                           |      |      |       |      |      |       |       |      |      |      |       |       |       |
| % valid obs                                          |      |      |       |      |      |       |       |      |      |      |       |       |       |
| Max speed                                            |      |      |       |      |      |       |       |      |      |      |       |       |       |
| Max direction                                        |      |      |       |      |      |       |       |      |      |      |       |       |       |
| <b>Solar radiation (KWh/m2)</b>                      |      |      |       |      |      |       |       |      |      |      |       |       |       |
| Total                                                |      |      |       |      |      |       |       |      |      |      |       |       |       |
| % valid obs                                          |      |      |       |      |      |       |       |      |      |      |       |       |       |

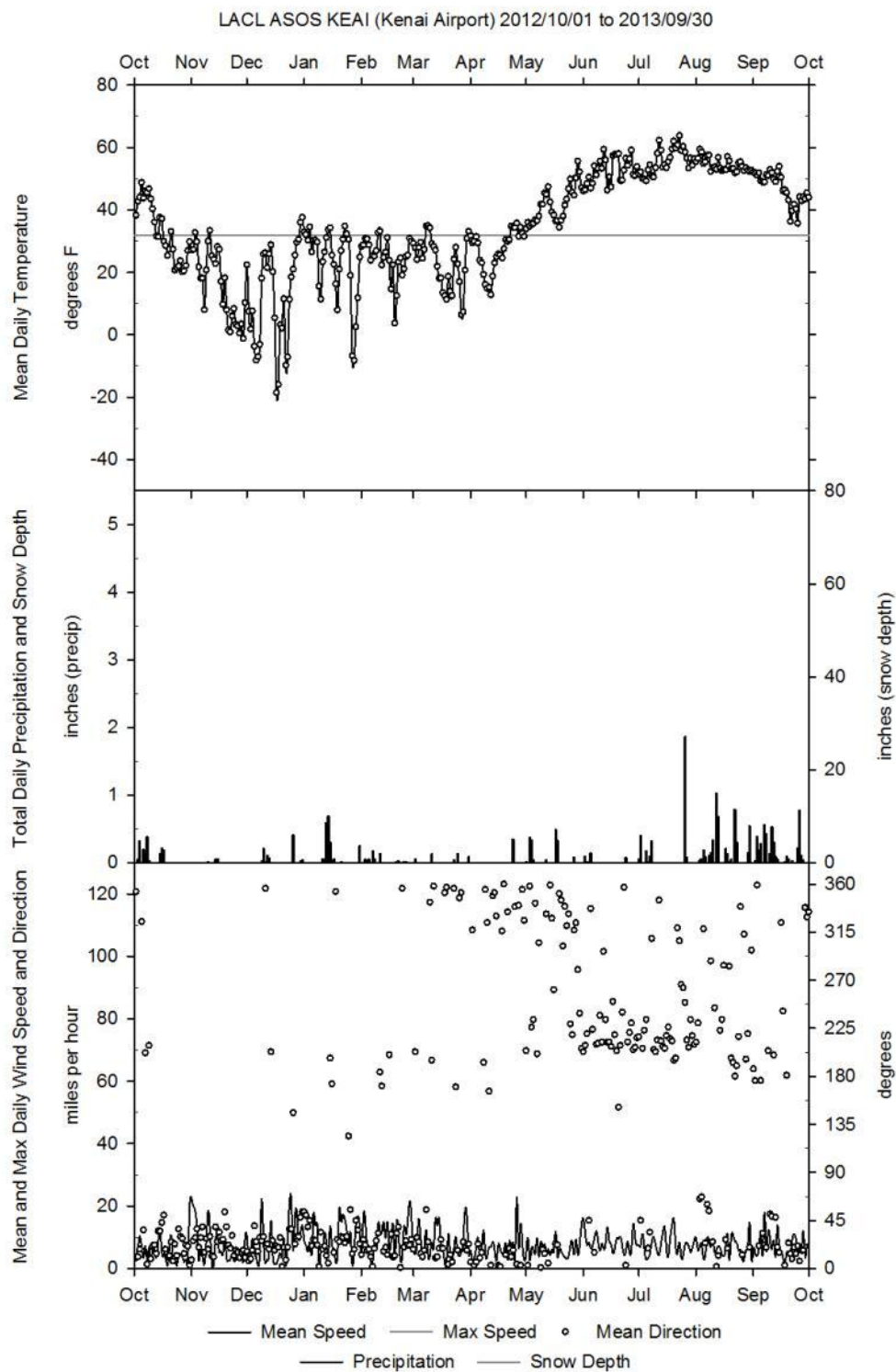
## Appendix 25-A Climate Graph for Iliamna Airport ASOS



## Appendix 25-B Climate Table for Iliamna Airport ASOS

| 2013 Hydrologic Year - LACL ASOS ILAI (Iliamna Airport) |      |      |       |       |       |       |      |      |      |      |      |      |       |
|---------------------------------------------------------|------|------|-------|-------|-------|-------|------|------|------|------|------|------|-------|
|                                                         | Oct  | Nov  | Dec   | Jan   | Feb   | Mar   | Apr  | May  | Jun  | Jul  | Aug  | Sep  | Year  |
| <b>Minimum air temperature (F)</b>                      |      |      |       |       |       |       |      |      |      |      |      |      |       |
| Min.                                                    | 13.0 | -1.0 | -14.0 | -11.0 | -11.0 | -12.0 | -1.0 | 23.0 | 38.0 | 45.0 | 44.0 | 29.0 | -14.0 |
| Max.                                                    | 47.0 | 39.0 | 37.0  | 37.5  | 35.0  | 36.0  | 35.0 | 48.0 | 54.0 | 62.0 | 57.0 | 54.0 | 62.0  |
| Mean                                                    | 27.8 | 11.9 | 8.9   | 20.1  | 17.1  | 16.4  | 21.0 | 34.2 | 46.7 | 51.9 | 51.7 | 41.7 | 29.2  |
| # days <32 F                                            | 20   | 29   | 24    | 20    | 24    | 24    | 26   | 11   | 0    | 0    | 0    | 2    | 180   |
| % valid obs                                             | 100  | 100  | 100   | 100   | 100   | 100   | 100  | 100  | 100  | 100  | 100  | 100  | 100   |
| <b>Maximum air temperature (F)</b>                      |      |      |       |       |       |       |      |      |      |      |      |      |       |
| Min                                                     | 23.0 | 7.0  | -6.0  | 0.0   | 5.0   | 3.0   | 13.0 | 38.5 | 51.0 | 50.0 | 54.0 | 38.0 | -6.0  |
| Max                                                     | 55.0 | 43.0 | 43.0  | 43.0  | 42.0  | 41.0  | 52.0 | 77.0 | 85.0 | 83.0 | 73.0 | 65.0 | 85.0  |
| Mean                                                    | 38.6 | 21.9 | 20.9  | 31.3  | 31.1  | 29.8  | 36.2 | 51.1 | 65.2 | 66.3 | 60.4 | 52.6 | 42.2  |
| # days <32 F                                            | 6    | 23   | 19    | 10    | 12    | 19    | 7    | 0    | 0    | 0    | 0    | 0    | 96    |
| % valid obs                                             | 100  | 100  | 100   | 100   | 100   | 100   | 100  | 100  | 100  | 100  | 100  | 100  | 100   |
| <b>Mean air temperature (F)</b>                         |      |      |       |       |       |       |      |      |      |      |      |      |       |
| Observed                                                | 32.6 | 16.9 | 14.8  | 25.6  | 24.9  | 23.7  | 28.7 | 43.1 | 55.8 | 58.7 | 55.6 | 47.1 | 35.7  |
| % valid obs                                             | 100  | 100  | 100   | 100   | 100   | 100   | 100  | 100  | 100  | 100  | 100  | 100  | 100   |
| POR mean<br>1981-2010                                   |      |      |       |       |       |       |      |      |      |      |      |      |       |
| <b>Precipitation</b>                                    |      |      |       |       |       |       |      |      |      |      |      |      |       |
| Total                                                   | 0.84 | 0.83 | 1.61  | 2.02  | 1.05  | 0.90  | 0.12 | 0.23 | 1.42 | 3.36 | 5.83 | 4.21 | 22.42 |
| % valid obs                                             | 100  | 100  | 100   | 100   | 100   | 100   | 100  | 100  | 100  | 100  | 100  | 100  | 100   |
| POR mean<br>1981-2010                                   |      |      |       |       |       |       |      |      |      |      |      |      |       |
| <b>Snow depth (in)</b>                                  |      |      |       |       |       |       |      |      |      |      |      |      |       |
| Average                                                 |      |      |       |       |       |       |      |      |      |      |      |      |       |
| % valid obs                                             |      |      |       |       |       |       |      |      |      |      |      |      |       |
| POR mean                                                |      |      |       |       |       |       |      |      |      |      |      |      |       |
| <b>Wind (mph, degrees)</b>                              |      |      |       |       |       |       |      |      |      |      |      |      |       |
| Mean speed                                              | 10.9 | 9.6  | 10.9  | 11.3  | 9.0   | 10.8  | 9.0  | 8.2  | 8.0  | 7.0  | 7.7  | 11.6 |       |
| % valid obs                                             | 100  | 100  | 100   | 99    | 100   | 100   | 100  | 100  | 100  | 100  | 97   | 96   |       |
| Max speed                                               |      |      |       |       |       |       |      |      |      |      |      |      |       |
| Max direction                                           |      |      |       |       |       |       |      |      |      |      |      |      |       |
| <b>Solar radiation (KWh/m2)</b>                         |      |      |       |       |       |       |      |      |      |      |      |      |       |
| Total                                                   |      |      |       |       |       |       |      |      |      |      |      |      |       |
| % valid obs                                             |      |      |       |       |       |       |      |      |      |      |      |      |       |

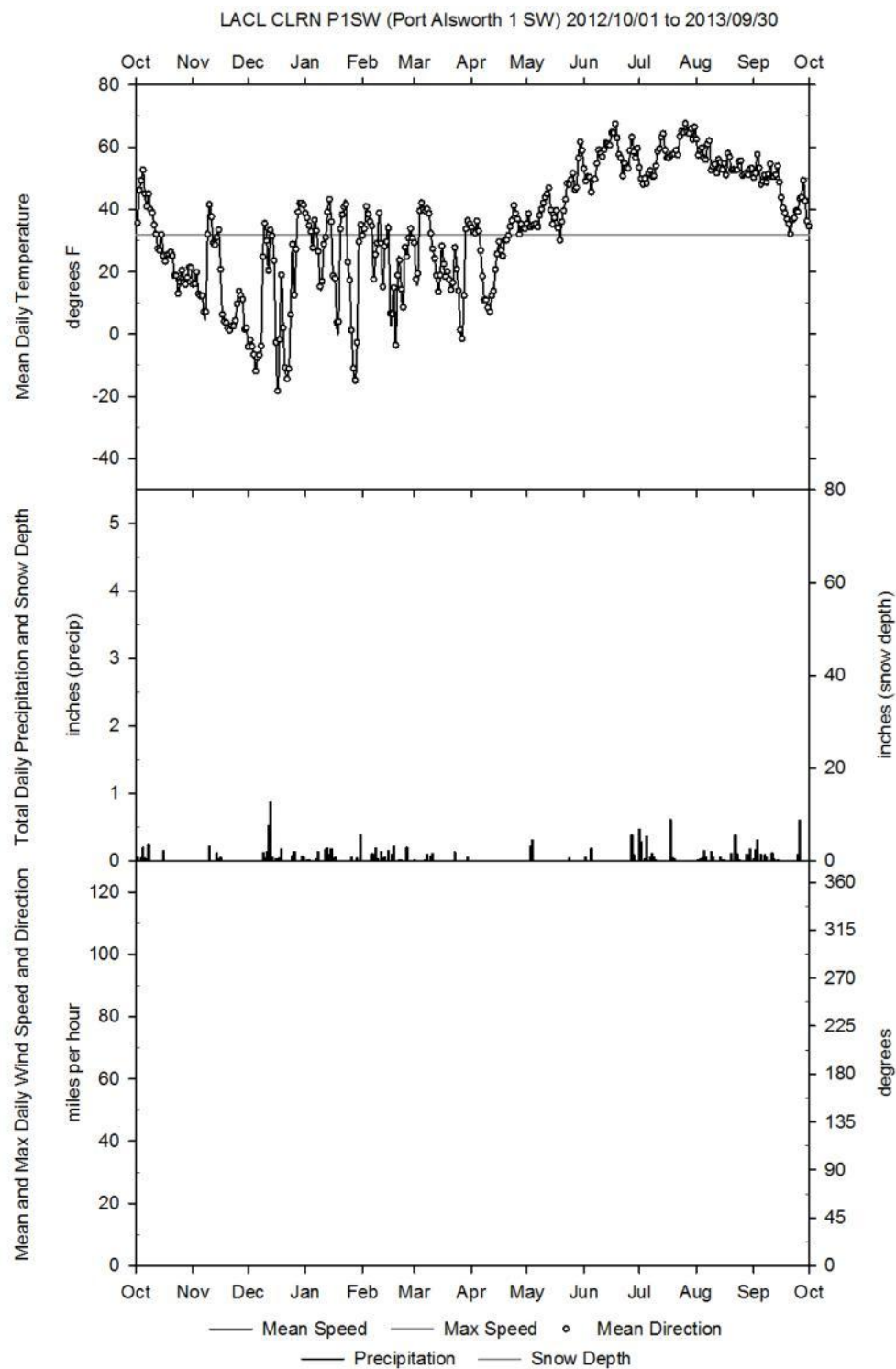
## Appendix 26-A Climate Graph for Kenai Airport ASOS



## Appendix 26-B Climate Table for Kenai Airport ASOS

| 2013 Hydrologic Year - LACL ASOS KEAI (Kenai Airport) |      |      |      |      |      |      |      |      |      |      |      |      |       |
|-------------------------------------------------------|------|------|------|------|------|------|------|------|------|------|------|------|-------|
|                                                       | Oct  | Nov  | Dec  | Jan  | Feb  | Mar  | Apr  | May  | Jun  | Jul  | Aug  | Sep  | Year  |
| <b>Minimum air temperature (F)</b>                    |      |      |      |      |      |      |      |      |      |      |      |      |       |
| Min.                                                  | 8    | -11  | -27  | -20  | -12  | -11  | 0    | 24   | 37   | 44   | 41   | 26   | -27   |
| Max.                                                  | 46   | 31   | 35   | 34   | 30   | 31   | 32   | 44   | 50   | 57   | 54   | 50   | 57    |
| Mean                                                  | 25.7 | 7.3  | 2.5  | 16.6 | 18.0 | 14.1 | 17.0 | 34.4 | 44.8 | 49.2 | 49.3 | 40.7 | 26.7  |
| # days <32 F                                          | 20   | 30   | 29   | 29   | 28   | 31   | 29   | 9    | 0    | 0    | 0    | 4    | 209   |
| % valid obs                                           | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100   |
| <b>Maximum air temperature (F)</b>                    |      |      |      |      |      |      |      |      |      |      |      |      |       |
| Min                                                   | 29   | 14   | -10  | 3    | 18   | 17   | 19   | 38   | 48   | 52   | 54   | 42   | -10   |
| Max                                                   | 57   | 36   | 40   | 38   | 39   | 42   | 43   | 73   | 75   | 75   | 67   | 64   | 75    |
| Mean                                                  | 40.7 | 25.1 | 20.1 | 27.9 | 29.5 | 30.2 | 34.3 | 49.6 | 61.2 | 62.4 | 59.6 | 52.9 | 41.2  |
| # days <32 F                                          | 1    | 23   | 25   | 14   | 18   | 18   | 8    | 0    | 0    | 0    | 0    | 0    | 107   |
| % valid obs                                           | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100   |
| <b>Mean air temperature (F)</b>                       |      |      |      |      |      |      |      |      |      |      |      |      |       |
| Observed                                              | 33.0 | 15.9 | 12.1 | 22.9 | 24.9 | 23.0 | 27.0 | 41.9 | 52.8 | 55.9 | 54.3 | 46.8 | 34.3  |
| % valid obs                                           | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100   |
| POR mean<br>1981-2010                                 |      |      |      |      |      |      |      |      |      |      |      |      |       |
| <b>Precipitation</b>                                  |      |      |      |      |      |      |      |      |      |      |      |      |       |
| Total                                                 | 1.73 | 0.15 | 0.92 | 2.04 | 0.61 | 0.45 | 0.38 | 1.73 | 0.41 | 2.96 | 4.88 | 4.32 | 20.58 |
| % valid obs                                           | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100   |
| POR mean<br>1981-2010                                 |      |      |      |      |      |      |      |      |      |      |      |      |       |
| <b>Snow depth (in)</b>                                |      |      |      |      |      |      |      |      |      |      |      |      |       |
| Average                                               |      |      |      |      |      |      |      |      |      |      |      |      |       |
| % valid obs                                           |      |      |      |      |      |      |      |      |      |      |      |      |       |
| POR mean                                              |      |      |      |      |      |      |      |      |      |      |      |      |       |
| <b>Wind (mph, degrees)</b>                            |      |      |      |      |      |      |      |      |      |      |      |      |       |
| Mean speed                                            | 6.0  | 6.8  | 8.1  | 9.6  | 10.5 | 8.0  | 6.9  | 6.7  | 8.2  | 7.6  | 6.8  | 7.3  |       |
| % valid obs                                           | 100  | 98   | 100  | 100  | 100  | 100  | 99   | 100  | 100  | 100  | 100  | 100  |       |
| Max speed                                             |      |      |      |      |      |      |      |      |      |      |      |      |       |
| Max direction                                         |      |      |      |      |      |      |      |      |      |      |      |      |       |
| <b>Solar radiation (KWh/m2)</b>                       |      |      |      |      |      |      |      |      |      |      |      |      |       |
| Total                                                 |      |      |      |      |      |      |      |      |      |      |      |      |       |
| % valid obs                                           |      |      |      |      |      |      |      |      |      |      |      |      |       |

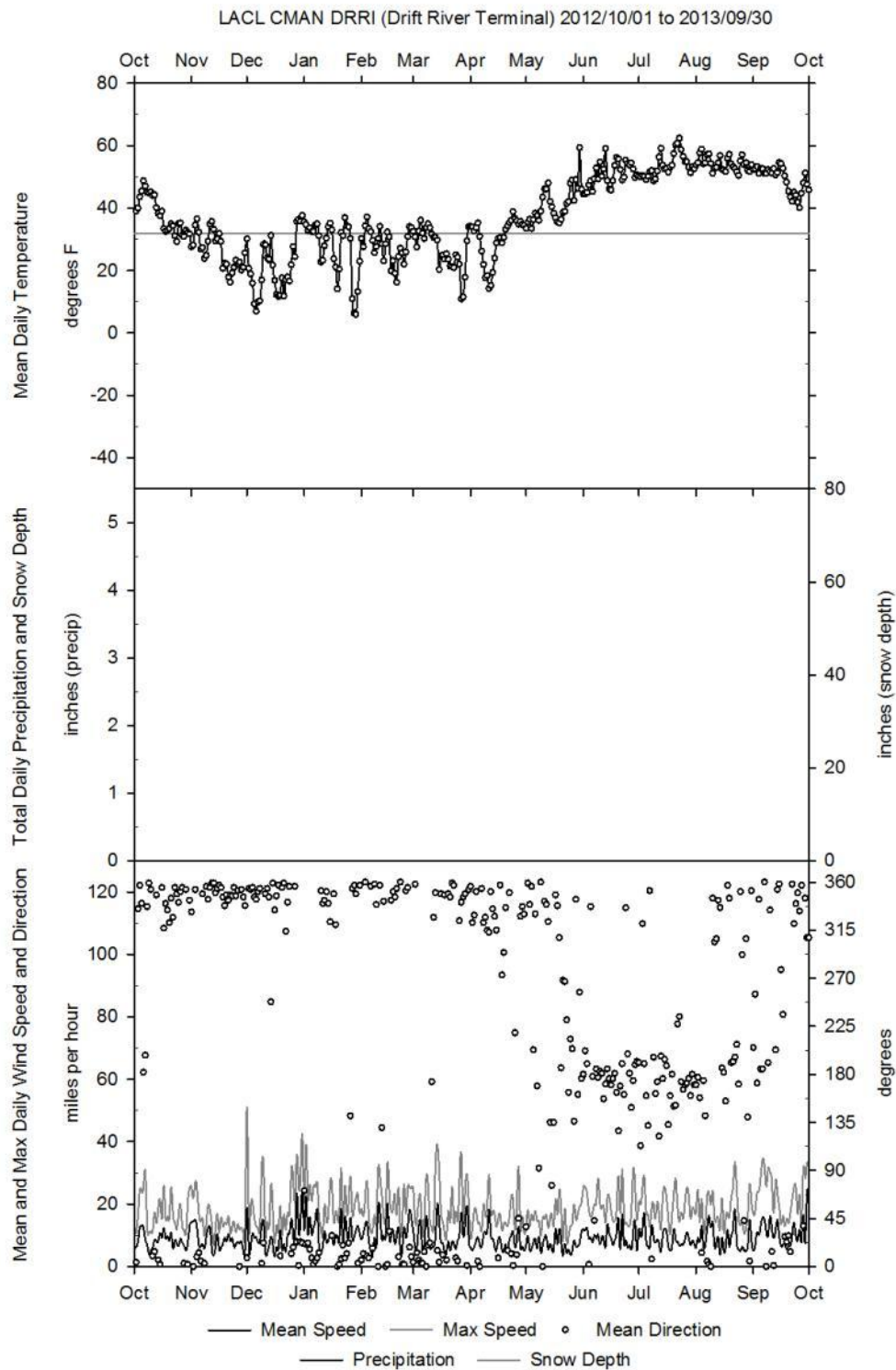
## Appendix 27-A Climate Graph for Port Alsworth 1 SW CLRN



## Appendix 27-B Climate Table for Port Alsworth 1 SW CLRN

| 2013 Hydrologic Year - LACL CLRN P1SW (Port Alsworth 1 SW) |      |       |       |       |       |       |       |       |       |       |      |      |       |
|------------------------------------------------------------|------|-------|-------|-------|-------|-------|-------|-------|-------|-------|------|------|-------|
|                                                            | Oct  | Nov   | Dec   | Jan   | Feb   | Mar   | Apr   | May   | Jun   | Jul   | Aug  | Sep  | Year  |
| <b>Minimum air temperature (F)</b>                         |      |       |       |       |       |       |       |       |       |       |      |      |       |
| Min.                                                       | 3.2  | -10.1 | -24.0 | -20.6 | -17.5 | -16.4 | -6.3  | 18.3  | 27.3  | 39.9  | 35.6 | 20.1 | -24.0 |
| Max.                                                       | 38.3 | 39.2  | 38.7  | 38.5  | 35.1  | 37.6  | 35.2  | 41.0  | 55.0  | 55.6  | 53.1 | 53.4 | 55.6  |
| Mean                                                       | 20.6 | 6.3   | 3.7   | 15.2  | 14.3  | 14.0  | 14.0  | 27.9  | 40.6  | 46.5  | 46.9 | 36.4 | 23.9  |
| # days <32 F                                               | 25   | 29    | 27    | 28    | 26    | 26    | 29    | 24    | 1     | 0     | 0    | 10   | 225   |
| % valid obs                                                | 100  | 100   | 100   | 100   | 100   | 100   | 100   | 100   | 100   | 100   | 99   | 100  | 100   |
| <b>Maximum air temperature (F)</b>                         |      |       |       |       |       |       |       |       |       |       |      |      |       |
| Min                                                        | 21.6 | 1.0   | -13.5 | -4.4  | 6.3   | 6.6   | 14.7  | 39.6  | 52.3  | 54.9  | 52.9 | 36.9 | -13.5 |
| Max                                                        | 62.6 | 43.9  | 47.3  | 49.5  | 45.9  | 46.4  | 53.2  | 81.9  | 86.9  | 81.9  | 71.6 | 65.3 | 86.9  |
| Mean                                                       | 37.2 | 20.4  | 20.5  | 31.9  | 33.5  | 33.1  | 38.9  | 55.3  | 71.2  | 70.1  | 62.1 | 53.5 | 44.0  |
| # days <32 F                                               | 16   | 21    | 20    | 11    | 9     | 14    | 8     | 0     | 0     | 0     | 0    | 0    | 99    |
| % valid obs                                                | 100  | 100   | 100   | 100   | 100   | 100   | 100   | 100   | 100   | 100   | 99   | 100  | 100   |
| <b>Mean air temperature (F)</b>                            |      |       |       |       |       |       |       |       |       |       |      |      |       |
| Observed                                                   | 28.8 | 13.8  | 12.8  | 24.1  | 24.9  | 24.6  | 27.4  | 42.7  | 56.7  | 58.4  | 54.6 | 45.0 | 34.5  |
| % valid obs                                                | 100  | 100   | 100   | 100   | 100   | 100   | 100   | 100   | 100   | 100   | 99   | 100  | 100   |
| POR mean                                                   |      |       |       |       |       |       |       |       |       |       |      |      |       |
| 1981-2010                                                  |      |       |       |       |       |       |       |       |       |       |      |      |       |
| <b>Precipitation</b>                                       |      |       |       |       |       |       |       |       |       |       |      |      |       |
| Total                                                      | 0.77 | 0.42  | 2.37  | 1.39  | 1.40  | 0.49  | 0.00  | 0.59  | 1.20  | 1.60  | 1.64 | 1.57 | 13.43 |
| % valid obs                                                | 100  | 100   | 100   | 100   | 100   | 100   | 100   | 100   | 100   | 100   | 98   | 100  | 100   |
| POR mean                                                   |      |       |       |       |       |       |       |       |       |       |      |      |       |
| 1981-2010                                                  |      |       |       |       |       |       |       |       |       |       |      |      |       |
| <b>Snow depth (in)</b>                                     |      |       |       |       |       |       |       |       |       |       |      |      |       |
| Average                                                    |      |       |       |       |       |       |       |       |       |       |      |      |       |
| % valid obs                                                |      |       |       |       |       |       |       |       |       |       |      |      |       |
| POR mean                                                   |      |       |       |       |       |       |       |       |       |       |      |      |       |
| <b>Wind (mph, degrees)</b>                                 |      |       |       |       |       |       |       |       |       |       |      |      |       |
| Mean speed                                                 |      |       |       |       |       |       |       |       |       |       |      |      |       |
| % valid obs                                                |      |       |       |       |       |       |       |       |       |       |      |      |       |
| Max speed                                                  |      |       |       |       |       |       |       |       |       |       |      |      |       |
| Max direction                                              |      |       |       |       |       |       |       |       |       |       |      |      |       |
| <b>Solar radiation (KWh/m2)</b>                            |      |       |       |       |       |       |       |       |       |       |      |      |       |
| Total                                                      | 31.9 | 7.4   | 1.6   | 5.0   | 16.7  | 71.2  | 151.3 | 180.3 | 168.1 | 146.1 | 68.8 | 56.7 | 905.1 |
| % valid obs                                                | 100  | 100   | 100   | 100   | 100   | 100   | 100   | 100   | 100   | 100   | 99   | 100  | 100   |

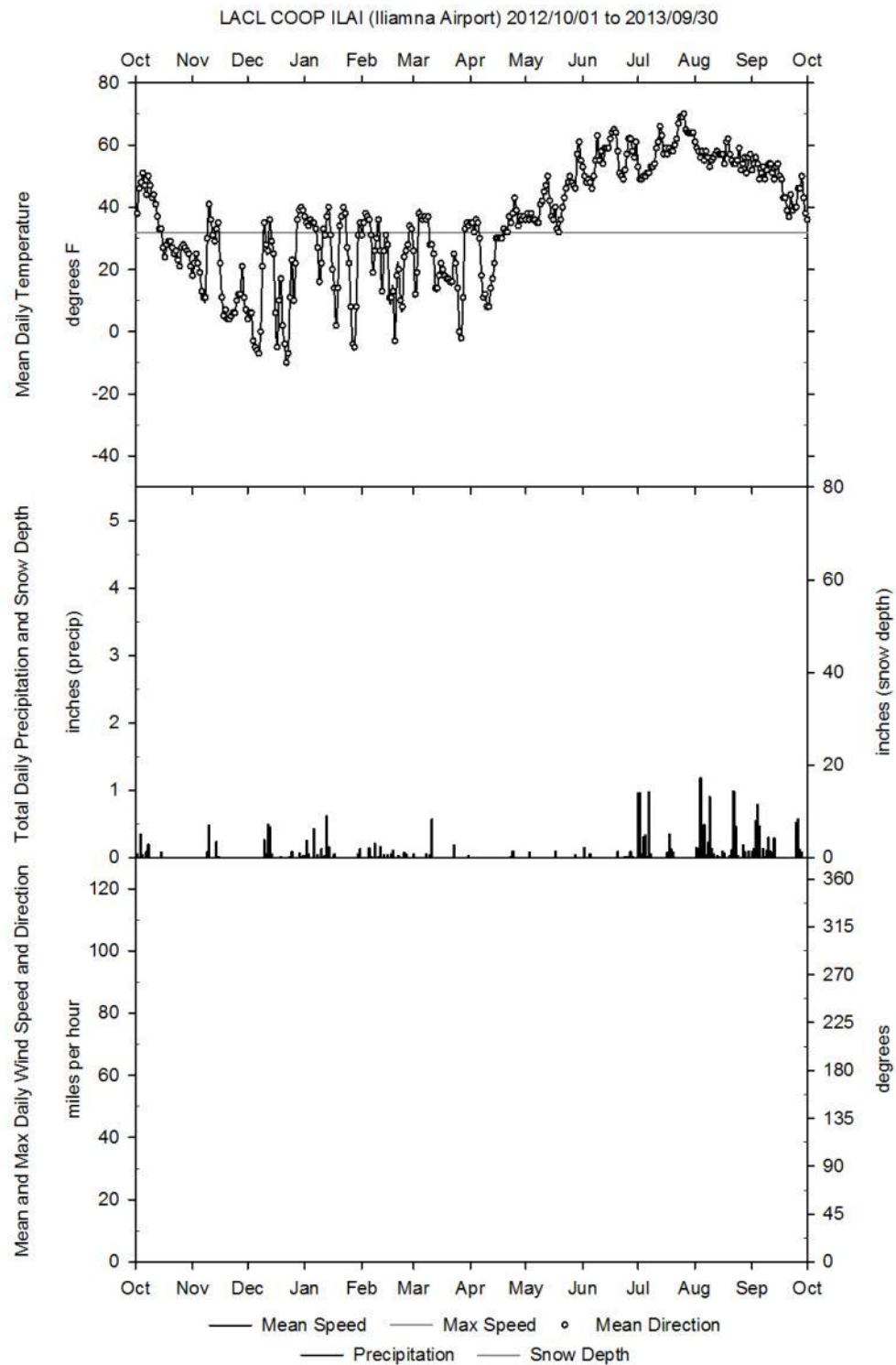
## Appendix 28-A Climate Graph for Drift River Terminal CMAN



## Appendix 28-B Climate Table for Drift River Terminal CMAN

| 2013 Hydrologic Year - LACL CMAN DRRI (Drift River Terminal) |      |      |      |      |      |      |      |      |      |      |      |      |      |
|--------------------------------------------------------------|------|------|------|------|------|------|------|------|------|------|------|------|------|
|                                                              | Oct  | Nov  | Dec  | Jan  | Feb  | Mar  | Apr  | May  | Jun  | Jul  | Aug  | Sep  | Year |
| <b>Minimum air temperature (F)</b>                           |      |      |      |      |      |      |      |      |      |      |      |      |      |
| Min.                                                         | 23.7 | 12.9 | 0.5  | -0.6 | 10.4 | 5.7  | 10.9 | 31.1 | 41.4 | 44.1 | 45.1 | 35.8 | -0.6 |
| Max.                                                         | 46.4 | 32.5 | 33.8 | 32.4 | 34.7 | 34.2 | 34.2 | 48.2 | 51.8 | 55.8 | 56.5 | 51.8 | 56.5 |
| Mean                                                         | 33.5 | 22.0 | 17.0 | 23.2 | 24.4 | 22.8 | 25.1 | 37.3 | 46.9 | 50.5 | 51.0 | 46.0 | 33.4 |
| # days <32 F                                                 | 15   | 28   | 26   | 24   | 24   | 26   | 25   | 1    | 0    | 0    | 0    | 0    | 169  |
| % valid obs                                                  | 100  | 100  | 99   | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  |
| <b>Maximum air temperature (F)</b>                           |      |      |      |      |      |      |      |      |      |      |      |      |      |
| Min                                                          | 32.5 | 20.5 | 11.3 | 11.3 | 18.7 | 15.1 | 19.2 | 36.5 | 45.7 | 50.2 | 52.0 | 43.0 | 11.3 |
| Max                                                          | 50.4 | 41.5 | 40.5 | 41.9 | 39.7 | 37.6 | 43.9 | 68.5 | 68.4 | 71.2 | 63.9 | 61.0 | 71.2 |
| Mean                                                         | 41.9 | 31.0 | 25.4 | 31.4 | 32.0 | 30.6 | 34.6 | 47.0 | 57.6 | 58.0 | 57.3 | 52.8 | 41.7 |
| # days <32 F                                                 | 0    | 15   | 23   | 12   | 13   | 16   | 8    | 0    | 0    | 0    | 0    | 0    | 87   |
| % valid obs                                                  | 100  | 100  | 99   | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  |
| <b>Mean air temperature (F)</b>                              |      |      |      |      |      |      |      |      |      |      |      |      |      |
| Observed                                                     | 37.4 | 26.4 | 21.1 | 27.1 | 28.2 | 26.7 | 29.8 | 41.5 | 50.8 | 53.7 | 54.1 | 49.1 | 37.2 |
| % valid obs                                                  | 100  | 100  | 99   | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  |
| POR mean                                                     |      |      |      |      |      |      |      |      |      |      |      |      |      |
| 1981-2010                                                    |      |      |      |      |      |      |      |      |      |      |      |      |      |
| <b>Precipitation</b>                                         |      |      |      |      |      |      |      |      |      |      |      |      |      |
| Total                                                        |      |      |      |      |      |      |      |      |      |      |      |      |      |
| % valid obs                                                  |      |      |      |      |      |      |      |      |      |      |      |      |      |
| POR mean                                                     |      |      |      |      |      |      |      |      |      |      |      |      |      |
| 1981-2010                                                    |      |      |      |      |      |      |      |      |      |      |      |      |      |
| <b>Snow depth (in)</b>                                       |      |      |      |      |      |      |      |      |      |      |      |      |      |
| Average                                                      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| % valid obs                                                  |      |      |      |      |      |      |      |      |      |      |      |      |      |
| POR mean                                                     |      |      |      |      |      |      |      |      |      |      |      |      |      |
| <b>Wind (mph, degrees)</b>                                   |      |      |      |      |      |      |      |      |      |      |      |      |      |
| Mean speed                                                   | 8.7  | 8.6  | 9.8  | 11.2 | 10.9 | 9.5  | 8.2  | 7.3  | 9.5  | 8.7  | 8.9  | 11.2 |      |
| % valid obs                                                  | 100  | 100  | 99   | 98   | 97   | 100  | 100  | 100  | 100  | 100  | 100  | 100  |      |
| Max speed                                                    | 30.6 | 51.0 | 42.1 | 39.1 | 33.3 | 39.1 | 31.8 | 25.3 | 31.3 | 28.6 | 33.6 | 34.4 | 51.0 |
| Max direction                                                |      |      |      |      |      |      |      |      |      |      |      |      |      |
| <b>Solar radiation (KWh/m2)</b>                              |      |      |      |      |      |      |      |      |      |      |      |      |      |
| Total                                                        |      |      |      |      |      |      |      |      |      |      |      |      |      |
| % valid obs                                                  |      |      |      |      |      |      |      |      |      |      |      |      |      |

## Appendix 29-A Climate Graph for Iliamna Airport COOP

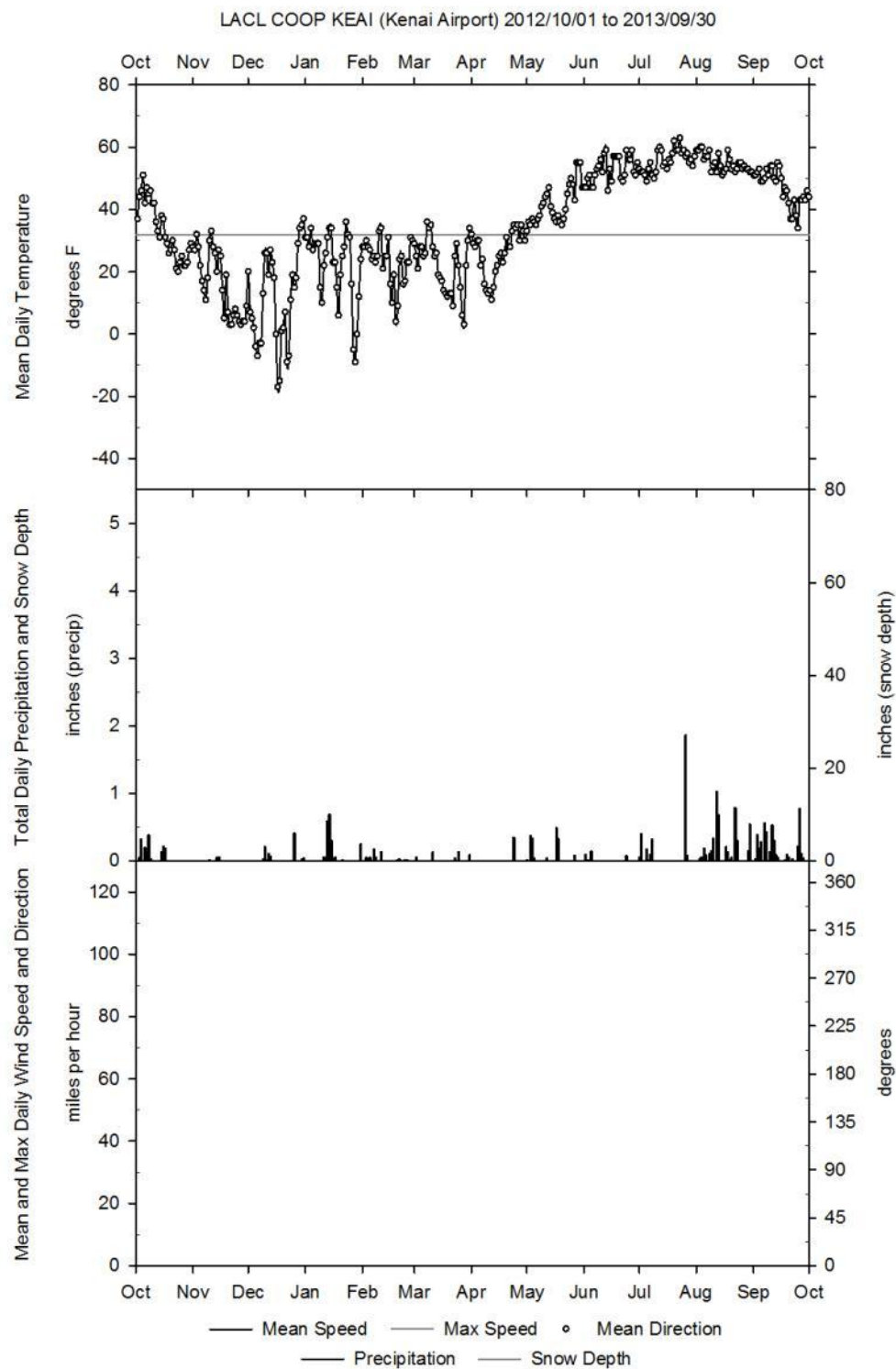


## Appendix 29-B Climate Table for Iliamna Airport COOP

| 2013 Hydrologic Year - LACL COOP ILAI (Iliamna Airport) |      |      |      |      |      |      |      |      |      |      |      |      |       |
|---------------------------------------------------------|------|------|------|------|------|------|------|------|------|------|------|------|-------|
|                                                         | Oct  | Nov  | Dec  | Jan  | Feb  | Mar  | Apr  | May  | Jun  | Jul  | Aug  | Sep  | Year  |
| <b>Minimum air temperature (F)</b>                      |      |      |      |      |      |      |      |      |      |      |      |      |       |
| Min.                                                    | 13   | -1   | -15  | -11  | -12  | -13  | -2   | 23   | 37   | 44   | 44   | 27   | -15   |
| Max.                                                    | 46   | 39   | 36   | 38   | 34   | 36   | 34   | 46   | 53   | 61   | 56   | 54   | 61    |
| Mean                                                    | 27.4 | 11.4 | 8.1  | 19.7 | 16.1 | 15.3 | 20.4 | 33.7 | 45.9 | 51.5 | 51.2 | 41.1 | 28.6  |
| # days <32 F                                            | 21   | 29   | 24   | 20   | 24   | 25   | 26   | 11   | 0    | 0    | 0    | 3    | 183   |
| % valid obs                                             | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100   |
| <b>Maximum air temperature (F)</b>                      |      |      |      |      |      |      |      |      |      |      |      |      |       |
| Min                                                     | 23   | 8    | -6   | 1    | 5    | 5    | 14   | 39   | 51   | 51   | 55   | 39   | -6    |
| Max                                                     | 55   | 43   | 44   | 44   | 43   | 42   | 53   | 77   | 85   | 83   | 75   | 65   | 85    |
| Mean                                                    | 39.1 | 22.2 | 21.4 | 31.7 | 31.6 | 30.4 | 36.9 | 51.9 | 65.9 | 66.9 | 61.0 | 53.2 | 42.8  |
| # days <32 F                                            | 6    | 23   | 19   | 10   | 12   | 16   | 7    | 0    | 0    | 0    | 0    | 0    | 93    |
| % valid obs                                             | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100   |
| <b>Mean air temperature (F)</b>                         |      |      |      |      |      |      |      |      |      |      |      |      |       |
| Observed                                                | 33.3 | 16.8 | 14.7 | 25.7 | 24.0 | 23.0 | 28.9 | 42.9 | 55.9 | 59.2 | 56.1 | 47.2 | 35.7  |
| % valid obs                                             | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100   |
| POR mean <sup>1</sup>                                   | 35.1 | 24.2 | 16.8 | 16.3 | 18.6 | 22.0 | 32.1 | 43.0 | 51.1 | 55.4 | 54.6 | 47.9 | 34.8  |
| 1981-2010                                               | 35.1 | 24.7 | 20.8 | 17.5 | 19.7 | 23.5 | 33.1 | 44.0 | 51.7 | 56.1 | 54.8 | 48.0 | 35.8  |
| <b>Precipitation</b>                                    |      |      |      |      |      |      |      |      |      |      |      |      |       |
| Total                                                   | 0.84 | 0.83 | 1.61 | 2.03 | 1.06 | 0.91 | 0.12 | 0.23 | 1.42 | 3.36 | 5.83 | 4.22 | 22.45 |
| % valid obs                                             | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100   |
| POR mean <sup>1</sup>                                   | 3.08 | 1.99 | 1.55 | 1.28 | 1.13 | 1.09 | 1.05 | 1.17 | 1.52 | 2.70 | 4.59 | 4.41 | 25.56 |
| 1981-2010                                               | 3.22 | 2.13 | 1.52 | 1.27 | 1.06 | 0.78 | 0.85 | 1.17 | 1.33 | 2.88 | 4.16 | 4.56 | 24.93 |
| <b>Snow depth (in)</b>                                  |      |      |      |      |      |      |      |      |      |      |      |      |       |
| Average                                                 |      |      |      |      |      |      |      |      |      |      |      |      |       |
| % valid obs                                             |      |      |      |      |      |      |      |      |      |      |      |      |       |
| POR mean <sup>1</sup>                                   | 0    | 2    | 4    | 8    | 9    | 10   | 7    | 1    | 0    | 0    | 0    | 0    |       |
| <b>Wind (mph, degrees)</b>                              |      |      |      |      |      |      |      |      |      |      |      |      |       |
| Mean speed                                              |      |      |      |      |      |      |      |      |      |      |      |      |       |
| % valid obs                                             |      |      |      |      |      |      |      |      |      |      |      |      |       |
| Max speed                                               |      |      |      |      |      |      |      |      |      |      |      |      |       |
| Max direction                                           |      |      |      |      |      |      |      |      |      |      |      |      |       |
| <b>Solar radiation (KWh/m2)</b>                         |      |      |      |      |      |      |      |      |      |      |      |      |       |
| Total                                                   |      |      |      |      |      |      |      |      |      |      |      |      |       |
| % valid obs                                             |      |      |      |      |      |      |      |      |      |      |      |      |       |

<sup>1</sup>Period of record used: 11/10/1939 to 09/30/2012

## Appendix 30-A Climate Graph for Kenai Airport COOP

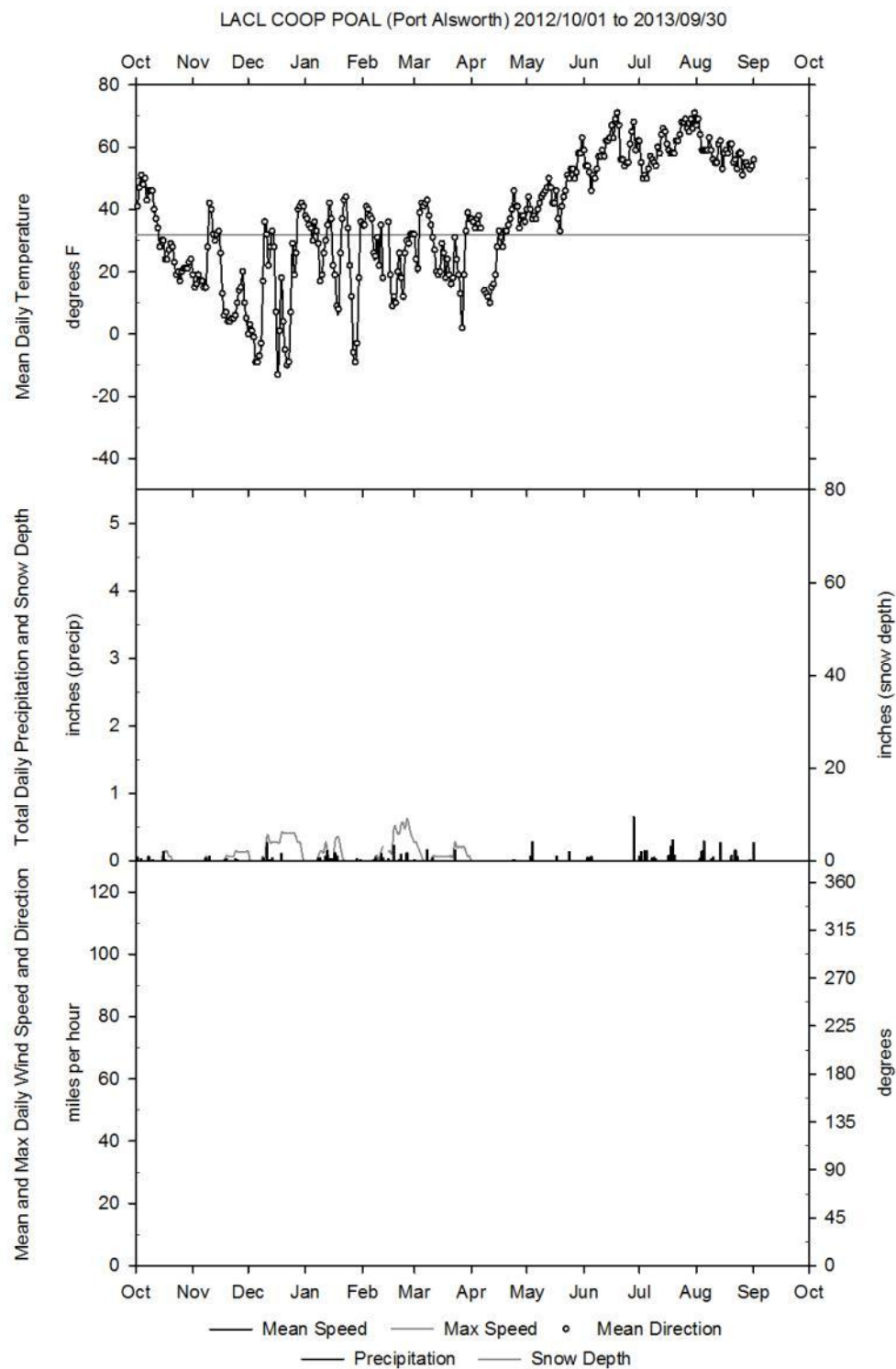


## Appendix 30-B Climate Table for Kenai Airport COOP

| 2013 Hydrologic Year - LACL COOP KEAI (Kenai Airport) |      |      |      |      |      |      |      |      |      |      |      |       |
|-------------------------------------------------------|------|------|------|------|------|------|------|------|------|------|------|-------|
|                                                       | Oct  | Nov  | Dec  | Jan  | Feb  | Mar  | Apr  | May  | Jun  | Jul  | Aug  | Year  |
| <b>Minimum air temperature (F)</b>                    |      |      |      |      |      |      |      |      |      |      |      |       |
| Min.                                                  | 7    | -12  | -28  | -20  | -12  | -11  | -1   | 24   | 36   | 43   | 39   | -28   |
| Max.                                                  | 45   | 31   | 34   | 34   | 30   | 29   | 32   | 43   | 49   | 57   | 54   | 57    |
| Mean                                                  | 25.1 | 6.0  | 1.1  | 15.8 | 16.6 | 13.1 | 16.0 | 33.5 | 44.2 | 48.5 | 48.7 | 25.8  |
| # days <32 F                                          | 20   | 30   | 30   | 29   | 28   | 31   | 29   | 10   | 0    | 0    | 0    | 211   |
| % valid obs                                           | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100   |
| <b>Maximum air temperature (F)</b>                    |      |      |      |      |      |      |      |      |      |      |      |       |
| Min                                                   | 30   | 14   | -8   | 3    | 19   | 17   | 19   | 38   | 49   | 51   | 54   | -8    |
| Max                                                   | 57   | 37   | 41   | 39   | 40   | 43   | 43   | 73   | 75   | 76   | 68   | 76    |
| Mean                                                  | 41.1 | 25.6 | 20.7 | 28.2 | 30.0 | 30.7 | 34.8 | 50.5 | 62.0 | 63.2 | 60.4 | 41.8  |
| # days <32 F                                          | 1    | 23   | 24   | 14   | 17   | 17   | 7    | 0    | 0    | 0    | 0    | 103   |
| % valid obs                                           | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100   |
| <b>Mean air temperature (F)</b>                       |      |      |      |      |      |      |      |      |      |      |      |       |
| Observed                                              | 33.1 | 15.8 | 11.0 | 22.0 | 23.4 | 22.0 | 25.8 | 42.1 | 53.1 | 55.8 | 54.6 | 33.9  |
| % valid obs                                           | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100   |
| POR mean <sup>1</sup>                                 | 35.0 | 21.8 | 15.0 | 12.5 | 17.5 | 22.8 | 34.6 | 44.3 | 50.9 | 54.8 | 53.9 | 34.2  |
| 1981-2010                                             | 35.2 | 23.2 | 19.0 | 16.4 | 19.7 | 25.7 | 36.2 | 46.0 | 52.5 | 56.3 | 55.0 | 36.2  |
| <b>Precipitation</b>                                  |      |      |      |      |      |      |      |      |      |      |      |       |
| Total                                                 | 1.74 | 0.15 | 0.92 | 2.04 | 0.62 | 0.45 | 0.38 | 1.74 | 0.41 | 2.96 | 4.88 | 20.63 |
| % valid obs                                           | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100   |
| POR mean <sup>1</sup>                                 | 2.44 | 1.50 | 1.34 | 0.99 | 0.96 | 0.80 | 0.74 | 0.89 | 1.21 | 1.89 | 2.61 | 18.71 |
| 1981-2010                                             | 2.63 | 1.38 | 1.35 | 0.96 | 0.88 | 0.64 | 0.59 | 0.91 | 1.07 | 1.84 | 2.69 | 18.21 |
| <b>Snow depth (in)</b>                                |      |      |      |      |      |      |      |      |      |      |      |       |
| Average                                               |      |      |      |      |      |      |      |      |      |      |      |       |
| % valid obs                                           |      |      |      |      |      |      |      |      |      |      |      |       |
| POR mean                                              |      |      |      |      |      |      |      |      |      |      |      |       |
| <b>Wind (mph, degrees)</b>                            |      |      |      |      |      |      |      |      |      |      |      |       |
| Mean speed                                            |      |      |      |      |      |      |      |      |      |      |      |       |
| % valid obs                                           |      |      |      |      |      |      |      |      |      |      |      |       |
| Max speed                                             |      |      |      |      |      |      |      |      |      |      |      |       |
| Max direction                                         |      |      |      |      |      |      |      |      |      |      |      |       |
| <b>Solar radiation (KWh/m2)</b>                       |      |      |      |      |      |      |      |      |      |      |      |       |
| Total                                                 |      |      |      |      |      |      |      |      |      |      |      |       |
| % valid obs                                           |      |      |      |      |      |      |      |      |      |      |      |       |

<sup>1</sup>Period of record used: 09/03/1949 to 09/30/2012

## Appendix 31-A Climate Graph for Port Alsworth COOP



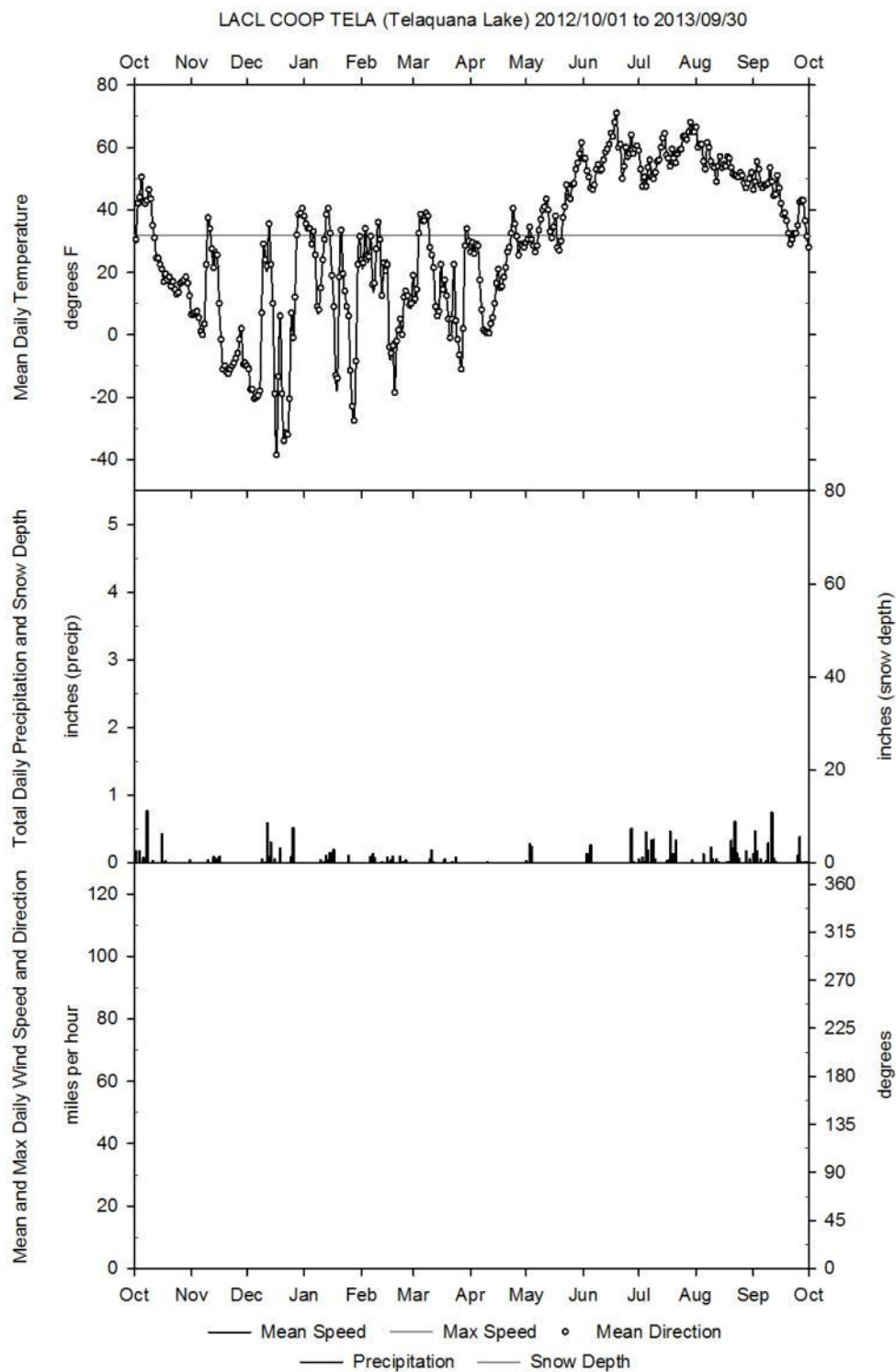
## Appendix 31-B Climate Table for Port Alsworth COOP

| 2013 Hydrologic Year - LACL COOP POAL (Port Alsworth) |      |      |      |      |      |      |      |      |      |      |      |      |       |
|-------------------------------------------------------|------|------|------|------|------|------|------|------|------|------|------|------|-------|
|                                                       | Oct  | Nov  | Dec  | Jan  | Feb  | Mar  | Apr  | May  | Jun  | Jul  | Aug  | Sep  | Year  |
| Minimum air temperature (F)                           |      |      |      |      |      |      |      |      |      |      |      |      |       |
| Min.*                                                 | 7    | -3   | -17  | -18  | 0    | -10  | 0    | 24   | 30   | 42   | 36   |      | -18   |
| Max.*                                                 | 48   | 40   | 40   | 42   | 40   | 40   | 40   | 45   | 56   | 59   | 62   |      | 62    |
| Mean*                                                 | 23.4 | 10.8 | 7.9  | 19.5 | 20.0 | 19.5 | 19.7 | 34.4 | 44.9 | 50.3 | 51.1 |      | 27.5  |
| # days <32 F*                                         | 21   | 28   | 25   | 23   | 21   | 22   | 29   | 8    | 1    | 0    | 0    |      | 178   |
| % valid obs                                           | 100  | 100  | 100  | 100  | 93   | 100  | 100  | 100  | 100  | 100  | 100  | 0    | 91    |
| Maximum air temperature (F)                           |      |      |      |      |      |      |      |      |      |      |      |      |       |
| Min.*                                                 | 25   | 3    | -10  | 0    | 14   | 14   | 20   | 42   | 55   | 55   | 56   |      | -10   |
| Max.*                                                 | 62   | 44   | 45   | 46   | 43   | 50   | 54   | 82   | 89   | 83   | 75   |      | 89    |
| Mean*                                                 | 39.7 | 22.6 | 21.0 | 31.1 | 33.1 | 34.9 | 41.7 | 58.0 | 72.8 | 71.5 | 64.3 |      | 44.8  |
| # days <32 F*                                         | 9    | 20   | 18   | 12   | 6    | 10   | 7    | 0    | 0    | 0    | 0    |      | 82    |
| % valid obs                                           | 100  | 100  | 100  | 100  | 93   | 100  | 97   | 100  | 100  | 100  | 100  | 0    | 91    |
| Mean air temperature (F)                              |      |      |      |      |      |      |      |      |      |      |      |      |       |
| Observed*                                             | 31.5 | 16.7 | 14.4 | 25.4 | 26.6 | 27.3 | 30.7 | 46.3 | 58.9 | 60.8 | 57.7 |      | 36.2  |
| % valid obs                                           | 100  | 100  | 100  | 100  | 93   | 100  | 97   | 100  | 100  | 100  | 100  | 0    | 91    |
| POR mean <sup>1</sup>                                 | 34.5 | 23.6 | 16.7 | 14.1 | 17.3 | 22.3 | 34.1 | 44.9 | 53.2 | 57.1 | 55.2 | 47.4 | 35.0  |
| 1981-2010                                             | 34.5 | 23.8 | 19.4 | 15.5 | 18.6 | 24.3 | 35.2 | 46.0 | 54.3 | 57.9 | 55.5 | 47.4 | 36.1  |
| Precipitation                                         |      |      |      |      |      |      |      |      |      |      |      |      |       |
| Total*                                                | 0.33 | 0.22 | 0.51 | 0.60 | 0.74 | 0.36 | 0.02 | 0.56 | 0.84 | 1.24 | 1.43 |      | 6.86  |
| % valid obs                                           | 100  | 100  | 100  | 100  | 93   | 100  | 100  | 100  | 100  | 100  | 100  | 0    | 91    |
| POR mean <sup>1</sup>                                 | 1.63 | 1.40 | 1.11 | 0.82 | 0.69 | 0.70 | 0.57 | 0.52 | 1.14 | 1.59 | 2.39 | 2.35 | 14.91 |
| 1981-2010                                             | 1.50 | 1.46 | 0.91 | 0.81 | 0.82 | 0.66 | 0.49 | 0.41 | 0.74 | 1.33 | 1.89 | 2.21 | 13.23 |
| Snow depth (in)                                       |      |      |      |      |      |      |      |      |      |      |      |      |       |
| Average                                               | 0    | 1    | 3    | 1    | 4    | 1    | 0    | 0    | 0    | 0    | 0    |      |       |
| % valid obs                                           | 100  | 100  | 100  | 100  | 93   | 100  | 100  | 100  | 100  | 100  | 100  | 0    |       |
| POR mean <sup>1</sup>                                 | 0    | 3    | 6    | 6    | 6    | 5    | 2    | 0    | 0    | 0    | 0    | 0    |       |
| Wind (mph, degrees)                                   |      |      |      |      |      |      |      |      |      |      |      |      |       |
| Mean speed                                            |      |      |      |      |      |      |      |      |      |      |      |      |       |
| % valid obs                                           |      |      |      |      |      |      |      |      |      |      |      |      |       |
| Max speed                                             |      |      |      |      |      |      |      |      |      |      |      |      |       |
| Max direction                                         |      |      |      |      |      |      |      |      |      |      |      |      |       |
| Solar radiation (KWh/m2)                              |      |      |      |      |      |      |      |      |      |      |      |      |       |
| Total                                                 |      |      |      |      |      |      |      |      |      |      |      |      |       |
| % valid obs                                           |      |      |      |      |      |      |      |      |      |      |      |      |       |

\* Station data not available for September, 2013. Yearly summaries reflect missing values.

<sup>1</sup>Period of record used: 07/01/1962 to 07/31/2012

## Appendix 32-A Climate Graph for Telaquana Lake COOP

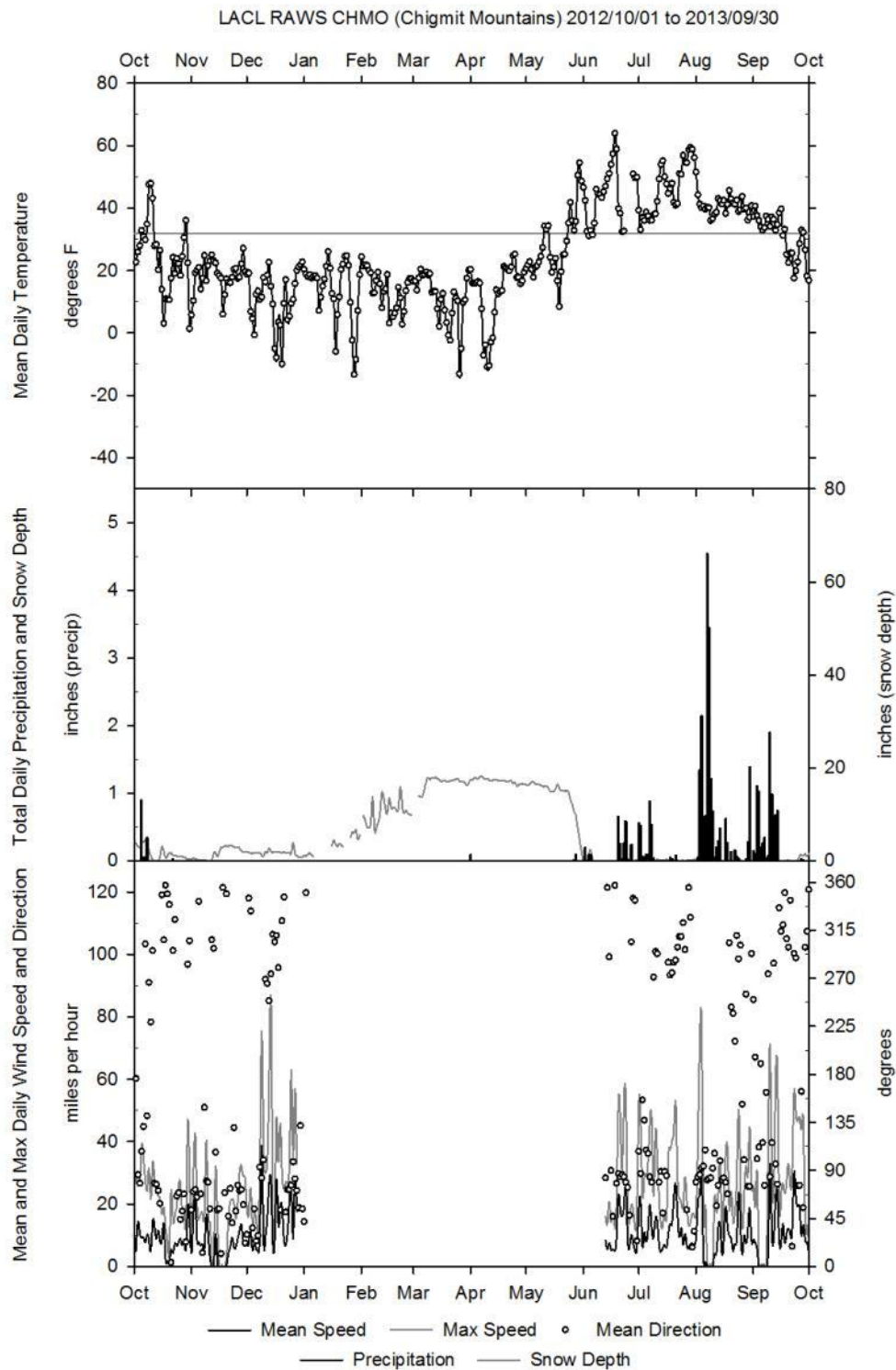


## Appendix 32-B Climate Table for Telaquana Lake COOP

| 2013 Hydrologic Year - LACL COOP TELA (Telaquana Lake) |      |      |      |      |      |      |      |      |      |      |      |      |       |
|--------------------------------------------------------|------|------|------|------|------|------|------|------|------|------|------|------|-------|
|                                                        | Oct  | Nov  | Dec  | Jan  | Feb  | Mar  | Apr  | May  | Jun  | Jul  | Aug  | Sep  | Year  |
| <b>Minimum air temperature (F)</b>                     |      |      |      |      |      |      |      |      |      |      |      |      |       |
| Min.                                                   | -1   | -19  | -46  | -35  | -28  | -25  | -11  | 14   | 34   | 43   | 38   | 19   | -46   |
| Max.                                                   | 40   | 35   | 37   | 36   | 32   | 36   | 33   | 45   | 57   | 56   | 55   | 52   | 57    |
| Mean                                                   | 19.9 | -2.3 | -8.9 | 7.9  | 3.8  | 7.9  | 9.1  | 28.7 | 46.3 | 49.3 | 46.7 | 35.9 | 20.5  |
| # days <32 F                                           | 23   | 29   | 27   | 28   | 27   | 28   | 29   | 19   | 0    | 0    | 0    | 9    | 219   |
| % valid obs                                            | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100   |
| <b>Maximum air temperature (F)</b>                     |      |      |      |      |      |      |      |      |      |      |      |      |       |
| Min                                                    | 14   | -7   | -31  | -20  | -9   | -2   | 7    | 32   | 52   | 51   | 49   | 31   | -31   |
| Max                                                    | 61   | 40   | 44   | 45   | 43   | 42   | 48   | 78   | 87   | 80   | 73   | 61   | 87    |
| Mean                                                   | 31.3 | 10.0 | 10.8 | 24.2 | 24.3 | 27.6 | 31.2 | 50.6 | 68.1 | 66.4 | 60.6 | 48.0 | 37.9  |
| # days <32 F                                           | 20   | 25   | 20   | 17   | 17   | 18   | 12   | 0    | 0    | 0    | 0    | 1    | 130   |
| % valid obs                                            | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100   |
| <b>Mean air temperature (F)</b>                        |      |      |      |      |      |      |      |      |      |      |      |      |       |
| Observed                                               | 25.6 | 3.9  | 1.0  | 16.1 | 14.1 | 17.7 | 20.1 | 39.7 | 57.2 | 57.9 | 53.7 | 42.0 | 29.2  |
| % valid obs                                            | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100   |
| POR mean                                               |      |      |      |      |      |      |      |      |      |      |      |      |       |
| 1981-2010                                              |      |      |      |      |      |      |      |      |      |      |      |      |       |
| <b>Precipitation</b>                                   |      |      |      |      |      |      |      |      |      |      |      |      |       |
| Total <sup>2</sup>                                     | 1.78 | 0.30 | 1.95 | 0.70 | 0.73 | 0.42 | 0.05 | 0.52 | 1.01 | 2.66 | 2.31 | 2.50 | 14.93 |
| % valid obs                                            | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100   |
| POR mean                                               |      |      |      |      |      |      |      |      |      |      |      |      |       |
| 1981-2010                                              |      |      |      |      |      |      |      |      |      |      |      |      |       |
| <b>Snow depth (in)</b>                                 |      |      |      |      |      |      |      |      |      |      |      |      |       |
| Average                                                |      |      |      |      |      |      |      |      |      |      |      |      |       |
| % valid obs                                            |      |      |      |      |      |      |      |      |      |      |      |      |       |
| POR mean                                               |      |      |      |      |      |      |      |      |      |      |      |      |       |
| <b>Wind (mph, degrees)</b>                             |      |      |      |      |      |      |      |      |      |      |      |      |       |
| Mean speed                                             |      |      |      |      |      |      |      |      |      |      |      |      |       |
| % valid obs                                            |      |      |      |      |      |      |      |      |      |      |      |      |       |
| Max speed                                              |      |      |      |      |      |      |      |      |      |      |      |      |       |
| Max direction                                          |      |      |      |      |      |      |      |      |      |      |      |      |       |
| <b>Solar radiation (KWh/m2)</b>                        |      |      |      |      |      |      |      |      |      |      |      |      |       |
| Total                                                  |      |      |      |      |      |      |      |      |      |      |      |      |       |
| % valid obs                                            |      |      |      |      |      |      |      |      |      |      |      |      |       |

<sup>2</sup>Total precipitation (rain and snow water equivalent) reported for the 2013 hydrologic year.

## Appendix 33-A Climate Graph for Chigmit Mountains RAWS

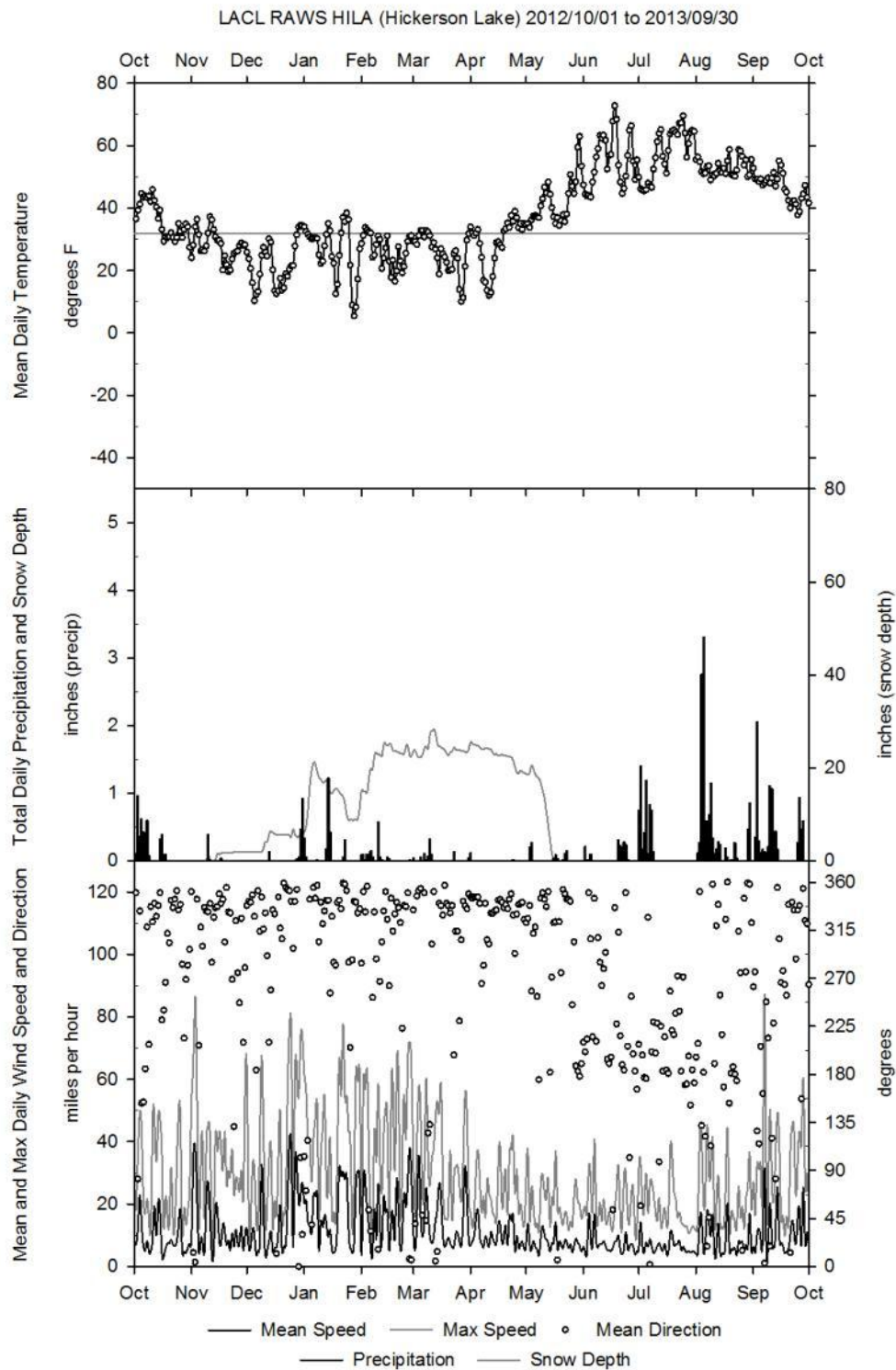


## Appendix 33-B Climate Table for Chigmit Mountains RAWS

| 2013 Hydrologic Year - LACL RAWS CHMO (Chigmit Mountains) |      |      |       |       |       |       |       |       |       |       |       |      |        |
|-----------------------------------------------------------|------|------|-------|-------|-------|-------|-------|-------|-------|-------|-------|------|--------|
|                                                           | Oct  | Nov  | Dec   | Jan   | Feb   | Mar   | Apr   | May   | Jun   | Jul   | Aug   | Sep  | Year   |
| <b>Minimum air temperature (F)</b>                        |      |      |       |       |       |       |       |       |       |       |       |      |        |
| Min.                                                      | -1.5 | 2.3  | -18.2 | -19.3 | -11.9 | -20.6 | -16.6 | 3.0   | 28.2  | 31.1  | 32.4  | 12.6 | -20.6  |
| Max.                                                      | 44.4 | 23.0 | 20.8  | 23.7  | 20.7  | 19.0  | 20.5  | 48.7  | 56.7  | 53.4  | 41.7  | 38.3 | 56.7   |
| Mean                                                      | 18.5 | 14.0 | 5.3   | 9.2   | 8.8   | 6.1   | 6.6   | 23.3  | 39.5  | 42.2  | 37.5  | 26.9 | 19.8   |
| # days <32 F                                              | 28   | 30   | 31    | 31    | 28    | 31    | 30    | 25    | 9     | 1     | 0     | 18   | 262    |
| % valid obs                                               | 100  | 100  | 100   | 100   | 100   | 100   | 100   | 100   | 84    | 100   | 100   | 98   | 99     |
| <b>Maximum air temperature (F)</b>                        |      |      |       |       |       |       |       |       |       |       |       |      |        |
| Min                                                       | 4.8  | 9.9  | -1.7  | -6.9  | 8.4   | 2.8   | -7.4  | 14.9  | 33.4  | 35.1  | 39.0  | 18.9 | -7.4   |
| Max                                                       | 54.1 | 34.3 | 28.2  | 32.4  | 25.3  | 36.1  | 37.2  | 62.8  | 71.1  | 67.6  | 52.7  | 50.4 | 71.1   |
| Mean                                                      | 30.4 | 23.7 | 15.9  | 17.9  | 18.8  | 18.2  | 20.3  | 37.6  | 50.1  | 52.2  | 43.9  | 36.1 | 30.3   |
| # days <32 F                                              | 18   | 28   | 31    | 30    | 28    | 30    | 28    | 12    | 4     | 0     | 0     | 7    | 216    |
| % valid obs                                               | 100  | 100  | 100   | 100   | 100   | 100   | 100   | 100   | 83    | 100   | 100   | 98   | 98     |
| <b>Mean air temperature (F)</b>                           |      |      |       |       |       |       |       |       |       |       |       |      |        |
| Observed                                                  | 23.9 | 18.8 | 10.9  | 13.8  | 13.6  | 11.1  | 12.4  | 28.9  | 43.8  | 46.6  | 40.3  | 30.7 | 24.3   |
| % valid obs                                               | 100  | 100  | 100   | 100   | 100   | 100   | 100   | 100   | 83    | 100   | 100   | 99   | 98     |
| POR mean                                                  |      |      |       |       |       |       |       |       |       |       |       |      |        |
| 1981-2010                                                 |      |      |       |       |       |       |       |       |       |       |       |      |        |
| <b>Precipitation</b>                                      |      |      |       |       |       |       |       |       |       |       |       |      |        |
| Total <sup>2</sup>                                        | 1.34 | 0.00 |       | 0.01  |       | 0.09  | 0.00  | 0.14  | 3.02  | 2.46  | 18.36 | 7.53 | 32.95  |
| % valid obs                                               | 26   | 1    | 0     | 0     | 0     | 1     | 1     | 40    | 95    | 100   | 99    | 62   | 36     |
| POR mean                                                  |      |      |       |       |       |       |       |       |       |       |       |      |        |
| 1981-2010                                                 |      |      |       |       |       |       |       |       |       |       |       |      |        |
| <b>Snow depth (in)</b>                                    |      |      |       |       |       |       |       |       |       |       |       |      |        |
| Average                                                   | 1.6  | 1.7  | 1.7   | 3.1   | 9.7   | 17.1  | 17.2  | 13.4  | 0.3   | 0.2   | 0.2   | 1.1  |        |
| % valid obs                                               | 98   | 100  | 99    | 43    | 47    | 84    | 91    | 89    | 20    | 55    | 7     | 21   |        |
| POR mean                                                  |      |      |       |       |       |       |       |       |       |       |       |      |        |
| <b>Wind (mph, degrees)</b>                                |      |      |       |       |       |       |       |       |       |       |       |      |        |
| Mean speed                                                | 8.5  | 6.9  | 14.8  |       |       |       |       |       | 11.2  | 11.1  | 9.7   | 11.1 |        |
| % valid obs                                               | 100  | 100  | 84    | 0     | 0     | 0     | 0     | 0     | 60    | 100   | 100   | 99   |        |
| Max speed                                                 | 46.8 | 42.5 | 84.8  |       |       |       |       |       | 53.2  | 52.6  | 76.5  | 71.1 | 84.8   |
| Max direction                                             | 287  | 68   | 271   |       |       |       |       |       | 86    | 280   | 68    | 73   | 271    |
| <b>Solar radiation (KWh/m2)</b>                           |      |      |       |       |       |       |       |       |       |       |       |      |        |
| Total                                                     | 52.3 | 18.1 | 7.5   | 8.2   | 27.3  | 84.9  | 175.7 | 227.7 | 209.3 | 201.0 | 95.7  | 76.4 | 1184.2 |
| % valid obs                                               | 100  | 100  | 100   | 100   | 100   | 100   | 100   | 100   | 100   | 100   | 100   | 99   | 100    |

<sup>2</sup>Station is only capable of measuring liquid precipitation. Precipitation reported when maximum air temperature is below 31.1 °F is not considered valid and these data are not used for summarizing purposes. The water equivalent of solid precipitation (e.g. snowfall) is not measured and this is reflected in the percentage of valid observations that are reported as a measure of the reliability of cumulative values.

## Appendix 34-A Climate Graph for Hickerson Lake RAWS

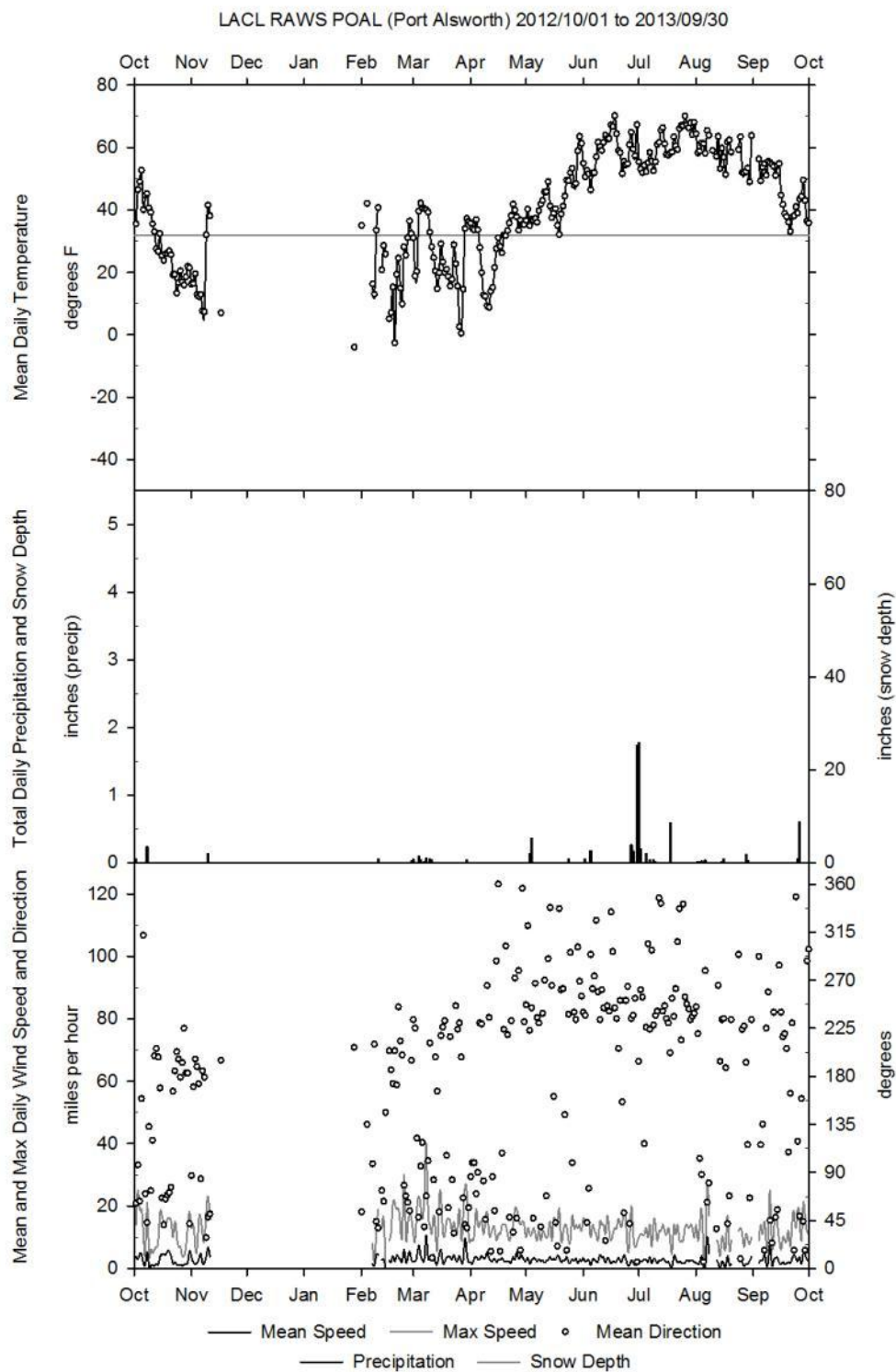


## Appendix 34-B Climate Table for Hickerson Lake RAWS

| 2013 Hydrologic Year - LACL RAWS HILA (Hickerson Lake) |      |      |      |      |      |      |       |       |       |       |       |      |        |
|--------------------------------------------------------|------|------|------|------|------|------|-------|-------|-------|-------|-------|------|--------|
|                                                        | Oct  | Nov  | Dec  | Jan  | Feb  | Mar  | Apr   | May   | Jun   | Jul   | Aug   | Sep  | Year   |
| <b>Minimum air temperature (F)</b>                     |      |      |      |      |      |      |       |       |       |       |       |      |        |
| Min.                                                   | 20.7 | 15.8 | 5.4  | 2.5  | 9.9  | 0.1  | 2.3   | 27.9  | 39.2  | 43.9  | 44.6  | 34.0 | 0.1    |
| Max.                                                   | 42.8 | 34.3 | 32.7 | 34.5 | 31.6 | 31.5 | 32.4  | 51.1  | 60.8  | 61.0  | 52.3  | 48.9 | 61.0   |
| Mean                                                   | 31.9 | 23.5 | 17.4 | 22.1 | 21.9 | 20.8 | 22.3  | 35.8  | 47.2  | 51.5  | 49.3  | 42.4 | 32.2   |
| # days <32 F                                           | 17   | 27   | 29   | 27   | 28   | 31   | 29    | 10    | 0     | 0     | 0     | 0    | 198    |
| % valid obs                                            | 100  | 100  | 100  | 100  | 100  | 100  | 100   | 100   | 100   | 100   | 100   | 100  | 100    |
| <b>Maximum air temperature (F)</b>                     |      |      |      |      |      |      |       |       |       |       |       |      |        |
| Min                                                    | 28.6 | 21.9 | 13.5 | 9.5  | 20.8 | 15.8 | 18.9  | 37.0  | 46.2  | 47.3  | 52.0  | 40.5 | 9.5    |
| Max                                                    | 53.1 | 42.6 | 38.5 | 41.7 | 39.4 | 49.5 | 49.1  | 73.4  | 83.3  | 78.1  | 71.4  | 63.5 | 83.3   |
| Mean                                                   | 41.2 | 32.7 | 26.2 | 29.7 | 31.3 | 32.0 | 37.6  | 50.4  | 63.5  | 65.2  | 58.5  | 51.6 | 43.4   |
| # days <32 F                                           | 1    | 13   | 25   | 19   | 15   | 11   | 6     | 0     | 0     | 0     | 0     | 0    | 90     |
| % valid obs                                            | 100  | 100  | 100  | 100  | 100  | 100  | 100   | 100   | 100   | 100   | 100   | 100  | 100    |
| <b>Mean air temperature (F)</b>                        |      |      |      |      |      |      |       |       |       |       |       |      |        |
| Observed                                               | 35.8 | 28.0 | 21.9 | 26.1 | 26.5 | 25.6 | 28.8  | 42.3  | 55.2  | 58.0  | 53.0  | 46.3 | 37.4   |
| % valid obs                                            | 100  | 100  | 100  | 100  | 100  | 100  | 100   | 100   | 100   | 100   | 100   | 100  | 100    |
| POR mean<br>1981-2010                                  |      |      |      |      |      |      |       |       |       |       |       |      |        |
| <b>Precipitation</b>                                   |      |      |      |      |      |      |       |       |       |       |       |      |        |
| Total <sup>2</sup>                                     | 4.18 | 0.46 | 1.95 | 2.37 | 1.32 | 1.00 | 0.03  | 0.90  | 2.38  | 4.99  | 12.52 | 8.50 | 40.60  |
| % valid obs                                            | 100  | 99   | 99   | 100  | 100  | 100  | 100   | 100   | 100   | 100   | 100   | 99   | 100    |
| POR mean<br>1981-2010                                  |      |      |      |      |      |      |       |       |       |       |       |      |        |
| <b>Snow depth (in)</b>                                 |      |      |      |      |      |      |       |       |       |       |       |      |        |
| Average                                                | 0.0  | 1.1  | 4.5  | 14.2 | 22.2 | 24.3 | 22.5  | 6.5   | 0.0   | 0.0   | 0.0   | 0.1  |        |
| % valid obs                                            | 100  | 100  | 100  | 100  | 100  | 100  | 100   | 100   | 100   | 100   | 86    | 0    |        |
| POR mean                                               |      |      |      |      |      |      |       |       |       |       |       |      |        |
| <b>Wind (mph, degrees)</b>                             |      |      |      |      |      |      |       |       |       |       |       |      |        |
| Mean speed                                             | 9.3  | 12.5 | 14.6 | 16.3 | 17.2 | 13.8 | 9.8   | 7.6   | 7.2   | 6.5   | 8.6   | 11.0 |        |
| % valid obs                                            | 100  | 100  | 100  | 100  | 100  | 100  | 100   | 100   | 100   | 100   | 100   | 100  |        |
| Max speed                                              | 53.7 | 86.6 | 75.4 | 77.6 | 71.8 | 60.4 | 41.4  | 37.1  | 40.7  | 37.6  | 45.4  | 87.2 | 87.2   |
| Max direction                                          | 344  | 347  | 353  | 0    | 358  | 66   | 340   | 330   | 348   | 259   | 1     | 358  | 358    |
| <b>Solar radiation (KWh/m2)</b>                        |      |      |      |      |      |      |       |       |       |       |       |      |        |
| Total                                                  | 45.8 | 19.1 | 7.5  | 9.4  | 28.2 | 89.5 | 181.9 | 198.6 | 192.5 | 187.8 | 84.2  | 72.4 | 1116.8 |
| % valid obs                                            | 100  | 100  | 100  | 100  | 100  | 100  | 100   | 100   | 100   | 100   | 100   | 100  | 100    |

<sup>2</sup>Station is only capable of measuring liquid precipitation. Precipitation reported when maximum air temperature is below 31.1 °F is not considered valid and these data are not used for summarizing purposes. The water equivalent of solid precipitation (e.g. snowfall) is not measured and this is reflected in the percentage of valid observations that are reported as a measure of the reliability of cumulative values.

## Appendix 35-A Climate Graph for Port Alsworth RAWS

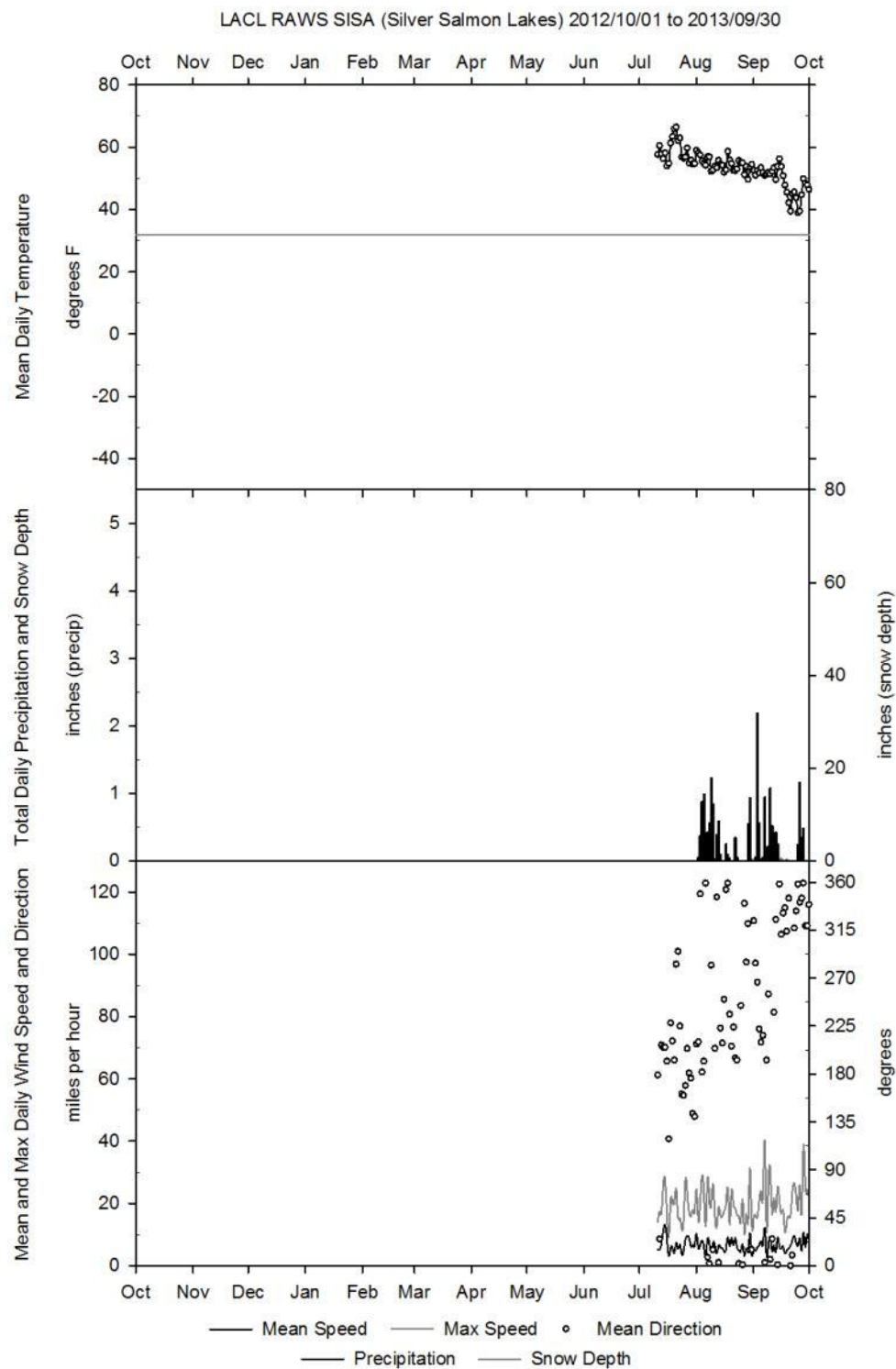


## Appendix 35-B Climate Table for Port Alsworth RAWS

| 2013 Hydrologic Year - LACL RAWS POAL (Port Alsworth) |      |      |     |      |      |      |       |       |       |       |      |      |       |
|-------------------------------------------------------|------|------|-----|------|------|------|-------|-------|-------|-------|------|------|-------|
|                                                       | Oct  | Nov  | Dec | Jan  | Feb  | Mar  | Apr   | May   | Jun   | Jul   | Aug  | Sep  | Year  |
| <b>Minimum air temperature (F)</b>                    |      |      |     |      |      |      |       |       |       |       |      |      |       |
| Min.*                                                 | 2    | -3   |     | -8   | -18  | -17  | -5    | 18    | 27    | 40    | 35   | 20   | -18   |
| Max.*                                                 | 42   | 40   |     | 33   | 39   | 39   | 35    | 42    | 55    | 56    | 63   | 54   | 63    |
| Mean*                                                 | 20.9 | 8.5  |     | 12.5 | 14.1 | 14.0 | 14.4  | 28.4  | 41.4  | 47.9  | 50.6 | 36.8 | 28.8  |
| # days <32 F*                                         | 25   | 10   |     | 1    | 19   | 25   | 29    | 22    | 1     | 0     | 0    | 10   | 142   |
| % valid obs                                           | 93   | 33   | 0   | 1    | 58   | 100  | 100   | 100   | 97    | 86    | 44   | 73   | 65    |
| <b>Maximum air temperature (F)</b>                    |      |      |     |      |      |      |       |       |       |       |      |      |       |
| Min.*                                                 | 24   | 15   |     | -1   | 9    | 11   | 16    | 41    | 56    | 56    | 49   | 38   | -1    |
| Max.*                                                 | 63   | 43   |     | 36   | 45   | 51   | 55    | 85    | 90    | 86    | 74   | 70   | 90    |
| Mean*                                                 | 38.8 | 28.2 |     | 17.5 | 30.5 | 36.2 | 41.6  | 57.8  | 73.6  | 72.7  | 64.0 | 54.6 | 51.4  |
| # days <32 F*                                         | 8    | 7    |     | 1    | 10   | 7    | 7     | 0     | 0     | 0     | 0    | 0    | 40    |
| % valid obs                                           | 93   | 33   | 0   | 1    | 58   | 100  | 100   | 100   | 97    | 86    | 44   | 73   | 65    |
| <b>Mean air temperature (F)</b>                       |      |      |     |      |      |      |       |       |       |       |      |      |       |
| Observed*                                             | 27.8 | 19.5 |     | 13.3 | 21.5 | 25.7 | 28.7  | 44.4  | 58.6  | 61.7  | 57.4 | 44.0 | 39.7  |
| % valid obs                                           | 93   | 33   | 0   | 1    | 58   | 100  | 100   | 100   | 97    | 86    | 44   | 73   | 65    |
| POR mean<br>1981-2010                                 |      |      |     |      |      |      |       |       |       |       |      |      |       |
| <b>Precipitation</b>                                  |      |      |     |      |      |      |       |       |       |       |      |      |       |
| Total <sup>2</sup>                                    | 0.29 | 0.14 |     | 0.00 | 0.13 | 0.40 | 0.01  | 0.56  | 4.18  | 1.06  | 0.33 | 1.35 | 8.45  |
| % valid obs                                           | 30   | 8    | 0   | 1    | 15   | 40   | 45    | 82    | 97    | 84    | 43   | 63   | 42    |
| POR mean<br>1981-2010                                 |      |      |     |      |      |      |       |       |       |       |      |      |       |
| <b>Snow depth (in)</b>                                |      |      |     |      |      |      |       |       |       |       |      |      |       |
| Average                                               |      |      |     |      |      |      |       |       |       |       |      |      |       |
| % valid obs                                           |      |      |     |      |      |      |       |       |       |       |      |      |       |
| POR mean                                              |      |      |     |      |      |      |       |       |       |       |      |      |       |
| <b>Wind (mph, degrees)</b>                            |      |      |     |      |      |      |       |       |       |       |      |      |       |
| Mean speed*                                           | 2.7  | 3.1  |     | 1.7  | 3.2  | 3.8  | 3.1   | 2.7   | 2.5   | 2.3   | 2.1  | 2.8  |       |
| % valid obs                                           | 93   | 33   | 0   | 1    | 58   | 100  | 100   | 100   | 97    | 86    | 44   | 73   |       |
| Max speed*                                            | 25   | 23   |     | 6    | 30   | 40   | 19    | 19    | 20    | 15    | 28   | 25   | 40    |
| Max direction*                                        | 124  | 40   |     | 220  | 32   | 136  | 305   | 283   | 140   | 232   | 54   | 85   | 136   |
| <b>Solar radiation (KWh/m2)</b>                       |      |      |     |      |      |      |       |       |       |       |      |      |       |
| Total                                                 | 40.7 | 7.7  | 0.0 | 0.7  | 12.7 | 84.0 | 170.9 | 201.6 | 187.5 | 160.4 | 55.1 | 62.6 | 983.8 |
| % valid obs                                           | 93   | 33   | 0   | 1    | 58   | 100  | 100   | 100   | 97    | 86    | 44   | 73   | 65    |

\*With the exception of March to May, the station worked only intermittently. Yearly summaries reflect missing data. <sup>2</sup>Station is only capable of measuring liquid precipitation. Precipitation reported when maximum air temperature is below 31.1 °F is not considered valid and these data are not used for summarizing purposes. The water equivalent of solid precipitation (e.g. snowfall) is not measured and this is reflected in the percentage of valid observations that are reported as a measure of the reliability of cumulative values.

## Appendix 36-A Climate Graph for Silver Salmon Lakes RAWS



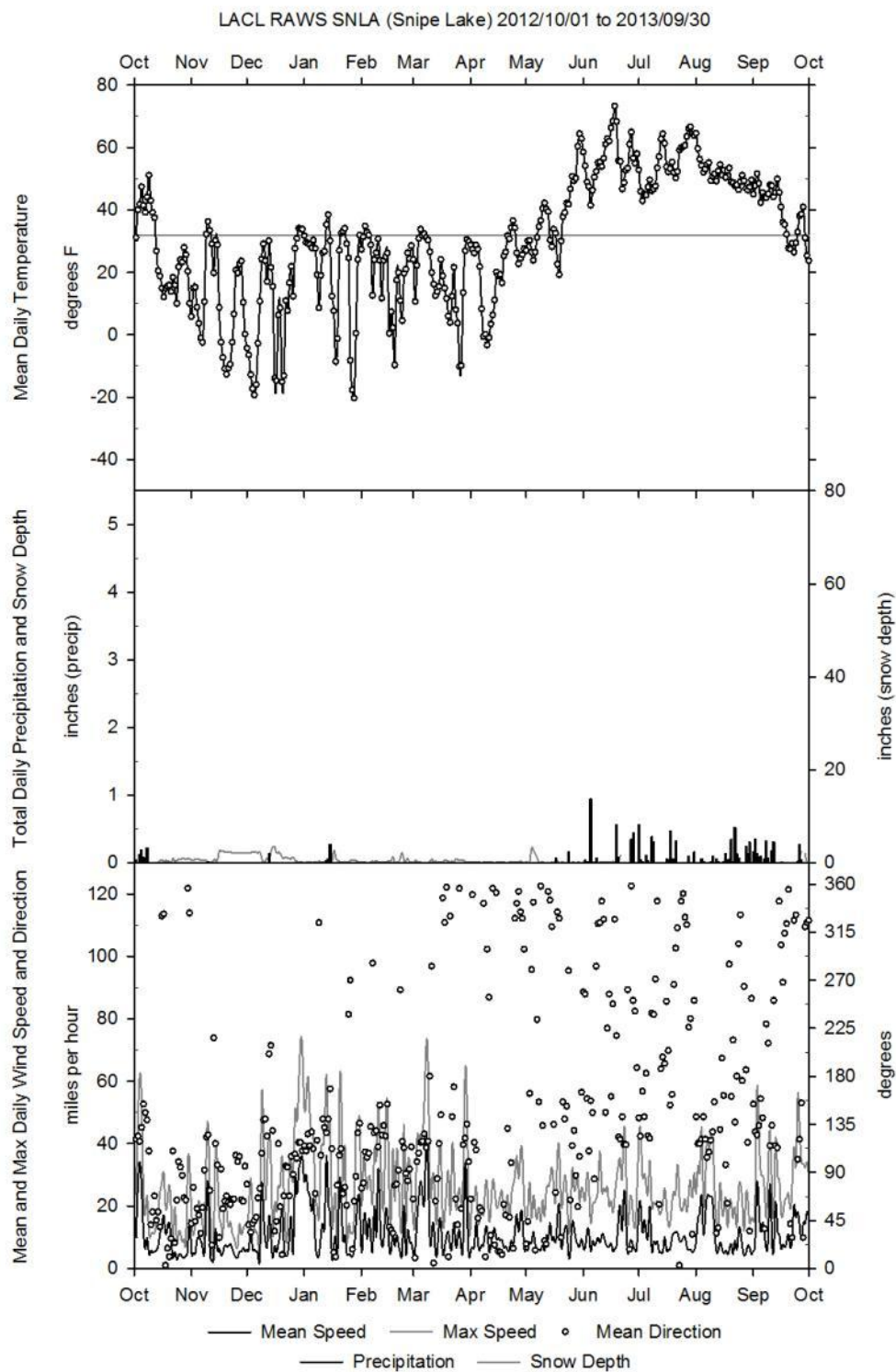
## Appendix 36-B Climate Table for Silver Salmon Lakes RAWS

| 2013 Hydrologic Year - LACL RAWS SISA (Silver Salmon Lakes) |     |     |     |     |     |     |     |     |     |       |      |      |       |
|-------------------------------------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-------|------|------|-------|
|                                                             | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul   | Aug  | Sep  | Year  |
| <b>Minimum air temperature (F)</b>                          |     |     |     |     |     |     |     |     |     |       |      |      |       |
| Min.*                                                       |     |     |     |     |     |     |     |     |     | 45.9  | 40.1 | 30.2 | 30.2  |
| Max.*                                                       |     |     |     |     |     |     |     |     |     | 55.0  | 55.9 | 51.1 | 55.9  |
| Mean*                                                       |     |     |     |     |     |     |     |     |     | 50.3  | 49.5 | 43.1 | 47.4  |
| # days <32 F*                                               |     |     |     |     |     |     |     |     |     | 0     | 0    | 2    | 2     |
| % valid obs                                                 | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 70    | 100  | 100  | 23    |
| <b>Maximum air temperature (F)</b>                          |     |     |     |     |     |     |     |     |     |       |      |      |       |
| Min*                                                        |     |     |     |     |     |     |     |     |     | 58.6  | 53.8 | 42.8 | 42.8  |
| Max*                                                        |     |     |     |     |     |     |     |     |     | 77.5  | 66.9 | 65.3 | 77.5  |
| Mean*                                                       |     |     |     |     |     |     |     |     |     | 67.1  | 59.7 | 54.8 | 59.8  |
| # days <32 F*                                               |     |     |     |     |     |     |     |     |     | 0     | 0    | 0    | 0     |
| % valid obs                                                 | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 70    | 100  | 100  | 23    |
| <b>Mean air temperature (F)</b>                             |     |     |     |     |     |     |     |     |     |       |      |      |       |
| Observed*                                                   |     |     |     |     |     |     |     |     |     | 58.6  | 54.3 | 48.7 | 53.4  |
| % valid obs                                                 | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 70    | 100  | 100  | 23    |
| POR mean<br>1981-2010                                       |     |     |     |     |     |     |     |     |     |       |      |      |       |
| <b>Precipitation</b>                                        |     |     |     |     |     |     |     |     |     |       |      |      |       |
| Total <sup>2</sup>                                          |     |     |     |     |     |     |     |     |     | 0.00  | 9.13 | 8.97 | 18.10 |
| % valid obs                                                 | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 70    | 100  | 100  | 23    |
| POR mean<br>1981-2010                                       |     |     |     |     |     |     |     |     |     |       |      |      |       |
| <b>Snow depth (in)</b>                                      |     |     |     |     |     |     |     |     |     |       |      |      |       |
| Average*                                                    |     |     |     |     |     |     |     |     |     | 0.0   | 0.3  | 0.2  |       |
| % valid obs                                                 | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0     | 2    | 16   |       |
| POR mean                                                    |     |     |     |     |     |     |     |     |     |       |      |      |       |
| <b>Wind (mph, degrees)</b>                                  |     |     |     |     |     |     |     |     |     |       |      |      |       |
| Mean speed*                                                 |     |     |     |     |     |     |     |     |     | 7.0   | 6.2  | 6.9  |       |
| % valid obs                                                 | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 70    | 100  | 100  |       |
| Max speed                                                   |     |     |     |     |     |     |     |     |     | 27.7  | 31.5 | 40.3 | 40.3  |
| Max direction                                               |     |     |     |     |     |     |     |     |     | 190   | 7    | 326  | 326   |
| <b>Solar radiation (KWh/m2)</b>                             |     |     |     |     |     |     |     |     |     |       |      |      |       |
| Total*                                                      |     |     |     |     |     |     |     |     |     | 148.1 | 77.6 | 65.4 | 291.1 |
| % valid obs                                                 | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 70    | 100  | 100  | 23    |

\*Station started operation on July 10, 2013. Yearly summaries reflect missing values.

<sup>2</sup>Station is only capable of measuring liquid precipitation. Precipitation reported when maximum air temperature is below 31.1 °F is not considered valid and these data are not used for summarizing purposes. The water equivalent of solid precipitation (e.g. snowfall) is not measured and this is reflected in the percentage of valid observations that are reported as a measure of the reliability of cumulative values.

## Appendix 37-A Climate Graph for Snipe Lake RAWS

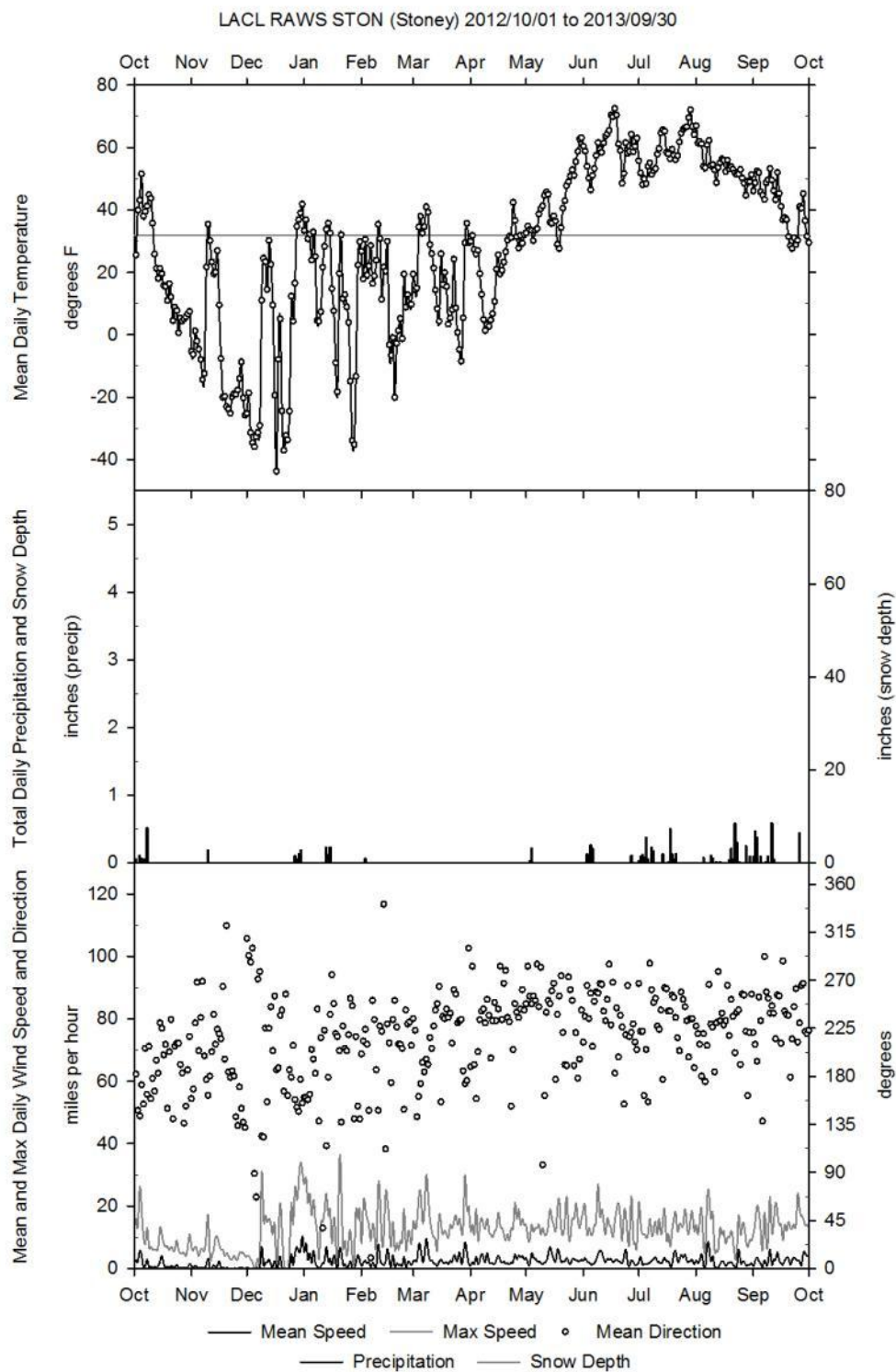


## Appendix 37-B Climate Table for Snipe Lake RAWS

| 2013 Hydrologic Year - LACL RAWS SNLA (Snipe Lake) |      |       |       |       |       |       |       |       |       |       |      |      |       |
|----------------------------------------------------|------|-------|-------|-------|-------|-------|-------|-------|-------|-------|------|------|-------|
|                                                    | Oct  | Nov   | Dec   | Jan   | Feb   | Mar   | Apr   | May   | Jun   | Jul   | Aug  | Sep  | Year  |
| <b>Minimum air temperature (F)</b>                 |      |       |       |       |       |       |       |       |       |       |      |      |       |
| Min.                                               | 1.2  | -15.0 | -25.1 | -27.0 | -19.5 | -18.0 | -9.8  | 11.3  | 32.0  | 38.1  | 40.8 | 18.7 | -27.0 |
| Max.                                               | 44.6 | 33.4  | 32.0  | 35.2  | 30.2  | 32.2  | 30.0  | 53.2  | 60.1  | 57.4  | 54.0 | 47.7 | 60.1  |
| Mean                                               | 21.2 | 4.3   | 3.1   | 12.2  | 11.8  | 12.1  | 12.1  | 30.5  | 46.9  | 48.5  | 46.0 | 33.9 | 23.6  |
| # days <32 F                                       | 22   | 29    | 30    | 30    | 28    | 30    | 30    | 17    | 0     | 0     | 0    | 12   | 228   |
| % valid obs                                        | 100  | 100   | 100   | 100   | 100   | 100   | 100   | 100   | 100   | 100   | 100  | 100  | 100   |
| <b>Maximum air temperature (F)</b>                 |      |       |       |       |       |       |       |       |       |       |      |      |       |
| Min                                                | 13.6 | -9.0  | -17.1 | -12.6 | 5.9   | -5.6  | 2.7   | 27.9  | 48.0  | 48.4  | 48.9 | 25.9 | -17.1 |
| Max                                                | 59.0 | 38.7  | 37.4  | 42.3  | 38.1  | 36.5  | 44.8  | 76.3  | 84.0  | 78.4  | 65.5 | 57.0 | 84.0  |
| Mean                                               | 33.2 | 16.9  | 16.7  | 26.2  | 27.1  | 24.4  | 27.7  | 46.8  | 65.3  | 63.4  | 57.4 | 45.1 | 37.6  |
| # days <32 F                                       | 15   | 25    | 23    | 18    | 19    | 22    | 15    | 4     | 0     | 0     | 0    | 2    | 143   |
| % valid obs                                        | 100  | 100   | 100   | 100   | 100   | 100   | 100   | 100   | 100   | 100   | 100  | 100  | 100   |
| <b>Mean air temperature (F)</b>                    |      |       |       |       |       |       |       |       |       |       |      |      |       |
| Observed                                           | 26.2 | 10.4  | 10.2  | 19.5  | 20.0  | 18.1  | 20.1  | 38.8  | 56.2  | 55.2  | 50.9 | 38.8 | 30.4  |
| % valid obs                                        | 100  | 100   | 100   | 100   | 100   | 100   | 100   | 100   | 100   | 100   | 100  | 100  | 100   |
| POR mean                                           |      |       |       |       |       |       |       |       |       |       |      |      |       |
| 1981-2010                                          |      |       |       |       |       |       |       |       |       |       |      |      |       |
| <b>Precipitation</b>                               |      |       |       |       |       |       |       |       |       |       |      |      |       |
| Total <sup>2</sup>                                 | 0.66 | 0.02  | 0.13  | 0.36  | 0.00  | 0.00  | 0.01  | 0.23  | 3.07  | 2.18  | 2.43 | 1.95 | 11.04 |
| % valid obs                                        | 36   | 12    | 19    | 24    | 16    | 16    | 22    | 72    | 100   | 100   | 100  | 77   | 50    |
| POR mean                                           |      |       |       |       |       |       |       |       |       |       |      |      |       |
| 1981-2010                                          |      |       |       |       |       |       |       |       |       |       |      |      |       |
| <b>Snow depth (in)</b>                             |      |       |       |       |       |       |       |       |       |       |      |      |       |
| Average                                            | 0.6  | 1.4   | 1.4   | 0.3   | 0.4   | 0.3   | 0.1   | 0.9   | 0.1   |       |      | 1.0  |       |
| % valid obs                                        | 60   | 100   | 98    | 94    | 93    | 86    | 53    | 36    | 19    | 0     | 0    | 10   |       |
| POR mean                                           |      |       |       |       |       |       |       |       |       |       |      |      |       |
| <b>Wind (mph, degrees)</b>                         |      |       |       |       |       |       |       |       |       |       |      |      |       |
| Mean speed                                         | 10.0 | 7.4   | 13.4  | 13.9  | 11.4  | 14.1  | 9.6   | 9.4   | 10.0  | 9.2   | 10.6 | 13.3 |       |
| % valid obs                                        | 100  | 100   | 100   | 100   | 100   | 100   | 100   | 100   | 100   | 100   | 100  | 100  |       |
| Max speed                                          | 62.2 | 45.9  | 72.7  | 62.2  | 52.1  | 71.8  | 37.1  | 37.6  | 45.0  | 44.3  | 45.4 | 57.9 | 72.7  |
| Max direction                                      | 119  | 118   | 119   | 121   | 121   | 117   | 338   | 307   | 120   | 124   | 93   | 128  | 119   |
| <b>Solar radiation (KWh/m2)</b>                    |      |       |       |       |       |       |       |       |       |       |      |      |       |
| Total                                              | 40.8 | 13.5  | 5.2   | 9.1   | 28.1  | 86.0  | 157.6 | 181.4 | 176.7 | 141.2 | 89.8 | 61.5 | 990.8 |
| % valid obs                                        | 100  | 100   | 100   | 100   | 100   | 100   | 100   | 100   | 100   | 100   | 100  | 100  | 100   |

<sup>2</sup>Station is only capable of measuring liquid precipitation. Precipitation reported when maximum air temperature is below 31.1 °F is not considered valid and these data are not used for summarizing purposes. The water equivalent of solid precipitation (e.g. snowfall) is not measured and this is reflected in the percentage of valid observations that are reported as a measure of the reliability of cumulative values.

## Appendix 38-A Climate Graph for Stoney RAWS

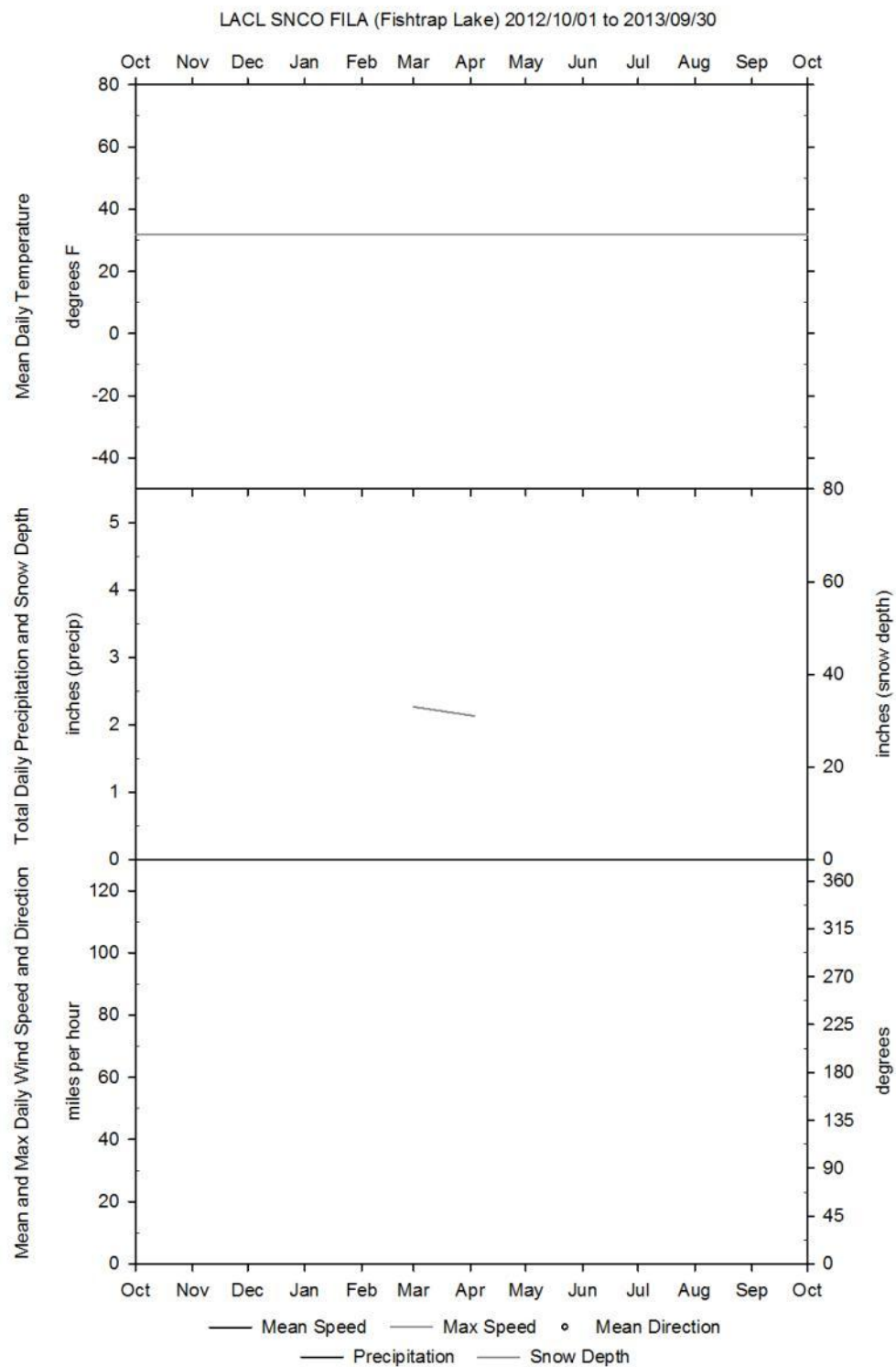


## Appendix 38-B Climate Table for Stoney RAWS

| 2013 Hydrologic Year - LACL RAWS STON (Stoney) |      |       |       |      |      |      |       |       |       |       |      |      |       |
|------------------------------------------------|------|-------|-------|------|------|------|-------|-------|-------|-------|------|------|-------|
|                                                | Oct  | Nov   | Dec   | Jan  | Feb  | Mar  | Apr   | May   | Jun   | Jul   | Aug  | Sep  | Year  |
| <b>Minimum air temperature (F)</b>             |      |       |       |      |      |      |       |       |       |       |      |      |       |
| Min.                                           | -18  | -33   | -47   | -46  | -38  | -35  | -23   | 12    | 26    | 31    | 27   | 4    | -47   |
| Max.                                           | 42   | 31    | 38    | 34   | 26   | 38   | 28    | 40    | 55    | 54    | 53   | 48   | 55    |
| Mean                                           | 8.3  | -15.0 | -13.4 | 1.6  | -1.6 | 3.4  | 2.7   | 24.7  | 40.3  | 43.9  | 42.0 | 30.3 | 14.1  |
| # days <32 F                                   | 25   | 30    | 30    | 30   | 28   | 28   | 30    | 24    | 4     | 1     | 2    | 16   | 248   |
| % valid obs                                    | 100  | 100   | 88    | 97   | 98   | 93   | 97    | 100   | 100   | 100   | 100  | 100  | 98    |
| <b>Maximum air temperature (F)</b>             |      |       |       |      |      |      |       |       |       |       |      |      |       |
| Min                                            | 17   | -9    | -34   | -14  | 0    | 3    | 15    | 34    | 59    | 53    | 49   | 33   | -34   |
| Max                                            | 65   | 40    | 45    | 42   | 45   | 53   | 58    | 84    | 94    | 89    | 77   | 63   | 94    |
| Mean                                           | 34.4 | 10.5  | 8.7   | 23.3 | 26.5 | 33.7 | 39.7  | 56.5  | 74.2  | 72.5  | 65.4 | 51.0 | 41.5  |
| # days <32 F                                   | 17   | 25    | 23    | 18   | 15   | 13   | 8     | 0     | 0     | 0     | 0    | 0    | 119   |
| % valid obs                                    | 100  | 100   | 88    | 97   | 98   | 93   | 97    | 100   | 100   | 100   | 100  | 100  | 98    |
| <b>Mean air temperature (F)</b>                |      |       |       |      |      |      |       |       |       |       |      |      |       |
| Observed                                       | 20.3 | -5.0  | 0.2   | 14.1 | 13.7 | 19.7 | 22.1  | 42.8  | 59.6  | 59.5  | 53.6 | 40.9 | 29.0  |
| % valid obs                                    | 100  | 100   | 88    | 97   | 98   | 93   | 97    | 100   | 100   | 100   | 100  | 100  | 98    |
| POR mean                                       |      |       |       |      |      |      |       |       |       |       |      |      |       |
| 1981-2010                                      |      |       |       |      |      |      |       |       |       |       |      |      |       |
| <b>Precipitation</b>                           |      |       |       |      |      |      |       |       |       |       |      |      |       |
| Total                                          | 0.87 | 0.19  | 0.51  | 0.58 | 0.08 | 0.01 | 0.00  | 0.25  | 0.77  | 2.11  | 1.96 | 2.17 | 9.50  |
| % valid obs                                    | 31   | 6     | 16    | 25   | 15   | 29   | 34    | 72    | 98    | 100   | 99   | 79   | 50    |
| POR mean                                       |      |       |       |      |      |      |       |       |       |       |      |      |       |
| 1981-2010                                      |      |       |       |      |      |      |       |       |       |       |      |      |       |
| <b>Snow depth (in)</b>                         |      |       |       |      |      |      |       |       |       |       |      |      |       |
| Average                                        |      |       |       |      |      |      |       |       |       |       |      |      |       |
| % valid obs                                    |      |       |       |      |      |      |       |       |       |       |      |      |       |
| POR mean                                       |      |       |       |      |      |      |       |       |       |       |      |      |       |
| <b>Wind (mph, degrees)</b>                     |      |       |       |      |      |      |       |       |       |       |      |      |       |
| Mean speed                                     | 1.3  | 0.5   | 2.5   | 2.6  | 2.2  | 3.4  | 2.8   | 3.0   | 2.7   | 2.6   | 2.1  | 2.8  |       |
| % valid obs                                    | 100  | 100   | 88    | 97   | 98   | 93   | 97    | 100   | 100   | 100   | 100  | 100  |       |
| Max speed                                      | 26.0 | 17.0  | 34.0  | 34.0 | 26.0 | 30.0 | 21.0  | 23.0  | 27.0  | 19.0  | 24.0 | 24.0 | 34.0  |
| Max direction                                  | 108  | 98    | 84    | 158  | 176  | 297  | 348   | 260   | 215   | 343   | 311  | 156  | 158   |
| <b>Solar radiation (KWh/m2)</b>                |      |       |       |      |      |      |       |       |       |       |      |      |       |
| Total                                          | 30.1 | 7.4   | 2.2   | 5.6  | 19.8 | 76.9 | 162.3 | 197.3 | 181.3 | 169.8 | 2.1  | 0.0  | 854.9 |
| % valid obs                                    | 100  | 100   | 88    | 97   | 97   | 93   | 96    | 100   | 100   | 100   | 2    | 0    | 81    |

<sup>2</sup>Station is only capable of measuring liquid precipitation. Precipitation reported when maximum air temperature is below 31.1 °F is not considered valid and these data are not used for summarizing purposes. The water equivalent of solid precipitation (e.g. snowfall) is not measured and this is reflected in the percentage of valid observations that are reported as a measure of the reliability of cumulative values.

## Appendix 39-A Climate Graph for Fishtrap Lake SNCO



## Appendix 39-B Climate Table for Fishtrap Lake SNCO

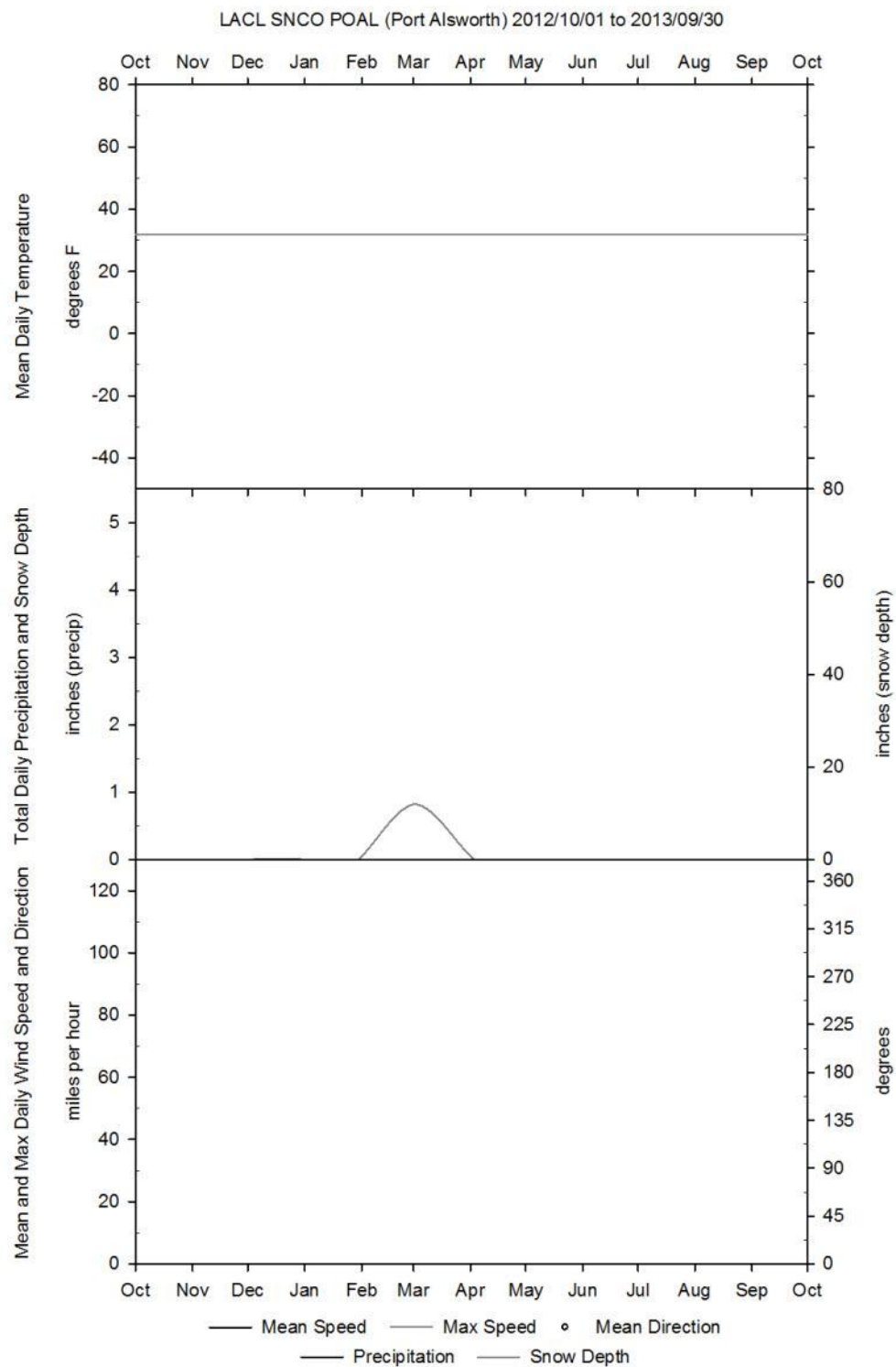
| 2013 Hydrologic Year - LACL SNCO FILA (Fishtrap Lake) |     |     |     |     |     |     |     |     |     |     |     |      |
|-------------------------------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|
|                                                       | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Year |
| <b>Minimum air temperature (F)</b>                    |     |     |     |     |     |     |     |     |     |     |     |      |
| Min.                                                  |     |     |     |     |     |     |     |     |     |     |     |      |
| Max.                                                  |     |     |     |     |     |     |     |     |     |     |     |      |
| Mean                                                  |     |     |     |     |     |     |     |     |     |     |     |      |
| # days <32 F                                          |     |     |     |     |     |     |     |     |     |     |     |      |
| % valid obs                                           |     |     |     |     |     |     |     |     |     |     |     |      |
| <b>Maximum air temperature (F)</b>                    |     |     |     |     |     |     |     |     |     |     |     |      |
| Min                                                   |     |     |     |     |     |     |     |     |     |     |     |      |
| Max                                                   |     |     |     |     |     |     |     |     |     |     |     |      |
| Mean                                                  |     |     |     |     |     |     |     |     |     |     |     |      |
| # days <32 F                                          |     |     |     |     |     |     |     |     |     |     |     |      |
| % valid obs                                           |     |     |     |     |     |     |     |     |     |     |     |      |
| <b>Mean air temperature (F)</b>                       |     |     |     |     |     |     |     |     |     |     |     |      |
| Observed                                              |     |     |     |     |     |     |     |     |     |     |     |      |
| % valid obs                                           |     |     |     |     |     |     |     |     |     |     |     |      |
| POR mean                                              |     |     |     |     |     |     |     |     |     |     |     |      |
| 1981-2010                                             |     |     |     |     |     |     |     |     |     |     |     |      |
| <b>Precipitation</b>                                  |     |     |     |     |     |     |     |     |     |     |     |      |
| Total <sup>3</sup>                                    |     |     |     |     | 7.9 | 8.6 |     |     |     |     |     |      |
| % valid obs                                           |     | 0   | 0   | 0   | 100 | 100 | 0   |     |     |     |     |      |
| POR mean                                              |     |     |     |     |     |     |     |     |     |     |     |      |
| 1981-2010 <sup>5</sup>                                |     |     |     | 6.6 | 9.5 | 9.5 |     |     |     |     |     |      |
| <b>Snow depth (in)</b>                                |     |     |     |     |     |     |     |     |     |     |     |      |
| Average <sup>4</sup>                                  |     |     |     |     | 33  | 31  |     |     |     |     |     |      |
| % valid obs                                           |     | 0   | 0   | 0   | 100 | 100 | 0   |     |     |     |     |      |
| POR mean <sup>5</sup>                                 |     |     |     | 30  | 38  | 36  |     |     |     |     |     |      |
| <b>Wind (mph, degrees)</b>                            |     |     |     |     |     |     |     |     |     |     |     |      |
| Mean speed                                            |     |     |     |     |     |     |     |     |     |     |     |      |
| % valid obs                                           |     |     |     |     |     |     |     |     |     |     |     |      |
| Max speed                                             |     |     |     |     |     |     |     |     |     |     |     |      |
| Max direction                                         |     |     |     |     |     |     |     |     |     |     |     |      |
| <b>Solar radiation (KWh/m2)</b>                       |     |     |     |     |     |     |     |     |     |     |     |      |
| Total                                                 |     |     |     |     |     |     |     |     |     |     |     |      |
| % valid obs                                           |     |     |     |     |     |     |     |     |     |     |     |      |

<sup>3</sup>Snow water equivalent measured close to the end of the month listed.

<sup>4</sup>Cummulative snow depth measured close to the end of the month listed.

<sup>5</sup>Values cited are from National Water and Climate Data Center (current Feb. 7, 2014)

## Appendix 40-A Climate Graph for Port Alsworth SNCO



## Appendix 40-B Climate Table for Port Alsworth SNCO

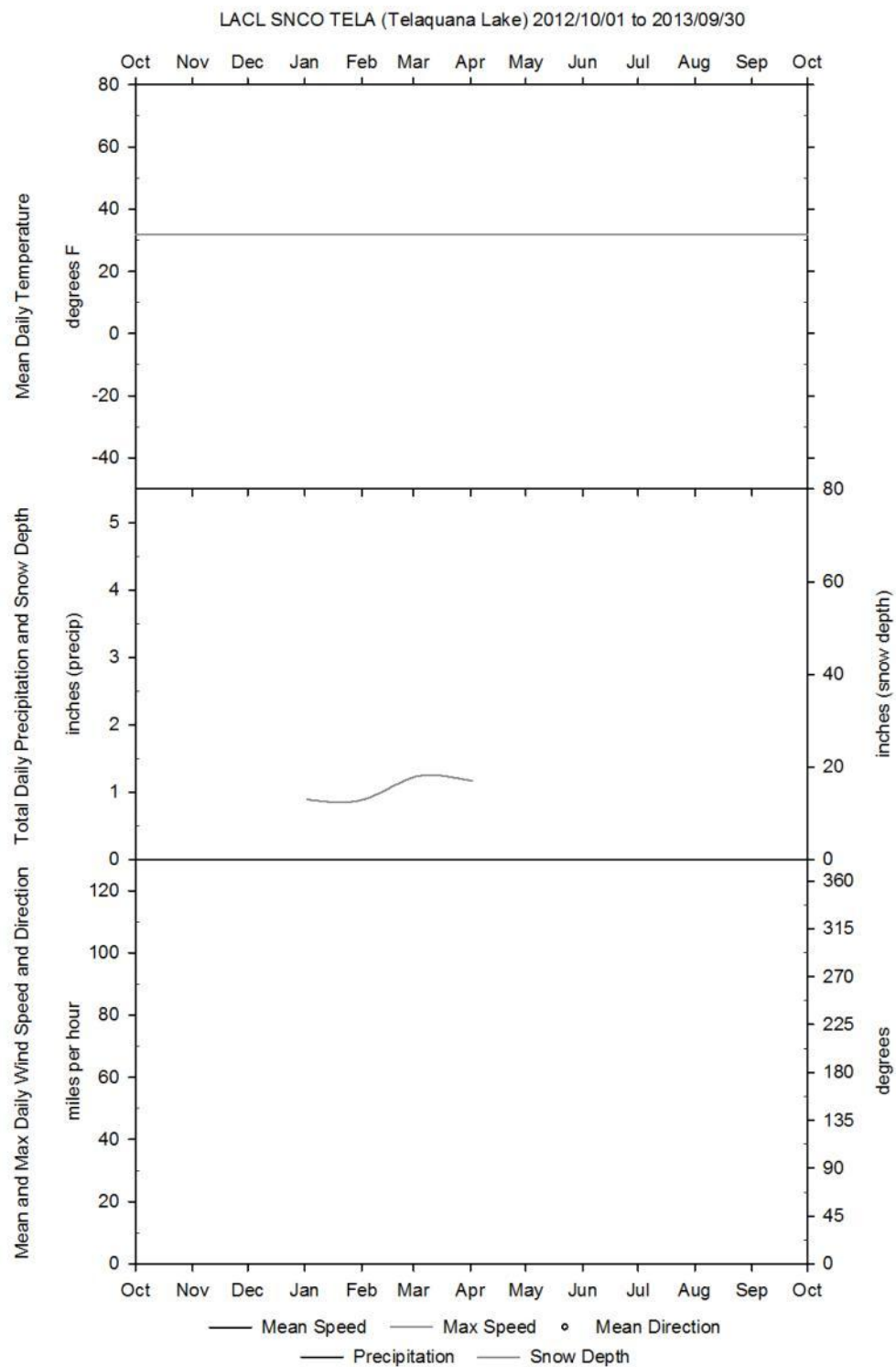
| 2013 Hydrologic Year - LACL SNCO POAL (Port Alsworth) |     |     |     |     |     |     |     |     |     |     |     |      |
|-------------------------------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|
|                                                       | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Year |
| <b>Minimum air temperature (F)</b>                    |     |     |     |     |     |     |     |     |     |     |     |      |
| Min.                                                  |     |     |     |     |     |     |     |     |     |     |     |      |
| Max.                                                  |     |     |     |     |     |     |     |     |     |     |     |      |
| Mean                                                  |     |     |     |     |     |     |     |     |     |     |     |      |
| # days <32 F                                          |     |     |     |     |     |     |     |     |     |     |     |      |
| % valid obs                                           |     |     |     |     |     |     |     |     |     |     |     |      |
| <b>Maximum air temperature (F)</b>                    |     |     |     |     |     |     |     |     |     |     |     |      |
| Min                                                   |     |     |     |     |     |     |     |     |     |     |     |      |
| Max                                                   |     |     |     |     |     |     |     |     |     |     |     |      |
| Mean                                                  |     |     |     |     |     |     |     |     |     |     |     |      |
| # days <32 F                                          |     |     |     |     |     |     |     |     |     |     |     |      |
| % valid obs                                           |     |     |     |     |     |     |     |     |     |     |     |      |
| <b>Mean air temperature (F)</b>                       |     |     |     |     |     |     |     |     |     |     |     |      |
| Observed                                              |     |     |     |     |     |     |     |     |     |     |     |      |
| % valid obs                                           |     |     |     |     |     |     |     |     |     |     |     |      |
| POR mean                                              |     |     |     |     |     |     |     |     |     |     |     |      |
| 1981-2010                                             |     |     |     |     |     |     |     |     |     |     |     |      |
| <b>Precipitation</b>                                  |     |     |     |     |     |     |     |     |     |     |     |      |
| Total <sup>3</sup>                                    |     |     |     | 0.0 | 2.6 | 0.0 | 0.0 |     |     |     |     |      |
| % valid obs                                           |     | 0   | 0   | 100 | 100 | 100 | 100 |     |     |     |     |      |
| POR mean                                              |     |     |     |     |     |     |     |     |     |     |     |      |
| 1981-2010 <sup>5</sup>                                |     |     |     | 3.1 | 3.6 | 3.3 |     |     |     |     |     |      |
| <b>Snow depth (in)</b>                                |     |     |     |     |     |     |     |     |     |     |     |      |
| Average <sup>4</sup>                                  |     | 0   | 0   | 0   | 12  | 0   | 0   |     |     |     |     |      |
| % valid obs                                           |     |     |     | 100 | 100 | 100 | 100 |     |     |     |     |      |
| POR mean <sup>5</sup>                                 |     |     |     | 14  | 14  | 11  |     |     |     |     |     |      |
| <b>Wind (mph, degrees)</b>                            |     |     |     |     |     |     |     |     |     |     |     |      |
| Mean speed                                            |     |     |     |     |     |     |     |     |     |     |     |      |
| % valid obs                                           |     |     |     |     |     |     |     |     |     |     |     |      |
| Max speed                                             |     |     |     |     |     |     |     |     |     |     |     |      |
| Max direction                                         |     |     |     |     |     |     |     |     |     |     |     |      |
| <b>Solar radiation (KWh/m2)</b>                       |     |     |     |     |     |     |     |     |     |     |     |      |
| Total                                                 |     |     |     |     |     |     |     |     |     |     |     |      |
| % valid obs                                           |     |     |     |     |     |     |     |     |     |     |     |      |

<sup>3</sup>Snow water equivalent measured close to the end of the month listed.

<sup>4</sup>Cummulative snow depth measured close to the end of the month listed.

<sup>5</sup>Values cited are from National Water and Climate Data Center (current Feb. 7, 2014).

## Appendix 41-A Climate Graph for Telaquana Lake SNCO



## Appendix 41-B Climate Table for Telaquana Lake SNCO

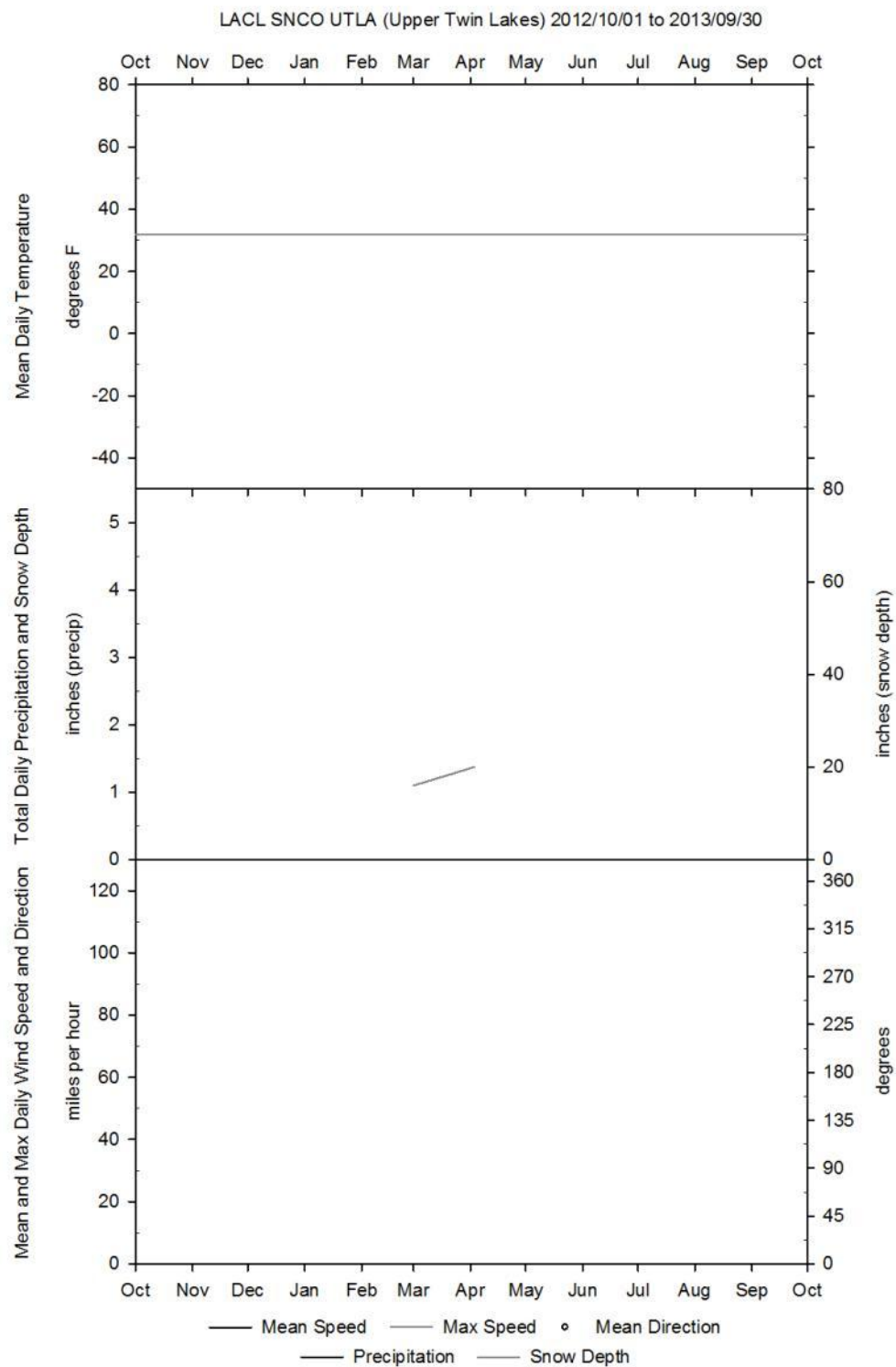
| 2013 Hydrologic Year - LACL SNCO TELA (Telaquana Lake) |     |     |     |     |     |     |     |     |     |     |     |      |
|--------------------------------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|
|                                                        | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Year |
| <b>Minimum air temperature (F)</b>                     |     |     |     |     |     |     |     |     |     |     |     |      |
| Min.                                                   |     |     |     |     |     |     |     |     |     |     |     |      |
| Max.                                                   |     |     |     |     |     |     |     |     |     |     |     |      |
| Mean                                                   |     |     |     |     |     |     |     |     |     |     |     |      |
| # days <32 F                                           |     |     |     |     |     |     |     |     |     |     |     |      |
| % valid obs                                            |     |     |     |     |     |     |     |     |     |     |     |      |
| <b>Maximum air temperature (F)</b>                     |     |     |     |     |     |     |     |     |     |     |     |      |
| Min                                                    |     |     |     |     |     |     |     |     |     |     |     |      |
| Max                                                    |     |     |     |     |     |     |     |     |     |     |     |      |
| Mean                                                   |     |     |     |     |     |     |     |     |     |     |     |      |
| # days <32 F                                           |     |     |     |     |     |     |     |     |     |     |     |      |
| % valid obs                                            |     |     |     |     |     |     |     |     |     |     |     |      |
| <b>Mean air temperature (F)</b>                        |     |     |     |     |     |     |     |     |     |     |     |      |
| Observed                                               |     |     |     |     |     |     |     |     |     |     |     |      |
| % valid obs                                            |     |     |     |     |     |     |     |     |     |     |     |      |
| POR mean                                               |     |     |     |     |     |     |     |     |     |     |     |      |
| 1981-2010                                              |     |     |     |     |     |     |     |     |     |     |     |      |
| <b>Precipitation</b>                                   |     |     |     |     |     |     |     |     |     |     |     |      |
| Total <sup>3</sup>                                     |     |     | 2.6 | 3.0 | 4.0 | 4.4 |     |     |     |     |     |      |
| % valid obs                                            |     | 0   | 100 | 100 | 100 | 100 | 0   |     |     |     |     |      |
| POR mean                                               |     |     |     |     |     |     |     |     |     |     |     |      |
| 1981-2010 <sup>5</sup>                                 |     |     |     | 4.4 | 4.6 |     |     |     |     |     |     |      |
| <b>Snow depth (in)</b>                                 |     |     |     |     |     |     |     |     |     |     |     |      |
| Average <sup>4</sup>                                   |     |     | 13  | 13  | 18  | 17  |     |     |     |     |     |      |
| % valid obs                                            |     | 0   | 100 | 100 | 100 | 100 | 0   |     |     |     |     |      |
| POR mean <sup>5</sup>                                  |     |     |     | 20  | 19  |     |     |     |     |     |     |      |
| <b>Wind (mph, degrees)</b>                             |     |     |     |     |     |     |     |     |     |     |     |      |
| Mean speed                                             |     |     |     |     |     |     |     |     |     |     |     |      |
| % valid obs                                            |     |     |     |     |     |     |     |     |     |     |     |      |
| Max speed                                              |     |     |     |     |     |     |     |     |     |     |     |      |
| Max direction                                          |     |     |     |     |     |     |     |     |     |     |     |      |
| <b>Solar radiation (KWh/m2)</b>                        |     |     |     |     |     |     |     |     |     |     |     |      |
| Total                                                  |     |     |     |     |     |     |     |     |     |     |     |      |
| % valid obs                                            |     |     |     |     |     |     |     |     |     |     |     |      |

<sup>3</sup>Snow water equivalent measured close to the end of the month listed.

<sup>4</sup>Cummulative snow depth measured close to the end of the month listed.

<sup>5</sup>Values cited are from National Water and Climate Data Center (current Feb. 7, 2014).

## Appendix 42-A Climate Graph for Upper Twin Lakes SNCO



## Appendix 42-B Climate Table for Upper Twin Lakes SNCO

| 2013 Hydrologic Year - LACL SNCO UTLA (Upper Twin Lakes) |     |     |     |     |     |     |     |     |     |     |     |     |      |
|----------------------------------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|
|                                                          | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Year |
| <b>Minimum air temperature (F)</b>                       |     |     |     |     |     |     |     |     |     |     |     |     |      |
| Min.                                                     |     |     |     |     |     |     |     |     |     |     |     |     |      |
| Max.                                                     |     |     |     |     |     |     |     |     |     |     |     |     |      |
| Mean                                                     |     |     |     |     |     |     |     |     |     |     |     |     |      |
| # days <32 F                                             |     |     |     |     |     |     |     |     |     |     |     |     |      |
| % valid obs                                              |     |     |     |     |     |     |     |     |     |     |     |     |      |
| <b>Maximum air temperature (F)</b>                       |     |     |     |     |     |     |     |     |     |     |     |     |      |
| Min                                                      |     |     |     |     |     |     |     |     |     |     |     |     |      |
| Max                                                      |     |     |     |     |     |     |     |     |     |     |     |     |      |
| Mean                                                     |     |     |     |     |     |     |     |     |     |     |     |     |      |
| # days <32 F                                             |     |     |     |     |     |     |     |     |     |     |     |     |      |
| % valid obs                                              |     |     |     |     |     |     |     |     |     |     |     |     |      |
| <b>Mean air temperature (F)</b>                          |     |     |     |     |     |     |     |     |     |     |     |     |      |
| Observed                                                 |     |     |     |     |     |     |     |     |     |     |     |     |      |
| % valid obs                                              |     |     |     |     |     |     |     |     |     |     |     |     |      |
| POR mean                                                 |     |     |     |     |     |     |     |     |     |     |     |     |      |
| 1981-2010                                                |     |     |     |     |     |     |     |     |     |     |     |     |      |
| <b>Precipitation</b>                                     |     |     |     |     |     |     |     |     |     |     |     |     |      |
| Total <sup>3</sup>                                       |     |     |     |     | 3.0 | 4.5 |     |     |     |     |     |     |      |
| % valid obs                                              |     | 0   | 0   | 0   | 100 | 100 | 0   |     |     |     |     |     |      |
| POR mean                                                 |     |     |     |     |     |     |     |     |     |     |     |     |      |
| 1981-2010                                                |     |     |     |     |     |     |     |     |     |     |     |     |      |
| <b>Snow depth (in)</b>                                   |     |     |     |     |     |     |     |     |     |     |     |     |      |
| Average <sup>4</sup>                                     |     |     |     |     | 16  | 20  |     |     |     |     |     |     |      |
| % valid obs                                              |     | 0   | 0   | 0   | 100 | 100 | 0   |     |     |     |     |     |      |
| 1981-2010 <sup>5</sup>                                   |     |     |     |     |     |     |     |     |     |     |     |     |      |
| <b>Wind (mph, degrees)</b>                               |     |     |     |     |     |     |     |     |     |     |     |     |      |
| Mean speed                                               |     |     |     |     |     |     |     |     |     |     |     |     |      |
| % valid obs                                              |     |     |     |     |     |     |     |     |     |     |     |     |      |
| Max speed                                                |     |     |     |     |     |     |     |     |     |     |     |     |      |
| Max direction                                            |     |     |     |     |     |     |     |     |     |     |     |     |      |
| <b>Solar radiation (KWh/m2)</b>                          |     |     |     |     |     |     |     |     |     |     |     |     |      |
| Total                                                    |     |     |     |     |     |     |     |     |     |     |     |     |      |
| % valid obs                                              |     |     |     |     |     |     |     |     |     |     |     |     |      |

<sup>3</sup>Snow water equivalent measured close to the end of the month listed.

<sup>4</sup>Cumulative snow depth measured close to the end of the month listed.

<sup>5</sup>Values cited are from National Water and Climate Data Center (current Feb. 7, 2014).



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